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**Examining Three-way Interaction Effects of Dual N-back
Working Memory Training, Metamemory, and Anxiety Levels
on L2 Writing Performance**

**The Case of Second Year EFL Students at the University of Larbi Ben
M'hidi, Oum El Bouaghi**

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Dedication

I dedicate this work to my family: my husband, my mother, father, and my brothers.

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List of Abbreviations

ACT: attentional control theory

ANOVA: Analysis of Variance

ANCOVA: Analysis of Covariance

AS: auditory stimulus/stimuli

AT: Auditory target

CG: control group

CE: central executive

EB: episodic buffer

EFL: English as a foreign language

EG: Experimental group

ELAS: English learning anxiety scale

EOL: ease of learning

EFL: English as a foreign language

ESL: English as a second language

FLA: foreign language anxiety

FLCAC: Foreign language classroom anxiety scale

FOK: feeling of knowing

JOL: judgment of learning

L1: first language

L2: second language

LAD: language acquisition device

LAWPA: Lexical access without phonological access

LTM: long term memory

M: mean

MFQ: Memory Functioning Questionnaire

MIA: Metamemory in Adulthood Questionnaire

MMQ: Multifactorial memory Questionnaire

Ms: milliseconds

OSPAN: Operation span

PET: processing efficiency theory

PL: phonological loop

PTA: partial-target access

RST: reading span task

SD: standard deviation

SLA: second language acquisition

SLWA: second language writing anxiety

SLWAI: second language writing anxiety inventory

SPSS: Statistical Package for the Social Sciences

STM: Short term memory

TOT: tip of the tongue

VS: visual Stimulus/stimuli

VT: visual target

VSS: visuospatial sketchpad

WM: working memory

WMC: working memory capacity

WMT: Working memory training

Abstract

As a vital constituent of any human function, working memory (WM) is a complex construct that has gained the attention of second language researchers. Likewise, dual N-back WM training has attracted the attention of researchers, yet claims of improving untrained tasks with WM training have been highly controversial. This study attempts to put these claim to the test by implementing the dual N-back program in the language learning classroom in aims of assessing its effect on second language writing performance. The study not only examines the main treatment effect on writing, but it also tests for a two-way treatment-anxiety interaction effect, two-way treatment-metamemory interaction effect, and a three-way treatment-anxiety-metamemory interaction effect. The sample comprised 80 second year learners of EFL at the University of Larbi Ben M'hidi in Oum El Bouaghi, 42 of whom were allocated to the control group (CG), and the other 38 were allocated to the experimental group (EG). The EG received a treatment of dual N-back WM training for a duration of eight weeks while the CG was not manipulated. All writing scores were measured before and after the intervention in order to assess differences in group means. Anxiety and metamemory levels were measured using self-report questionnaires: the Multifactorial Metamemory Questionnaire and the Second Language Writing Anxiety Inventory. Results from Pearson's correlation analysis, Spearman's correlation analysis, ANCOVA, two-way ANOVA, and three-way ANOVA have revealed that writing scores are significantly correlated with anxiety but not metamemory. The EG outperformed the CG in the post-test after controlling for pre-test scores. Results also revealed a significant treatment-anxiety interaction effect but a non-significant treatment-metamemory interaction effect and a non-significant three-way interaction effects between all three independent variables.

Key Words: Working memory, dual N-back, metamemory, anxiety, L2 writing

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General Introduction

1. Background

Originally devised by Miller, Galanter, and Pribram in the 1960s (Baddeley, 2010), the term working memory is often defined as the system responsible for storage and processing of information (Baddeley, 2000). Atkinson and Shiffrin (1968) label it what researchers now describe as a short-term store. A distinction between WM and Short-term Memory (STM), however, has been made in order to emphasize the dynamic and active nature of the former in contradistinction to the latter's static nature (Cowan, 2008; Diamond, 2013). The source of this differentiation can be traced back to Baddeley and Hitch's (1974) original and groundbreaking multicomponent model of WM.

Since the development of Baddeley and Hitch's model, the fields of psychology, neurology, and cognitive science— among others— have seen burgeoning attempts at understanding the nature and significance of this processing system. The literature has thus far established an association between WMC and performance in various cognitive tasks, ranging from academic achievement and fluid intelligence to executive functioning and problem solving (Swanson, & Beebe-Frankenberger, 2004; Wiley & Jarosz, 2012).

In addition to the aforementioned cognitive tasks, Gathercole and Baddeley (1993) assert that WM plays a crucial role in various language tasks: reading, speech production, vocabulary, and comprehension. The vital role of WM in language acquisition and processing is anything but a surprise considering that one of the main components of WM (as a system) is a component solely responsible for processing language: the phonological loop (PL) (Baddeley, 2000; Baddeley, 2010; Baddeley, Gathercole & Papagno, 1998). Furthermore, in the domain of second language (L2)

learning, numerous researchers suggest that WM is a critical constituent of L2 aptitude (Skehan, 2002).

Empirical research into the relationship between the two constructs has been conducted by numerous researchers. For instance, Yalçın, Çeçen, and Erçetin (2016) test for the widely-theorized role of WMC in language aptitude, establishing a significant correlation between the two constructs. Likewise, Archibald (2017) illustrates a reciprocal relationship between WMC and language learning, asserting that scarce language knowledge increases the load placed on the PL since it would have to process and retain unfamiliar information; likewise, a limited WMC may lead to less efficient language encoding and retention.

In their meta-analysis of the relationship between WM and L2 production and comprehension, Linck, Osthus, Koeth and Bunting (2014) examine 79 samples containing over 3000 participants. The authors establish a positive correlation between WM and L2 production and processing. The increasing interest in WM and language is reflected in the recent integration of WM in the study of L2 acquisition and learning. The significant role of WM has been illustrated particularly in the domain of grammar (French & O'Brien, 2008), speaking (O'Brien, Segalowitz, Collentine & Freed, 2006), reading, and general proficiency (vanDen Noort, Bosch & Hugdahl, 2006).

In addition to aforementioned aspects of language learning, WM is also believed to play a crucial role in writing. This critical role is initially highlighted by Hayes (1996) in his model of writing and by Kellogg (1996) in his model of WM in writing. Likewise, McCutchen (1996) asserts that the limited storage capacity of WM limits processing capacity devoted to writing. This is illustrated by Olive (2012) as he states that “when processing requires more working memory capacity, less capacity is available for storing information, and vice versa” (p.486). Lu (2015) also

states that “language learners, when they are writing in their L2, they must use part of their cognitive resources to focus on the language so that other functions, such as higher-order functions for organization and discourse cannot be engaged at full capacity” (p.176).

Olive (2012) also explains how competent writers must switch back and forth between the various writing processes, a task that would demand more WMC. This increase in demand serves as a disadvantage for those with lower WMC. Hence, the various demands placed on WM during the writing process compete for scarce WM resources (Kellogg, Olive, & Piolat, 2007). In their study, McCutchen, Covill, Hoynes, and Mildes (1994) report that WMC influenced the quality of texts produced by writers. Those with higher WMC wrote better than those with lower WMC. Bergsleithner (2010) establish a direct and significant causal relationship between WM and writing performance, especially accuracy and complexity. Likewise, Yi and Luo (2013) report a significant association between WM and writing accuracy.

The literature that has been reviewed thus far provides sufficient evidence for the role of WM in L2 writing. To the researcher’s knowledge, however, no intervention of dual N-back WMT has been conducted in attempts at improving L2 writing performance. The literature on dual N-back WMT is vast and relatively inconsistent. Various researchers claim that the training program leads to significant far-transfer effects; that is, the training program improves not just WM-related tasks, but also other skills like fluid intelligence and problem solving (Soveri, Antfolk, Karlsson, Salo & Laine, 2017). Other researchers, however, claim that dual N-back training only does what any other training does: it improves performance in the trained task (Soveri et al., 2017). This study is thus driven by the gap in the literature. It first seeks to implement dual N-back WMT within the L2 paradigm. Secondly, it seeks to be one more piece of empirical evidence contributing to one of the two conflicting viewpoints of the dual N-back paradigm.

The two constructs of WM and L2 writing, however, are anything but simple constructs. The two variables under research may likely be influenced by other variables. Accordingly, the current study has adopted two variables as potential moderator in the relationship between WM and L2 writing, which are anxiety and metamemory. The literature presents an abundance of evidence in support of the assertion that text production is highly influenced by affective variables— one of the most influential variables being anxiety. Performance on written composition is believed to be hindered by high levels of anxiety, especially among language learners. In addition to L2 performance, anxiety is also often reported as a significant predictor of WM processing. Moran (2016) supports this assertion by conducting a meta-analysis comprising 177 samples containing over 22,000 participants, which revealed a significant negative correlation between anxiety and WMC.

The literature has also provided evidence for metacognition— specifically metamemory— being associated with writing as well as WM. Magno (2008), for instance, found a positive relationship between metamemory and writing performance. Henry (2000) and Troyer and Rich (2002) established a positive correlation between metamemory and WM. The two variables metamemory and anxiety are relevant for to the current study since they are assumed to affect both of the main variables (WM and L2 writing). Anxiety levels are believed to negatively affect both L2 performance and WM. Hence, more anxious students are predicted to be affected by the intervention differently compared to their less anxious counterparts. Metamemory, on the other hand, is believed to positively affect L2 performance and WM. Again, those with higher metamemory levels are predicted to react differently to the treatment compared to those with low metamemory levels.

Accordingly, in adopting anxiety and metamemory as potential moderator variables in the current study, the researcher has sought to examine whether the two variables interact with the intervention of dual N-back WMT and moderate its effect on L2 writing performance. This, also, is part of the attempt to reduce the gap in the literature since the researcher has yet to find any studies examining anxiety-WM interaction effects or any studies examining metamemory-WM interaction effects.

2. Problem Identification

In order to skillfully produce a complete and effective composition, a writer must master a range of categories of skills: grammar, vocabulary, punctuation, structure, coherence, and pragmatic knowledge. These are just several of the vast range of skills a writer needs to master in order to successfully complete a piece of writing. Accordingly, mastery of each skill serves as a demand that must be met by the writer. The writer is thus faced with the task of constantly juggling various demands while trying to translate his/her thoughts on paper (Olive, 2012). Moreover, information needed to carry out or process the various demands is stored in working memory (WM) (Olive, 2012). The function of WM is to temporarily store information being processed by an individual (Baddeley, 2000). For instance, as individuals are writing their thoughts on paper, they must constantly retain in their WM the initial question or prompt so as not to stray away from the topic. At the same time, they must retain in their WM any linguistic or non-linguistic rules that must be employed in their composition, and they must do all of this while retaining any content knowledge that may have been generated throughout the writing process.

These are just some of examples of what WM is responsible for storing throughout the writing process. However, WM capacity (WMC) is limited (Baddeley, 2000; Cowan, 2010). As a consequence of the limited nature of WMC (which is needed to store information for such tasks)

and the numerous demands placed on the writer throughout the process of text production, s/he often experiences a cognitive overload (Kellogg, 2008). In such case, information needed to be stored and processed exceeds storage and processing capacity of WM. For this reason, it appears that writers— especially English as a Foreign Language (EFL) writers— fall back when it comes to producing an effective text that succeeds in meeting all the demands of writing (Olson, Scarcella, & Matuchniak, 2014). It seems that EFL writers often have the necessary knowledge to successfully meet each demand in isolation. However, when it comes to managing all of them simultaneously—especially in a timed writing task— these learners often produce insufficient texts (Olson, Scarcella, & Matuchniak, 2014). A perfectly grammatical essay, for instance, may lack variety or coherence. Likewise, a coherent essay may lack in content or punctuation, or vice versa.

This problem is particularly evident in the Algerian context. Mohamed and Zouaoui (2014) highlight Algerian EFL learners' struggle in mastering the skill of writing despite having spent five to seven years learning English at a tertiary level. The authors attribute this lack of mastery to students not being equipped with essential pre-requisites upon entering the tertiary level and to teaching and learning methods adopted with the Licence-Master-Doctorat (LMD) system. In examining Algerian EFL learners' essays, Boucherfa (2015) reports that, at best, only 15% of the sample in his study wrote satisfactory essays with a clear and logical position, well-developed ideas, and overall accurate inter- and intra- sentence structure. The small percentage of participants who wrote merely satisfactory essays is a reflection of the writing deficit present among Algerian EFL learners. Boucherfa (2015) also notes that overall, learners performed better when writing essays that simply required them to re-write information they had memorized than when writing essays that required them to generate their own ideas and expand on them. This is an indication

that the processes of idea generation and/or execution are of a significant hurdle for learners, particularly when faced with the already-tedious task of accurately executing the linguistic demands of writing. Accordingly, the hurdle of trying to juggle these demands at once seems to lead to a discrepancy that appears to be the product of an overload in WM processing and/or storage capacity.

Since smaller WMC is believed to be responsible for more strain being placed on an individual, it should be the case that an increase in WMC should reduce the cognitive load. For this reason, this study attempts to examine whether WM training (WMT)— implemented in an attempt to increase WMC—is effective in decreasing cognitive load associated with writing and consequently improving writing performance.

3. Research Questions

This study has adopted the following research questions:

1. To what extent is EFL learners' writing performance associated with their writing anxiety levels?
2. To what extent is EFL learners' writing performance associated with their metamemory levels?
3. How does dual N-back WMT affect EFL learners' writing performance?
4. To what extent is there a two-way interaction effect of each of the two moderating variables (metamemory and anxiety) on dual N-back WMT in its effect on L2 writing performance?
5. To what extent is there a three-way interaction effect of the two moderating variables on the intervention in its effect on L2 writing performance?

4. Hypotheses

The study set out to test the following hypotheses:

H₁: A significant negative correlation exists between EFL learners' anxiety levels and their writing performance.

H₂: Learners' metamemory levels are positively correlated with their writing performance.

H₃: There is no main treatment effect of dual N-back WMT on EFL learners' writing performance.

H₄: There is a significant positive metamemory-treatment and negative anxiety-treatment two-way interaction effect on L2 writing performance.

H₅: There is a significant three-way interaction effect of dual N-back WMT and the moderating variables on writing performance.

5. Aim

The aim of this study is twofold. First, the study aims to replicate and put to the test the claim that dual N-back WMT is effective in improving un-trained tasks such as writing performance—a claim that has raised considerable controversy among researchers. Second, the study aims to examine the extent to which this intervention of dual N-back WMT affects EFL learners' writing performance. Not only does the study aim to examine the main effect of the treatment on writing performance, but it also seeks to examine how two other variables— anxiety and metamemory— come into play and affect the relationship between the treatment and writing performance. In doing so, the researcher aims to gain a better understanding of the nature of the writing process, a process considered by the researcher as remarkably complex and intricate. In gaining an understanding of how different variables interact in their effect on learners' performance, the researcher aims to provide practical explanations and perhaps recommendations for solving some problems encountered by EFL learners in the writing classroom and maybe even beyond.

6. Significance of the Study

The present study seeks to be one stepping stone towards filling the gap that exists in the literature. The literature on WMT has been quite controversial in the past decade. With some

researchers believing that WMT is effective at causing far-transfer effects and improving untrained tasks and others believing that it is only effective at improving what was initially being trained, this study contributes to the literature by providing more insight into how effective WMT really is at improving untrained tasks. Furthermore, this study provides significant empirical evidence in support of the complexities that lie at the heart of the writing process, notably when executed by L2 learners. This is a significant contribution since there seems to be a shortage of this kind of empirical evidence within the L2 writing literature. The study contributes even more to the L2 writing literature by adopting the variables anxiety and metamemory and examining the interaction between these two variables and the two main variables. To the knowledge of the researchers, this study may be the first to test for interaction effects between dual N-back WMT and metamemory or anxiety, and it is the first to do so in the field of writing.

Another area to which this study makes a contribution is to the practice of L2 teaching and learning in general. With a better understanding of the association between the four variables WMT, anxiety, metamemory, and writing performance, language teachers and practitioners can have a basis on which they can alter their teaching methods or activities in accordance with the findings. For instance, if WM is found to be a significant predictor of L2 performance, and anxiety is found to be a significant moderator of WM performance, then teaching activities and methods can be adopted to accommodate such findings so that L2 learners can get maximum benefit and experience minimum hindrances from writing lessons.

7. Operationalization of Variables

Dual N-back WMT: The main independent variable in this study is WMT (specifically, dual N-back WMT). Dual N-back WMT is designed to increase WMC and is believed to improve performance in various cognitive tasks, a claim originally made by Jaeggi and her colleagues, who

were the first to implement the training program (Jaeggi, Buschkuhl, Jonides, & Perrig 2008). The *N* in dual N-back refers to the number of stimuli a subject is responsible for retaining in WM. The *dual* refers to the fact that the subject must retain two types of stimuli at once: the auditory stimulus and visual stimulus. At 2.5 second intervals, the subject is responsible for remembering two sequences of stimuli simultaneously. The subject is responsible for identifying any matching positions of visual as well as auditory stimuli N-levels back. The N-back level then increases as the subject masters the previous level. If performance on a particular level worsens, however, the N-back level is reduced (Jaeggi et al., 2008) (refer to section 5.3. for a detailed description of the dual N-back program and the overall intervention).

This task depends on the subject's ability to retain and manipulate information in WM and constantly update this information in accordance with each new set of stimuli. It is believed that as an individual increases his mastery of the N-back levels, his or her WMC increases since he or she is gradually able to increase the amount of information retained and manipulated in WM (Jaeggi et al., 2003). It is recommended, however, that for training to be effective, the task should be practiced about 20 minutes a day, three to four days a week, or for at least eight hours in total (Jaeggi et al., 2008; Klingberg, 2010). The program is typically implemented via a computer software. In this study, the researcher was able to execute the training program via students' smart phones, which enabled them to practice even at home (refer to section 5.3. for detailed description of the procedures).

Metamemory: Metamemory is one's awareness, monitoring and assessment of his/her memory (Dunlosky & Bjork, 2008). The construct was measured using the Multifactorial Memory Questionnaire (MMQ) developed by Troyer and Rich (2002). The Likert-scale questionnaire originally contains 57 items measuring three dimensions of metamemory: contentment,

assessment of memory ability, and memory strategy-use. This variable serves as the first of the two moderating variables in the study (refer to section 5.3. for a detailed description of the questionnaire and its administration).

Anxiety: The type of anxiety with which this study is concerned is foreign language anxiety (FLA). It is defined as a feeling of worry, stress, or fear attached to learning a foreign language and has been well-established as being different from general anxiety (Horwitz et al., 1986). The construct, particularly writing anxiety, was measured using the Second Language Writing Anxiety Inventory (SLWAI), which was developed by Cheng (2004). This variable serves as the second of the two moderating variables in the study (refer to section 5.3. for a detailed description of the questionnaire and its administration).

Writing performance: Writing performance in this study serves as the dependent variable. Writing performance was measured through writing tests administered in the form of an essay prompt. Students' essays were evaluated based on an evaluation rubric based on a 30-point grading scale. The researcher assigned two raters for essay evaluations in an attempt to increase the reliability of scores (refer to section 5.3. for a detailed description of the test, evaluation, and administration).

8. Method

Design

This study is a quasi-experiment in which the researcher applied an intervention of dual N-back WMT on one group (the EG) of second year EFL learners at the University of L'arbi Ben M'hidi. The group was later compared against a CG for any differences in writing performance. The study is divided into three phases: exploratory analysis, the intervention, and confirmatory analysis. In the phase of exploratory analysis, the researcher administered the writing pre-test,

evaluated learners' performance, and compared between the two groups. In the intervention phase, the researcher implemented the intervention on the EG. In the phase of confirmatory analysis, the researcher administered the writing post-test and the two questionnaires. The researcher then proceeded by evaluating the learners' performance, comparing performance between the two groups, and answering the research questions. This is also the phase in which the researcher ran all significant test statistics, including those testing for any interaction effects between the treatment and the two moderator variables.

In terms of statistical analysis, the researcher ran Pearson's correlation analysis for the first research question, Spearman's correlation analysis for the second question, Analysis of Covariance (ANCOVA) for the third question, two-way Analysis of Variance (ANOVA) for the fourth question, and three-way ANOVA for the fifth question. In terms of reliability and validity, the researcher put forth much effort in attempt to achieve the maximum level of reliability and validity possible under the circumstances provided. First, the researcher implemented an intervention of dual N-back WMT for about eight weeks on the EG, the recommended duration for improvement. However, the researcher used a CG in attempt to avoid confounding and, consequently, threat to internal validity. Second, internal validity was also sought by accounting for possible moderating variables. Third, the researcher also chose to implement a double-blinded experiment. Participants were unaware of the true aim of the treatment in order to avoid the Hawthorne effect, and evaluators of writing performance were unaware of which group members they were evaluating. This was done in order to avoid conscious as well as subconscious bias. The researcher also attempted to achieve inter-rater reliability by having two evaluators evaluating writing scores. Finally, in terms of the questionnaires, the researcher opted for standardized questionnaires developed by highly competent researchers within their corresponding domain. These

questionnaires have been reported to hold strong psychometric properties (i.e., reliability and validity) (refer to section 5.3. for more details on the questionnaires and their properties).

9. Assumptions

The researcher started this study with a few basic assumptions. The first assumption is that the subjects involved in the study do not have any memory impairments. That is, their memory capacities and processing is of an average level and would not hinder their performance in any of the tasks. The second assumption is that the learners' writing performance is a reflection of their writing competence. This assumption is motivated by the fact that, sometimes, due to a range of reasons, a student's performance may appear to be better than the underlying competence, and sometimes the underlying competence far exceeds performance. For this reason, the researcher has no choice but to only assume that their performance on the writing task reflects their actual writing competence. Another assumption is that there upon implementation of the treatment, no treatment diffusion occurs; namely, the researcher assumed that the CG is not exposed to the treatment through such means as inter-group subject-to-subject interaction.

1. Chapter One: Working Memory

Introduction

The current chapter aims to provide a comprehensive review of the literature on WM. A significant factor in nearly any cognitive function, WM has gained the attention of researchers and practitioners alike, notably language learning researchers and practitioners. In an attempt to define and elaborate on WM, this chapter outlines different perspectives on what the construct is, its function, and its significance. Moreover, since the construct is often confused with the similar construct STM, this chapter also attempts to clarify the seemingly blurry distinction between the two. After a thorough explanation of WM, its constituents, and each of their functions, the literature is narrowed in focus, shedding light on its significance in the field of language learning. Accordingly, WM is reviewed in light of the writing literature in attempts to draw link between the two constructs.

1.1. Definition of Working Memory

Originally devised by Miller, Galanter, and Pribram in the 1960s (Baddeley, 2010), the term WM, in its simplest form, can be defined as a location in which information is stored (Spear & Riccio, 1994). The term, however, has been defined in a number of different ways depending on the field of study. The term is used to refer to the system responsible for storage and processing of on-line information. That is, it is responsible for storing and processing information needed for immediate use for the current or ongoing task (Baddeley, 2000; Baddeley & Hitch, 1974). Some researchers define WM as the collection of cognitive resources used to process information simultaneously with other mental tasks (Baddeley, 2000). Gathercole and Alloway (2004) define it as a mental workspace in which individuals temporarily hold relevant information while performing a cognitively-demanding task. For instance, while writing, an individual may suddenly

remember an important point s/he should add to the ongoing text, so s/he is faced with the task of storing this point in his/her WM while continuing to transcribe the rest of what s/he was writing.

1.2. Working Memory versus Short Term Memory

Both WM and STM are considered as temporary storage systems, and the two terms are sometimes used interchangeably. There seems, however, to be a distinction between the two systems, and this distinction has been and still is rather unclear.

Short term memory is sometimes defined as a system through which limited information is stored passively and “reproduced in an untransformed fashion, whereas WM is considered as a processing resource of limited capacity involved in the preservation of information while simultaneously processing the same or other information” (Nevo & Breznitz, 2011, p.74). It can refer to the cognitive system that is used for holding sensory events, movements, and cognitive information, such as digits, words, names, or other items for a brief period of time (Kolb & Wishaw, 2009). As Alloway and Alloway (2013) illustrate, STM reflects an individual’s ability to recall certain information for a very short period without retaining or processing it in their mind or doing anything with it, like a person’s name one just met. On the other hand, WM involves an individual processing or actively storing the information while processing other information, like someone consciously remembering a person’s name s/he just met while talking to someone else so that, later, s/he can recall for this someone else the name. Thus, the distinction here between the two constructs reflects the difference between a passive and active storage of information.

Some researchers believe the main difference between the STM and WM is that the latter has the extra function of attentional control rather than only being equipped with storage capacity. This is because attentional control is the distinguishing feature between a simply passive store and an active mechanism that retains information that can be accessible even with interference and at

the same time hinders irrelevant input (Kane, Bleckley, Conway, & Engle, 2001). Hence, the ability to focus, divide, and switch attention and the ability to block irrelevant stimuli are some of the key distinguishing features between the concept of a passive STM and an active WM store. There is also support for the idea that WM and STM overlap. According to this viewpoint, executive control (attention, for example) directs information into STM (or the short-term storage slave systems known in Baddeley's model as the PL and visuospatial sketchpad (VSS)).

To sum up, within the literature, some consider STM and WM as separate entities; others consider them as one and the same concept. On the other hand, some researchers consider STM as a component of WM, yet others believe the relationship is reversed, that WM is a component of STM. On another note, some consider the two entities as overlapping; hence, WM is considered as STM with the added function of executive control. Furthermore, others believe that information memorized in STM must undergo certain manipulation in WM and then transmitted back to STM. Regardless of the distinction, it is well-established that the term WM has now dominated the memory literature, replacing the old concept of STM.

1.3. History of Memory Research

Memory is one of the most intriguing phenomena of human thought. A central constituent of nearly any human function, memory has been of significant interest to scholars for millennia. Contemplation over the nature of memory can be traced as far back as ancient times. The earliest accounts of memory research were predominantly philosophical, or descriptive in nature. These accounts began with ancient Greek philosophers (Radvansky, 2015).

Plato (around 4th century B.C.) viewed memory as a construction of sensation and as being tied to intelligence. To Plato and Aristotle, memory was a means of human cognition and a source of information. Plato also viewed memory as the process of retrieval of information that is

internalized within every individual and that simply requires a question as stimulus to be triggered. Of the most famous of Plato's viewpoints is his comparison of memory to a wax tablet. According to this viewpoint, input is imprinted and lasts (i.e., it will always be available for retrieval), but whatever is wiped out becomes illegible (i.e., forever unavailable for retrieval) (Juliao et al., 2017), just like a wax tablet. These viewpoints were adopted and developed centuries later by such philosophers as Rene Descartes (1596-1650) and Immanuel Kant (1724-1804). Other philosophical attempts at understanding the nature of memory came from Aristotle (384–322 B.C.), and John Locke (1632–1704), among others (Radvansky, 2015).

The transition from a philosophical to a psychological study of memory took place in the mid-nineteenth century, and the first experimental study of memory took place in 1885, conducted by pioneer Hermann Ebbinghaus (1850–1909) (Radvansky, 2015). Ebbinghaus had set out to prove that higher mental processes could actually be studied experimentally. While controlling for confounding variables such as prior knowledge, Ebbinghaus scientifically studied his own acquisition, retrieval and forgetting of made-up, or nonsense, syllables (Radvansky, 2015). His findings contributed greatly to memory research and are still significant to this day. One of these contributions is the significant forgetting curve hypothesis, which states that an individual's retention and recall capacity of newly-learned information declines within the first day of learning unless conscious attempts are made at active recall or use of mnemonic techniques. Because rarely had any previously published works on memory existed, Ebbinghaus's groundbreaking research instantly proliferated and prompted a significant amount of memory research in the United States. Furthermore, Ebbinghaus's collection of research and findings are still considered a significant and reliable reference for research in psychology, from intelligence testing to perception and memory research (Newman & Loftus, 2012; Radvansky, 2015).

Within the field of psychology, further contributions to the understanding of the nature of memory were made by various researchers, from Sir Fredrick Bartlett (1886–1969), who highlighted the influence of prior knowledge on memory, to William James (1842–1910), who was one of the first to make a distinction similar to what is today known as the distinction between STM and LTM (Radvansky, 2015).

Two significant movements within the field of psychology contributed greatly to current understandings of memory (Radvansky, 2015). The first movement was the Gestalt movement, which advanced the argument (in its simplest form) that the whole of something is significantly different from the sum of its individual constituents. Today, this viewpoint holds true for memory; memory is known to be comprised of distinct sub-elements. Likewise, when remembering an event, most of the time individuals remember the whole of a story, but when it comes to details some details are remembered more clearly than others. The second movement was the behaviourist movement, which had focused on studying external, observable behaviour of individuals rather than latent mental processes. Although mental processes were not directly addressed, behaviourist experimentation had an indirect effect on the understanding of memory. Specifically, findings from experimentation on conditioning and Edward Tolman's (1886- 1959) experiments with maze rats provided insight into mental representations; it became clear that once the animals were exposed to the initial stimulus, they did not need to re-learn it per se; rather, they had built in their memories a mental representation of the stimulus that would only be reactivated with cues (Radvansky, 2015).

As a reaction to the drawbacks of behaviourism, psychologists began focusing on human mental processes, initiating what is known as the cognitive revolution in the mid- 20th century. The cognitive revolution was marked by a radical shift in perspectives on how people learn. Individuals

were no longer seen as passive receptors of knowledge, and learning was no longer seen as a product of repetition and imitation and stimulus-response. With this shift, researchers began studying cognitive processes involved in learning as well as everyday tasks. Such processes include those involved in language, perception, thinking, and memory (Radvansky, 2015).

Until the mid-twentieth century, memory was perceived as a single system (Baddeley, 2007). However, by the end of the 1960's researchers were becoming more observant of the separation between a mechanism that allowed for the long-term retention of information and a mechanism through which information was almost instantly forgotten without sufficient rehearsal (Baddeley, 2006). With growing evidence for two separate memory systems, researchers began devising theoretical models of memory.

1.4. Models of Working Memory

1.4.1. The Atkinson and Shiffrin (1968) Modal Model

The first attempt to construct a model of memory was made by Atkinson and Shiffrin (1968). According to this “multi-store”, or modal model, memory undergoes three phases, or surpasses three memory stores: a sensory memory store responsible for detecting external sensory stimuli, a limited STM register responsible for temporarily storing information, and a long term memory store responsible for storing unlimited information for a long time. Figure 1.1 presents the original multi-store model.

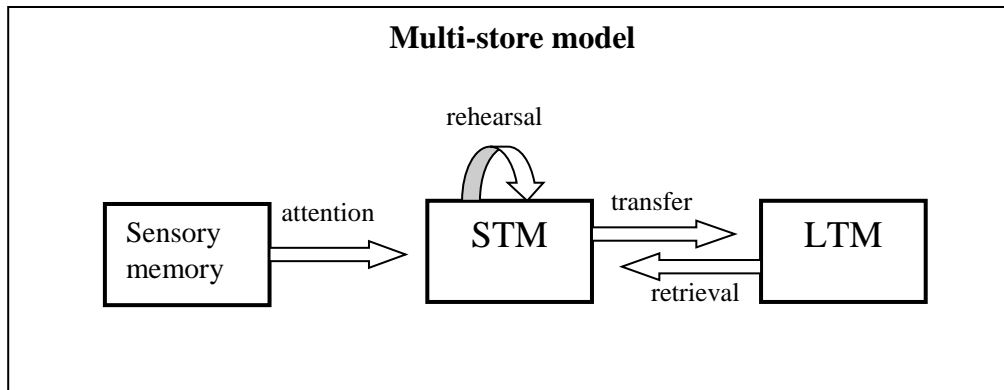


Figure 1.1. Atkinson and Shiffrin (1968) Multi-store Model of Memory

Information is first perceived by the sense organs and retained in the sensory memory system, which is built of a set of memory stores, each representing a different sensory modality (i.e., one for hearing, one for smell, etc.) (Radvansky, 2015). Once stimuli enter the sensory registers, they are retained in this system for less than a second since some information proceeds to the STM store, while the rest decays. Within the STM store, a limited amount of information is held for 15-30 seconds. Some of this information, with proper reinforcement via rehearsal, transitions into LTM while the rest, but without proper rehearsal, it decays. In this initial tri-partite view, however, the sensory register is responsible for coding sensory stimuli such as smell, touch and color while STM is responsible for coding verbal stimuli. Hence, the sensory stimulus encoded in the sensory register is assigned a verbal code; for instance, a particular color or smell gets assigned the names red or vanilla, respectively. The LTM store then is responsible for coding the semantic aspect of the stimuli; i.e., the meaning of the stimuli (Atkinson & Shiffrin, 1968).

A fundamental distinction should be noted: the distinction between STM and LTM (Atkinson & Shiffrin, 1968). Short-term memory refers to the part of memory responsible for receiving and storing information for very short time intervals. More specifically, it is believed to store information for only approximately 20 seconds before it either fades or is transferred into LTM (Bablekou, 2009). Furthermore, STM is known to be extremely limited in the number of

items it can retain at once. The reported number of items held in STM has ranged from four to seven. However, LTM is believed to be basically unlimited in duration and capacity. According to Atkinson and Shiffrin (1968), information entering LTM can be retained there for up to a lifetime. This is the memory system responsible for holding all of the information relevant to our life experiences. Information from STM sometimes fades away but other times, especially with practice or exposure upon exposure, it can make its way to LTM.

This initial model of memory was challenged for a few reasons. First, it was considered as lacking enough elaboration in terms of the nature of the memory stores. Second, it was criticized for assuming a sequential transition of information through the three memory systems, but evidence has shown the possibility of direct access of information to the LTM store without surpassing first STM. Third, the model assumes that rehearsal was the sole means through which information can transition into LTM. Evidence, however, has shown that information can make it to LTM without rehearsal and rehearsing information does not necessarily guarantee that it will make it into LTM (Bjork & Whitten, 1974). On the contrary, the nature of processing rather than length of retention in STM is what affects long-term retention (Baddeley, 2006).

In addition, this model represents each memory store as a single unit, a representation that subsequent research has disproven, revealing instead that separate coding systems exist within the STM store. For instance, Zlonga and Gerber (1986) report how an individual with brain damage showed impairments in STM, but only in verbal detection and processing. Visual STM processing, however, was unaffected. This account provides evidence for the separate STM stores for different types of stimuli. Another point on which this model was criticized concerns the claim that STM is the path through which information makes it into LTM. This, however, is not the case because

individuals with STM deficits generally do not exhibit LTM problems (Shallice & Warrington, 1970).

1.4.2. The Baddeley-Hitch (1974) Multi-component Model

In response to the various limitations of the original modal model of memory, Baddeley and Hitch (1974) introduced a model that consequently replaced the traditional notion of a static, unitary STM store with the notion of an active multi-component short-term storage mechanism. This latter mechanism widely became known as WM. In this new model, the authors elaborate further on the construct of STM by breaking it down into several sub-components and assigning each sub-component various functions. The three main constituents, or stores, of the original Baddeley and Hitch (1974) model are the PL, the VSS, and the central executive (CE). Figure 1.2 presents Baddeley and Hitch's (1974) model of WM.

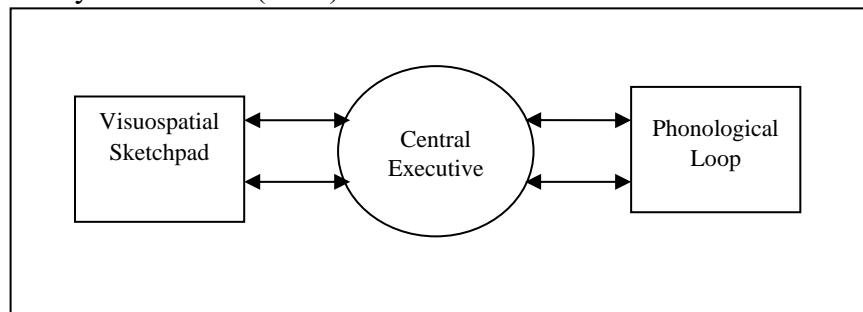


Figure 1. 2. Original Baddeley and Hitch (1974) Model of WM

1.4.2.1. The Phonological Loop

The PL is responsible for storing and processing stimuli related to language (spoken as well as written stimuli). For instance, when an individual is listening to a lecture, the PL is responsible for storing and processing information heard from the lecture as well as information written down while taking notes. Just like the other components of WM, the PL is believed to be limited in retention and processing capacity (Baddeley, 1992). In contrast to the traditional belief that such stimuli are held in STM for about 20 seconds, according to Baddeley, the PL only retains information for about two seconds before it fades, unless it is rehearsed. Moreover, when longer

and more difficult words are articulated, the PL it is reduced to storing fewer words (Baddeley, 1992; 2003).

The PL comprises two main sub-components: a passive phonological store and an active articulatory rehearsal. The former sub-component, believed to be linked to speech perception, is responsible for briefly (about 1-2 seconds) storing auditory stimuli, which is to quickly decay. The latter sub-component is responsible for restoring such decayed memory traces, typically through rehearsal. This is the mechanism responsible for an individual's ability to process and remember, for instance, a sentence that had been dictated moments prior to processing (Baddeley, 1992; 2003). Without the proper rehearsal of verbal stimuli by the articulatory rehearsal, information is lost. The number of words that are capable of being retained and rehearsed by the PL depends on the length of the words or stimuli and an individual's articulation rate. Furthermore, functioning of the PL is affected by such factors as the similarity, decency, and primacy. The similarity effect maintains that the more familiar the information, the better an individual is able to remember it. The primacy and decency effect maintain that the first and last elements in a list are more likely to be remembered than the middle items. Strategies such as chunking are believed to aid retention of more elements in the PL (Baddeley, 1992; 2003).

1.4.2.2. The Visuospatial Sketchpad

Another STM store in Baddeley's model is the VSS. The VSS is the component of WM responsible for storing visual and/or spatial stimuli. It is sometimes described as the 'inner eye', and it is used for navigation. The VSS processes images and information dealing with space, direction, and movement. For instance, when an individual receives directions on how to get to a restaurant, the VSS is the mechanism responsible for drawing a mental representation of the

directions and retaining such a representation so the individual successfully reaches the restaurant (Baddeley, 2000; Baddeley & Hitch, 1974).

Research has revealed that two separate mechanisms within the sketchpad are responsible for processing visual and spatial stimuli (Klauer & Zhao, 2004). There is believed to be a storage system in which visual and spatial stimuli from various sources (for instance, LTM, language, touch, or vision) are integrated into a single representation (Baddeley, 2007). Like the PL, the VSS is comprised of two storage features: a temporary, passive store and an active rehearsal process. Again, just like in the PL, retention or recall of visual or spatial information relies on the efficiency of the rehearsal process (Baddeley, 1992; 2003). When an individual is presented with both auditory and visual information simultaneously, such as in a PowerPoint lecture with visual images, the VSS and PL are believed to work independently to process their respective stimuli without either function being affected by the other (Baddeley, 2003).

1.4.2.3. The Central Executive

The third component of the original Baddeley and Hitch (1974) model is the CE. This is the mechanism most known for controlling attention (Baddeley, 1996). It is also believed to be responsible for regulating other cognitive processes, like coordinating between storage and conscious processing of different information, such as in the case of text comprehension or cooking while watching television (Bablekou, 2009).

Baddeley (2007) elaborates on the functions of the CE by assigning it three main attentional roles: focusing of attention, dividing attention, and shifting attention. The recent elaborations made by Baddeley on the CE mark it as an attentional control system (Bablekou, 2009). The first function of the CE, directing or focusing attention, is considered as one of the most significant functions of WM. An example of focusing attention may be paying attention to a lecture. An example of

switching attention is shifting from paying attention to the lecture to talking to a classmate. Diving attention, however, involves the allocation of attention to two or more tasks at once, such as listening to the lecture while taking notes while keeping track of time (Bablekou, 2009).

A fourth main feature of the CE, aside from attention, is its role as an interface between WM and LTM; that is, it allows for WM and LTM to work together. The CE is also the sub-component of WM responsible for steering the whole system and for channeling information to the slave systems (the PL and the VSS) and making sure they are actively functioning, otherwise refocusing their attention. This is accomplished by allocating information to its proper components (e.g., the PL or VSS) and by monitoring and regulating cognitive processes like making sure information makes it to LTM. Those with impaired CE functioning may have difficulty processing phonological and visual stimuli simultaneously (Baddeley & Della Sala, 1996).

In sum, the CE is responsible for four main processes: focus of attention, division of attention, switching of attention, and linking WM with LTM (Baddeley, 2007). Like the other components of WM, the CE is considered to be a limited in capacity; specifically, it is limited in attentional control (Bablekou, 2009).

1.4.3. Baddeley's (2000) Revised Model

This original Baddeley and Hitch (1974) model was found to be highly successful in providing a comprehensive account of human WM, an account that has been supported by data from numerous psychological and neurological studies (Baddeley, 2000). However, because the model still seemed to fail in accounting for various other memory functions, Baddeley (2000) added a fourth component and further elaborated on the functions of WM in his revised model (Figure 1.3.). As Baddeley (2000) asserts, “the revised model differs from the old principally in

focusing attention on the processes of integrating information, rather than on the isolation of the subsystems” (p. 417).

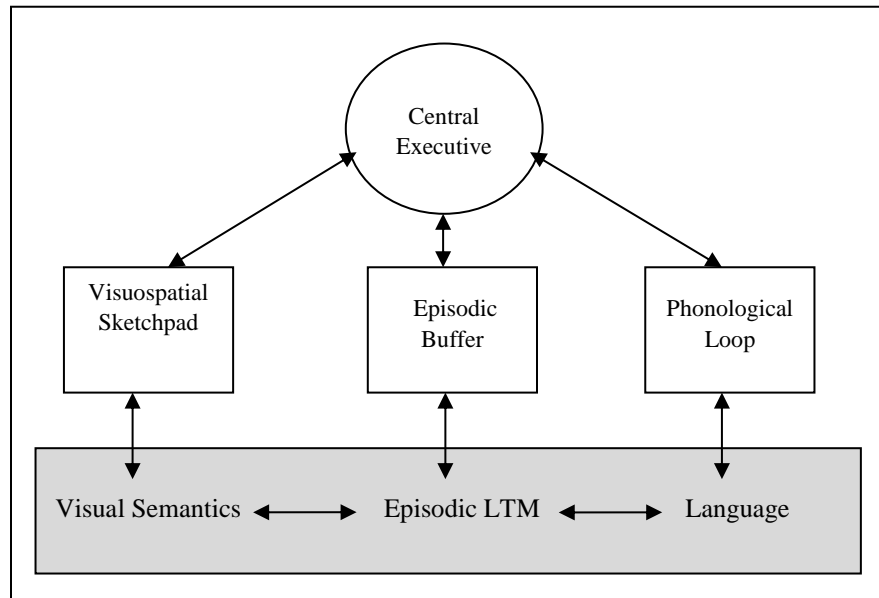


Figure 1. 3. Baddeley's (2000) Revised Model

The fourth component of the multi-component model of WM is the Episodic Buffer (EB) (refer to figure 1.3.). The EB, added by Baddeley (2000) to the original Baddeley and Hitch (1974) model, can be described as the interface between the other components of WM (Bablekou, 2009). It is believed to be the component responsible for associating stimuli of multiple domains to form all-encompassing units of spatial, visual, verbal and other types of information. Hence, it combines information retrieved from the VSS and the PL while retrieving information from LTM and perceptions in order to construct a coherent episode (i.e. the term “episodic”) of which an individual is to make sense (Baddeley, 2012). Baddeley (2015) clearly describes its function by asserting that it “is assumed to be a multidimensional storage system, capable of combining information from the visuospatial and verbal subsystems and linking it with further information from perception and LTM” (Baddeley, 2015, p.20). Furthermore, its reliance on attention means that it is dependent on the CE (Baddeley, 2012). The best example of such an episode is a movie

scene. When watching a movie scene, an individual's WM is responsible for processing, at once, visual/spatial stimuli (the images and movements), verbal stimuli (the sound), and perception (an individual's schematic knowledge making sense of the scene). This EB is believed to be accessible consciously by an individual. Like all other components of Baddeley's WM model, the EB is believed to be of a limited capacity, about four chunks or episodes (Baddeley, 2010; 2012).

Bablekou (2009) explains how the EB functions as an interface between multiple components. She does this by illustrating in her experiments how children can more easily recall information they have heard aurally than the information they have seen visually. This is because auditory information gains immediate access to the PL, so it is readily available while visual stimuli need to be first converted into speech-based code by the EB before it can be available for recall.

1.4.4. Cowan's (1999) Embedded-processes Model

According to Cowan (1999), WM refers, collectively, to the cognitive processes necessary for maintenance of information needed to be accessed in order to carry out certain tasks. These are the type of everyday tasks for which information needs to be stored in the mind for use or re-use. For instance, to solve a math problem, one needs to retain in his/her mind every step as s/he progresses through the problem. By the time s/he reaches the tenth step, for instance, s/he needs to retrieve information from the first step. Hence, the cognitive processes employed for retaining such information are what make up WM. Cowan's (1999) embedded-processes model is centered on the focus of attention, different activation levels, and expertise. According to this model, WM is an embedded constituent of LTM. WM is considered to be information originally stored in LTM but which has been activated (Bablekou, 2009). Hence, the distinction between WM and LTM lies in the various activation levels.

The embedded-processes model is presented in figure 1.4. In the figure, the rectangle in the center signifies all content in the LTM store. The serrated circle-like shape inside the rectangle represents the STM store, which has been activated temporarily from LTM. The circle inside this serrated shape represents specific information from the activated store of STM representations which has been brought to consciousness and has become the current focus of attention (Cowan, 1999).

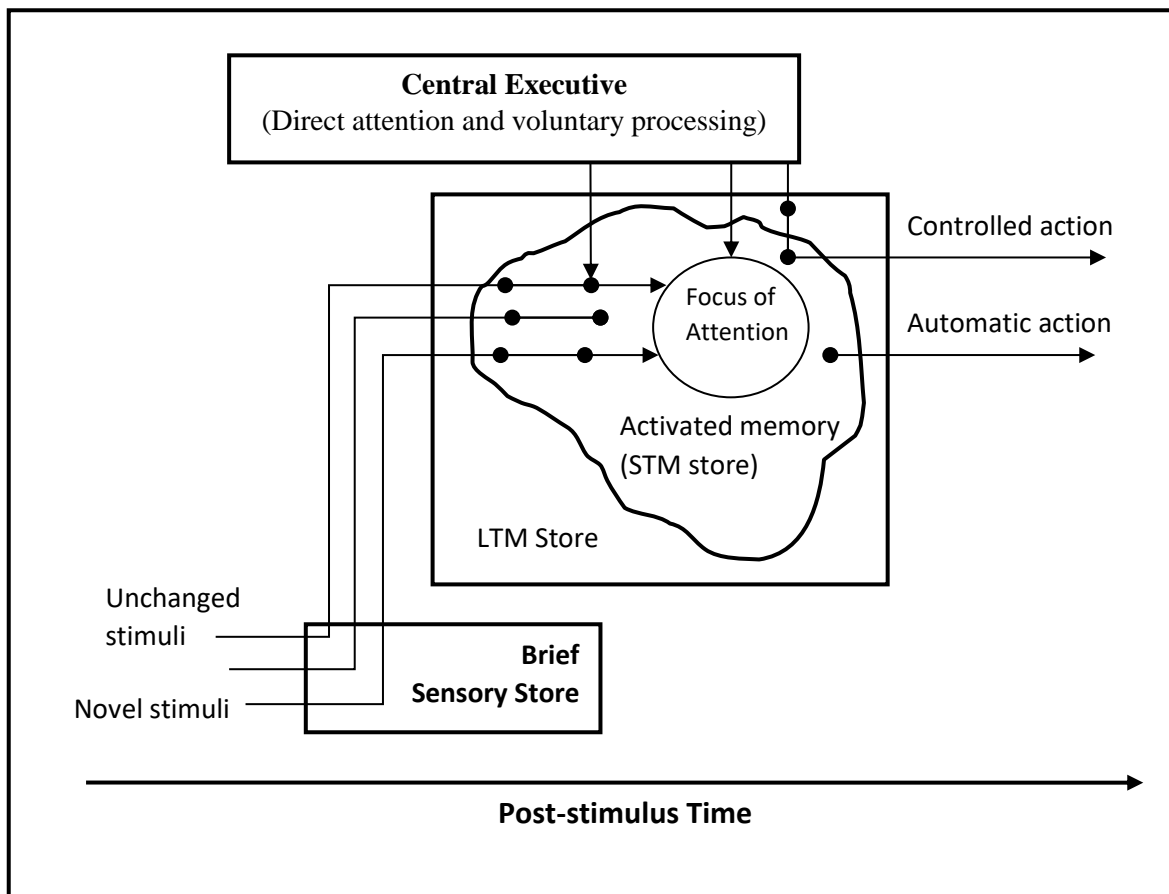


Figure 1. 4. Cowan's (1999) Embedded-processes Model

The CE, according to Cowan (1999), is responsible for regulating WM (which, in this model, is represented as STM store) by controlling, or directing, the focus of attention. This is also one way that information in memory can be activated. Cowan asserts that it is not possible to bring to consciousness (the inner-most circle) information without having already activated it (the

serrated circle). It is, however, possible to activate information without being conscious or paying attention to it. Some tasks seem to demand more consciousness, or attention, than others (Cowan, 1999). For instance, copying important numerical data from a paper into a computer requires an individual to inhibit most, if not all, other distracting information processing to focus attention on accurately entering the numbers. One may, for example, stop talking on the phone when carrying out such a task; otherwise, the numbers would be entered incorrectly. In contrast, if one were doing the laundry, less conscious attention would be required. The laundry can be done while talking on the phone.

Furthermore, more attention-demanding tasks or stimuli (those within the inner circle of focus of attention) are subject to more complete memory activation than stimuli outside the focus of attention. The focus of attention is typically driven by two kinds of stimuli. The first type of stimuli are events that immediately attract one's attention and initiate automatic focus of attention. Examples of such events are loud noises, major changes in one's environment, and strong lights. The second kind of stimuli are conscious effortful processes which demand manipulation by the CE. Examples of tasks which include such processes are solving a math problem and inserting data into a computer. Cowan also discusses the inhibition function in WM (Cowan, 1999). That is, he discusses how someone may push away certain memory features from his/her focus of attention.

Hence, the three main components of Cowan's WM model are activation, focus of attention, and long-term memory with one component embedded within another (i.e., the name "embedded-processes model"). Information within the inner circle is the most easily accessible information. Information in LTM, however, needs to be activated (the serrated shape) in order to make it accessible. The inactive items within rectangle of LTM are accessible for activation and retrieval. The jagged circle, which represents STM, consists of elements of LTM which have been

activated either consciously or automatically. The inner circle is considered to retain only a few (3-5 items or units of information) highly activated items that are believed to move in and out of this zone to the jagged circle to accommodate the attentional demands of the task. Likewise, information within the jagged circle is believed to make its way in and out of the LTM store in accordance with the cognitive demands of the task (Cowan, 1999).

The inner circle is believed to be equivalent to Baddeley's concept of CE (Bablekou, 2009). However, the jagged circle, which seems to be equivalent to Baddeley's concept of WM, is believed to hold a large number of items, contrary to Baddeley's account of WM capacity (WMC) (Bablekou, 2009). McElree (1998) supports this claim by revealing that information that has recently been activated but has come out of the focus of attention is retrieved by individuals more slowly than that which is expected to be within the focus because those in the jagged circle would need more time to be accessed (Verhaeaghen, Cerella, & Basak, 2004). Both the inner circle and jagged circle represent WM, but on different activation levels. In the inner circle, elements have been highly activated. Within the jagged circle, items have been moderately activated or have been within the focus of attention and are no longer there (Cowan, 2005).

Cowan (2001) also believes in the limited capacity of WM. Specifically, he argues that the number of items that can be held in WM is limited to four. The difference in the nature of items held lies in the size rather than the number of chunks individuals retain. For instance, two individuals may equally retain four chunks, with one retaining four chunks of three digits and the other retaining four chunks of five digits. The number of chunks retained by each individual is the same, but the number of digits varies greatly with the first individual retaining 12 total digits and the second individual retaining 20 total digits. The two individuals would put forth just about the same amount of effort into achieving two different results in retention. This is the rationale behind

the chunking method in learning. Chunking is the process, or strategy, of logically grouping large amounts of information into smaller chunks to facilitate storage and recall. In doing so, learners recall the same amount of information but in fewer chunks. Although Cowan (2001) provides evidence in support of a four-item WMC, it is believed that through such memory strategies as rehearsal, this capacity may reach 6 or 7 items (Bablekou, 2009).

1.4.5. Other Accounts of Working Memory

1.4.5.1. Daneman and Carpenter (1980)

Another account of WM was proposed by Daneman and Carpenter (1980). The authors believe that the seemingly limited nature of WMC is actually a result of processing inefficiency which has led to a reduction in available resources for storage. On the other hand, more efficient processing results in more available storage capacity and resources. Hence, they argue that processing efficiency rather than storage capacity is what determines WM performance (Daneman & Tardiff, 1987). They developed the complex reading span as a measure of WM operations.

1.4.5.2. Kane and Engle (2002)

According to Kane and Engle (2002), WM is solely an executive attention function (Engle, 2002; Kane, Conway, Bleckley, & Engle, 2001). Thus, they assign WM a definition similar to that of the CE in Baddeley's model. This means that WM, according to Kane and his colleagues, refers to the ability to suppress task-irrelevant stimuli while effectively retaining task-relevant information within an active state. This function of attentional control is what determines WMC (Kane et. al., 2001), contrary to Baddeley's view that WMC is determined by the PL.

1.4.5.3. Long-term Working Memory Model

Because of the interconnectedness of WM and LTM, some researchers have developed a long-term WM framework (Ericsson & Kintsch, 1995). According to long term WM perspectives,

WM and LTM are not separate systems; rather, WM is an activated component of LTM. According to this view, WM is responsible for processing stimuli and inscribing new information into LTM. This perspective shifts attention away from how many chunks can be retained at once to how many representations become active at once (Bablekou, 2009). The number of active representations reflects the number of elements that can be manipulated concurrently. Furthermore, activated information becomes inactive and new LTM information gets activated and becomes WM in accordance with demands of the task (Bablekou, 2009).

Furthermore, one's knowledge and use of memory strategies determine the effectiveness of activation of information from LTM (Ericsson & Kintsch, 1995). Such strategies are what aid encoding of new stimuli into LTM and their activation in WM (Bablekou, 2009). The different mastery levels of strategy-use are what give the impression of different retention capacities. What seems to be exceptional WM performance in an individual is actually well-activated LTM as a result of mastery of memory strategy use. With mastery of memory strategy use, retrieval or activation from LTM can become nearly automatic. Most evidence that exists, however, opposes the LT-WM hypothesis (Bablekou, 2009). For instance, Baddeley (2007) asserts that the LT-WM hypothesis fails to elaborate on how exactly WM is connected to LTM. Although it has been established that LTM and WM interact and that there is a link between the two systems (for instance, the PL draws on LTM to remember digits, words, letters, etc.), most cognitive tasks require an individual to draw on LTM, the assertion that the two systems are one and the same is widely-challenged (Bablekou, 2009).

1.4.6. A Comparison of the Models

The multiple theoretical perspectives hold differing viewpoints on how WM is exactly conceptualized. There are, however, several points of agreement among these perspectives. The

first point of agreement is that WM is limited in capacity. Second, WM is a temporary storage system responsible for encoding, storing, and retrieving information. Third, information in WM must be activated or rehearsed, otherwise it will likely decay. Disagreement, however, lies in the actual nature of such mechanisms underlying WM (Shah & Miyake, 1999), the association between WM and LTM, between WM and attention, whether WM is unitary or non-unitary, and the actual nature of WM limitations.

First, Atkinson and Shiffrin (1968) defined WM similarly to what researchers now describe as STM. A distinction between WM and STM, however, has now been made in order to emphasize the dynamic and active nature of the former in contradistinction to the latter's static nature (Cowan, 2008; Baddeley, 2000). The older concept of STM assumes a single store into which all information enters. However, WM assumes a variety of sub-systems responsible for storing and processing different types of stimuli (McLeod, 2012). The source of the differentiation can be traced to Baddeley and Hitch's original and groundbreaking multi-component model of WM (Baddeley & Hitch, 1974).

Second, Miller (1956) contended that WMC is limited to retaining "the magic number 7" as the average number of items, plus or minus two. More recent research, however, does not support Miller's theory. Rather, research has shown that the number of items held by WM is three to five (Cowan, 2001; Mandler, 1975). In addition, research has established that organizational processes or strategies such as chunking greatly influence retention. For instance, grouping items based on certain structures or properties like color and temporal or spatial structure they have in common with each other facilitates not only brief retention of new information but also extends retention over a longer time (Bower, 1972). An abundance of research supports the assertion that chunking is associated with increased retention and recall of information (Bablekou, 2009).

Baddeley's (2000) multicomponent model is the most influential and most widely-accepted model within the literature. It is considered as the model that provides the best account of the nature of WM and its association with other cognitive functions (Bablekou, 2009). It has been implemented and tested within a wide range of situations and experiments and has proven to be the most reliable. Its effectiveness in enabling research of various domains is believed to lay in its breadth and its ability to specifically account for not only various forms of information (i.e, verbal, auditory, visual, and spatial) but also storage and manipulation aspects of the system (Bablekou, 2009). This feature of the model has enabled researchers to set and test specific hypotheses on how such components affect or are affected by certain cognitive functions. Throughout the years, it has been elaborated further and modified according to new findings in the field. The model, however, has been criticized most for its lack of clarity on the CE. Because this component of WM has become of incredibly growing interest and importance, the lack of specific and elaborate explanation of the nature and function of the CE has made it a major drawback of the model (Bablekou, 2009).

1.5. Measuring Working Memory Capacity

The proliferating interest in the nature and effect of WM has brought with it the need to measure the construct as accurately and effectively as possible. Consequently, the last several decades have seen various attempts from researchers to devise a reliable measure of WMC. These attempts have been realized in the form of several tasks aimed at measuring the construct.

A common measure of WMC is the dual-task paradigm, in which the tasks are known as complex span tasks. In the complex span paradigm, two (hence dual) independent tasks are integrated: a processing task and a simultaneous memory task. One of the most well-known versions of the dual-task paradigm is Daneman and Carpenter's (1980) reading span task. Subjects

are required to read various utterances and memorize the final word of each utterance. These words are memorized so they are recalled in the right order at the completion of the series of utterances. Hence, the processing task is the task of reading the sentences while the memory task is the task of remembering the final word of each sentence. The rationale behind Daneman and Carpenter's (1980) reading span task is that there is a storage component as well as a processing component, both of which they believe are essential for reliably measuring WMC and its ability to process multiple simultaneous tasks while inhibiting any distractions (Engle, Tuholski, Laughlin, & Conway, 1999).

Another measurement within the dual-task paradigm is the operation span task, which was devised by Turner and Engle (1989). In operation span tasks, instead of reading sentences, subjects are required to solve simple mathematical operations (such as $(6/3)-1$), after which they are to read a simple word. Like in the reading span task, the subject is required to recall all of the words at the end of the series. In the case of operation span tasks, it is a series of operations instead of sentences. Once the subject completes the operations and recalls the words, the number of operation-word combinations increases as per the subject's retention capacity. Despite the use of mathematical operations, the task is used to measure general WMC and is used to test for associations with other skills such as reading comprehension and verbal ability. Other examples of complex span tasks include the listening span, speaking span, writing span, and the English opposites span. Other non-verbal complex span tasks include the math span and the N-back span (Wilhelm, Hildebrandt & Oberauer, 2013).

What is common between all of the complex span tasks is that the subjects are required to recall a series of information in a short period of time while a second task is provided. Information in the initial recall task can be words, numbers, letters, or spatial locations, etc. the second task,

the processing task, can be solving a math problem, reading sentences, counting circles, etc. (Case, Kurland, & Goldberg, 1982; Daneman & Carpenter, 1980). Such tasks test an individual's ability to switch back and forth between different tasks, both consuming WM resources. These tasks are effective measures because they reflect real-life demands of task-switching while remembering information in preceding steps. Such measures of WMC have been reported to be the most reliable predictors of WM in general and other cognitive capacities (Jarrold & Towse, 2006) as well as academic achievement (Alloway, 2009).

Today, however, WMC is sometimes measured using a task that only includes one of two components: either the processing or storage component. In this case, the researcher would employ a different paradigm of measurements, known as the simple span task. The difference between complex and simple span tasks is the use (or lack thereof) of a secondary task. Although some researchers use simple span tasks to measure WMC, others believe the simple span is merely a measure of STM capacity (Colom, Rebollo, Abad & Shih, 2006; Miyake & Friedman, 1998). These tasks were devised to measure one aspect of WM; however, WMC is typically measured using a range of tasks that require individuals to retain and, after certain intervals, recall a list or range of elements. Simple span tasks include some non-verbal tasks like the digit span, the counting span, and the backward digit span. Other simple span tasks, however, are verbal in nature; these include the word span and letter span tasks (Wilhelm, Hildebrandt & Oberauer, 2013).

1.6. The Significance of Working Memory Capacity

Since the development of Baddeley and Hitch's (1974) WM model, the fields of psychology, neurology, and cognitive science— among others— have seen burgeoning attempts at understanding the nature and significance of this processing system. The literature has thus far established an association between WMC and performance on various cognitive tasks, ranging

from academic achievement and fluid intelligence to executive function and problem solving. This is because of the nature of WM.

WM processing and storage capacities are believed to be highly limited; Miller's 'magical number' seven (Miller, 1956) and Cowan's four (Cowan, 2010) are some estimates of the fixed number of items that can be held in WM. The magic seven and four refer to the number of items, or chunks, that are believed to be retained in WM at one time. For instance, when provided with a ten-digit phone number in single digits (i.e., one number at a time), one can only retain, according to Miller, seven numbers at one time. According to Cowan, it is four numbers. Once information has been chunked (for instance, instead of providing one digit at a time, they are provided in chunks of, for instance, three and uttered as if they are each three-digit numbers), each chunk would then be considered as one item retained in WM. Again, an individual can retain seven (or four according to Cowan), chunks in WM at one time. So, instead of being able to retain only seven numbers as provided in single digits, one is able to retain 21 numbers as retained in chunks of three digits. This is the reason that the chunking method has become so popular and is considered to be so effective. This leads back to the significance of WM in complex tasks.

Accordingly, WMC plays a crucial role in most, if not all, complex cognitive tasks since such tasks usually require an individual to retain a significant number of items in memory at one point. Solving a math problem, for instance, requires an individual to retain in his/her memory a long chain of items (operations or results of calculations from such operations) in order to accurately reach the final result. Failure to do so (because of a limited WMC) is what leads most individuals to performing poorly on difficult tasks.

Another example of human reliance on WM is when one is making a presentation. One has to juggle (i.e., process) and constantly keep updated in his/her mind a range of tasks. The presenter

is faced with making sure s/he remembers the content of the presentation as well as any supplementary explanations or illustrations associated with such content. At the same time, s/he must maintain a mental schedule of when to change the slides. This is to be accomplished while always reminding his/herself to maintain proper body language and the attention and interest of the audience, all while making sure that what s/he is saying is comprehensible to the listeners. When and if s/he fails at any of these tasks, s/he is faced with devising a backup plan on the spot. All of this is accomplished alongside other processes, like keeping track of time so that s/he does not run through his/her presentation and filtering out distractions such as members of the audience entering, leaving, or talking in the middle of the presentation. This presenter's mind needs to focus on all of these components simultaneously.

These tasks of processing and updating on-line information serve as perfect examples of the function of WM. Hence, because WM is responsible for effectively carrying out such tasks as juggling large amounts of information, an individual's WMC is of great relevance. It has been well-established that WM is necessary for nearly everything. It is believed to be an essential aspect of basic, everyday human functioning or tasks, from speaking and listening to text comprehension and problem solving. Interest in WM has been evolving for decades, and so has knowledge of the nature of its functioning, its components, and its limitations. Capacity of WM is believed to vary from one individual to another. Some individuals are believed to have greater WM capacities than others. This difference is what seems to have initiated an inquiry process into how WMC can be improved.

1.6.1. Role of Working Memory in Language Learning

Baddeley's groundbreaking multi-component model of WM, throughout the decades, has not only provided a comprehensive description of the structure and function of human memory,

but it has also been adopted as a theoretical framework for empirical works in a wide range of fields. One of such fields is language acquisition and learning. Baddeley (2015) provides an overview of how the multi-component model serves as a framework for L2 acquisition.

The vital role of WM in language acquisition and processing is anything but a surprise considering that one of the main components of WM (as a system) is a component solely responsible for processing language—the PL (Baddeley, 2010). Baddeley et al. (1998) tested the role of the PL in language acquisition and found that interference with the PL hindered aspects of foreign language learning such as vocabulary acquisition. Those with reduced PL capacity, even those who were otherwise very competent, showed difficulties in acquiring L2 vocabulary (Gathercole & Baddeley, 1993). Furthermore, evidence for the role of the PL in language was presented by Papagno and Vallar (1995) after finding that multilinguals possessed greater PL capacity compared to their monolingual counterparts. Driven by these various findings, Baddeley updated his original model to account for the PL in language. In short, some researchers have found evidence to support the claim that the PL functions as a crucial language learning device in both the first language (L1) and L2 setting (Baddeley, 2003; Baddeley et al., 1998).

Although the PL is the main component of WM specifically associated with language processing, the CE is also believed to play an influential role in language learning since it is highly correlated with intelligence and with learning in general (Baddeley, 2015). This is due to aspects, like attention, of the language learning process that rely greatly on the CE. Some researchers examined inter-individual differences in CE capacity and the effect of such differences on language. Findings from such studies have yielded rather moderately positive correlations between WM, with a special focus on the CE, and language processing (Daneman & Merikle, 1996).

Research has shown that WM is a significant contributor in L1 acquisition (Baddeley et al., 1998). According to research conducted by cognitive psychologists, the association between WMC and L1 acquisition has primarily been attributed to two components of WM: the PL and the CE (Wen, 2015). While the PL has mainly been associated with vocabulary acquisition, the CE has been linked to other language processes such as comprehension and various syntactic processes (Wen, 2015). Archibald (2017) illustrates the reciprocal nature of the relationship between WMC and language learning, asserting that, firstly, scarce language knowledge increases the load placed on the PL since it would have to process and retain unfamiliar information and secondly, a limited WMC may lead to less efficient language encoding and retention.

In the domain of L2 learning, numerous researchers suggest that WM is a critical constituent of L2 aptitude (Skehan, 2002). In the field of L2 teaching and learning, researchers and practitioners have long been exploring inter-individual differences of learners and how such differences contribute to the language learning process. Researchers have consequently found that many such variables contribute to language learning ability. One of these major contributors is believed to be WM processing capacity and efficiency. Accordingly, recent years have seen an upsurge in research which explores the relationship between WM and L2 learning.

Empirical research on the relationship between the constructs WM and language learning has been conducted by numerous researchers. Some believe that WM is closely associated with language learning outcomes and language aptitude. Yalçın, Çeçen, and Erçetin (2016) tested for the widely- theorized role of WMC in language aptitude, finding a significant correlation between the two. Measures of WM have also been found to be associated with overall L2 proficiency (Harrington & Sawyer, 1992) and reading comprehension (Miyake & Friedman, 1998). Specifically, lower WMC has been found to be significantly associated with reading difficulties

(De Jong, 1998). This has been attributed to the numerous demands which are placed on WM during the reading process. Examples of such demands include text decoding and interpreting. The pressure from such demands being placed on a limited resource system is what is believed to lead to poor performance (Swanson & Jerman, 2007). Hence, improvements in WM performance have been found to correlate with improvements in reading performance (Minear & Shah, 2006), especially among those with learning disabilities (Dehn, 2008).

In addition to overall WM measures, the phonological component of WM has been found to be associated with vocabulary learning (O'Brien, Segalowitz, Collentine, & Freed, 2006), grammar (French & O'Brien, 2008), listening (Miki, 2012), and speaking (O'Brien, Segalowitz, Freed, & Collentine, 2007). Furthermore, in their meta-analysis of the relationship between WM and L2 production and comprehension, Linck, Osthus, Koeth and Bunting (2014) examined 79 samples containing over 3000 participants and revealed that WM is positively correlated with L2 production as well as processing. The increasing interest in WM in the context of language is reflected in the recent integration of WM in the study of L2 acquisition.

Based on the vast empirical evidence available, Wen (2015) devised an integrated framework of WM in L2 acquisition. Wen's framework is comprised of three essential elements: a comprehensive and working definition of WM in L2 learning, the constituents of WM associated with language in general and L2 processing, along with their respective functions, and recommended assessment method of the role of WM in L2 learning. Although Wen's (2015) framework has not been adopted for this study, it remains a significant contribution to the researcher's overall understanding of the study's theoretical foundation.

In defining WM with respect to L2 learning, Wen (2015) describes it as "the limited capacity of multiple mechanisms and processes implicated in L2 domains and activities" (Wen,

2015, p.52). In highlighting the constituents of WM associated with L2 learning, Wen (2015) pinpointed two constituents of WM most significant for language learning. The first constituent is the PL, which includes the phonological short-term store as well as the articulatory rehearsal. The second constituent is the CE, which includes both the attentional control as well as the executive control mechanism (Wen, 2015).

Despite all of the available evidence, other researchers believe that no association exists between WM and L2 learning (Juffs, 2004; Taguchi, 2008). Gathercole and Baddeley (1993) demonstrate how the PL, although important in language acquisition, is not mandatory to the point in which one cannot acquire aspects of the language with its reduced capacities. Some researchers believe the strong association exists only when mediated by other variables, such as certain learning conditions and inter-individual differences. Ando et al. (1992) reports that subjects with lower WMC learned better from implicit instruction, whereas those with higher WMC learned better from more explicit instruction.

In particular, the storage and processing capacity of the PL is what is believed to affect language processing. Limitations in the PL are believed to be the source of limitations in language processing (Gathercole & Baddeley, 1993). Jeffries and Everatt (2004) established a significant relationship between verbal, or phonological WM and reading. On the other hand, a limitation in phonological WMC hinders language processes such as syntactic evaluation or semantic retrieval (Stanovich, Siegel, & Gottardo, 1997).

1.6.2. Working Memory Training

With proliferating research on WM over the last decade also come proliferating attempts at enhancing WMC and, consequently, improving performance on various cognitive tasks. The growing interest in WMT comes from the numerous cognitive benefits believed to be associated

with greater WMC and performance. These attempts have come in the form of various WMT programs, which, nevertheless, have become intensely debated in the literature. While some believe that WMT is effective in enhancing WM performance and even performance on other tasks that demand WM resources, others believe such training to be ineffective.

Two main kinds of WMT methods are typically practiced: specific strategy training and general WMT (Vaagen, 2015). Examples of specific strategy training that aim at WM performance enhancement include mnemonics, chunking, and imagery (Dehn, 2008). Such strategies have been associated with improved academic performance (Holmes et al., 2010; Klingberg, 2010), especially among those with already low WMC (Turley-Ames & Whitfield, 2003). Furthermore, the use of such strategies has been associated with improved overall WMC (Minear & Shah, 2006).

The second type of training, which is general WMT, is usually carried out through computer-based software and has the aim of increasing WMC and improving performance. Instead of focusing on particular strategies, these programs include more general tasks that target multiple components of WM. Tasks in such training programs are typically very demanding in attention, encoding, and recall of information, and with enough practice, individuals are usually able to adapt to such demands. While individuals are able to adapt, the tasks also become more difficult, thus placing more demands to which the individual is again expected to adapt (Morrison & Chein, 2011). Overall, WMT has been found to benefit mostly individuals with learning disabilities and Attention Deficit Hyperactivity Disorder and have reported improvements in terms of both visuospatial WM (Klingberg et al., 2005) and verbal WM (Gropper et al., 2014). Some even found improvements in every component of WM (Holmes et al., 2010).

This study is concerned with the latter type of WMT— general WMT. The most popular examples of such programs are Cogmed and Dual N-back. Tasks in the Cogmed program are

tailored to an individual's performance, with difficulty increasing or decreasing as an individual either masters or falls back on the given task (Roche & Johnson, 2014). Each task assigned to the individual is aimed at improving a different component of WM. Some researchers (Klingberg, 2010) claim that Cogmed training is associated with improvements in attention as well as an increase in WMC. In applying the Cogmed WMT program, Vaagen (2015) reported a significant improvement of WM scores in the Cogmed group as compared to the non-training group. Furthermore, the effect of the intervention was different for learners with and without reading difficulties. Specifically, those with reading difficulties had experienced significantly greater improvements compared to those without reading difficulties. This study, however, is not concerned with Cogmed; rather, it is concerned with dual N-back training.

1.6.3. Dual N-back Working Memory Training

The most commonly-employed WMT program today is the dual N-back task. This task was devised by Wayne Kirchner in 1958 (Kirchner, 1958) in a slightly different form—the single N-back task. Originally, it was devised as a measure of WMC. In the N-back task, individuals are expected to constantly keep information updated in their memory in order to perform well on each new task. In the original task, participants are presented with a series of stimuli (letters or digits, for instance), and their role is to state when the same stimulus matches the previous stimulus. This, of course, is the most basic level, known as 1-N, with the “1” referring to the number of positions back the individual is responsible for remembering. Of course, this position is updated as each new stimulus is presented. The following series of stimuli serves as an illustration.

DFLGGNFIPOSTT

In the above series of stimuli, the participant would have to indicate the target that matches the preceding stimulus. In this case, they are the following bold underlined stimuli: G, P, and T. Although this is the most basic level, the position of the target changes in the next level, the 2-N level. In this level, the participant must remember the stimulus two positions back (i.e., 2-N) instead of one position back (Kirchner, 1958). The following series serves as an illustration:

FUYBRBIKSKNEJE

In the above series, the participant would indicate a matching stimulus at the bold underlined “B”, “K”, and “E” since in each case, the stimulus matches the stimulus mentioned two positions back. After a participant masters a level, the position increases and so does the difficulty of the task because the participant is responsible for remembering more and more items at a single time. For instance, in the 2-N level series above, one has to remember two positions back every single time, and, at the same time, these positions must constantly be updated. The participant would have to remember “F” and “U”, then, when presented with “Y”, s/he would have to remember “U” and “Y”, then when presented with “B”, s/he would have to remember “Y” and “B”. This may not seem like such a difficult task, but when the level increases to 3-N, it becomes significantly more challenging. The participant would have to remember “F”, “U” and “Y”, then “U”, “Y” and “B”, then “Y”, “B” and “R”, and so forth. This constant updating of information in memory while avoiding distractions, especially under potential time constraints, is what makes the task more challenging (Kirchner, 1958). In the 3-N level, for instance, the participant may be distracted by the stimulus at the second position back, leading to confusion between the 2-N level and the 3-N level. As Gazzaniga, Ivry, and Mangun (2009) explain, when the level increases

beyond 2-back, an individual is not only faced with the task of retaining information, but also manipulating it as s/he is constantly updating it against the aforementioned distractions.

This traditional form of the N-back task was adapted in 2003 by Susanne Jaeggi and her colleagues (Jaeggi et al., 2003) into a dual N-back task. Rather than the traditional single stimulus presented in a series, in dual N-back, two stimuli are presented simultaneously in series, both to be remembered together. The two stimuli to be remembered are generally a visual stimulus (VS) and an auditory stimulus (AS).

In 2008, Jaeggi, Buschkuhl, Jonides, and Perrig (2008) published a groundbreaking study in which the dual N-back task was used to train individuals in an attempt to increase their WMC and improve their fluid intelligence. Jaeggi and her colleagues presented the participants with a large square that is divided into nine smaller inner squares (three rows and three columns of inner squares). All of the squares are active with the exception of the middle square. At each position one of the squares flashes (the VS) and, at the same time, a letter is uttered (the AS). The participant is responsible for remembering both stimuli N positions back so that they indicate when the current position matches. The current position may match in terms of only one stimulus (either AS or VS) or it can match in terms of both stimuli. The participant is responsible for stating either case. Like in the traditional N-back task, the N-back level increases or decreases according to the participant's mastery of each level. Someone may master up to 6-N, while someone else may only master the 2-N level (refer to section 5.3 for full description of the task).

These two (hence dual) N-back tasks, when performed simultaneously, were originally claimed to improve WMC, which in turn is believed to be transferred to other cognitive tasks such as fluid intelligence (Jaeggi et al., 2008). Jaeggie et al. (2008) reported a significant improvement on untrained tasks, such as fluid intelligence, due to dual N-back training. Such claims raised a

wave of controversy on the effectiveness of dual N-back training that has yet to be settled today. Jaeggi and her colleagues (Jaeggi et al, 2010) successfully replicated the positive findings, and significant effects of dual n-back WMT were reported after 3 weeks of training (a total of eight hours of training) (Jaeggi et al., 2008; Klingberg, 2010). However, after repeated replications by other researchers, such impressive effects were questioned as research yielded mixed results (Bürki, Ludwig, Chicherio, & De Ribaupierre, 2014; Colom et al., 2013).

The main aim of the training program is to improve performance not only on the trained task but also on similar and untrained tasks. The former is an example of near transfer effects of WMT, and the latter is an example of far transfer effects. More specifically, tasks that measure near transfer effects measure performance on a task that requires the same cognitive function as dual N-back. On the other hand, measuring far transfer effects means measuring performance on a task that is not related to the trained task, such as intelligence and, in the case of the current study, L2 writing performance (Soveri et al., 2017). While some studies on WMT have reported only near transfer effects, others have reported far transfer effects, and others have reported no effects (Soveri et al., 2017). Researchers who found a significant effect of the intervention have failed to reproduce the same results, suggesting that N-back training does not transfer to other cognitive domains. Some argue that even if N-back training improves performance on certain tasks, these effects are only temporary. They are believed to eventually fade (Melby-Lervåg, Redick, & Hulme, 2016; Soveri et al., 2017).

In their comprehensive meta-analysis on the effectiveness of dual N-back WMT, Soveri et al. (2017) gathered data from 33 studies incorporating N-back training on healthy adults and yielded 203 effect sizes from the various tasks that had been implemented. The meta-analysis yielded a moderate effect size of n-back training on untrained tasks as well as general intelligence

and cognitive control but little to no far transfer effects. These results were obtained after controlling for several potential moderators, such as age and training type.

Conclusion

Although the complex nature of WM and its constituents are still debated, the significant role of the mechanism in various cognitive functions, particularly language acquisition and learning, seems indisputable. Furthermore, the excess cognitive load, or strain, placed on an individual throughout the writing process appears to be the main contributor to deficits in WM performance and, consequently, writing performance (more details are provided in section 4.4). Additionally, writers of a language not native to them have an extra disadvantage, notably due to the strain associated with having to generate, translate and transcribe information in a language they have not fully mastered while still having to manage the already-tedious task of juggling the demands associated with writing.

This chapter not only provided insight into the nature WM and elaborating on how it is associated with language learning, but it also provided theoretical explanations and empirical evidence for the critical role of WM in L2 writing performance (more details are provided in section 4.4). Having elaborated on WM in this chapter, the next chapter aims to do the same with metamemory, a construct critical for understanding the current study.

2. Chapter Two: Metamemory

Introduction

The current chapter presents the literature on metamemory. As a distinct yet related construct to memory, the review differentiates and highlights the link between the two. With a brief history of research related to metamemory and an elaborate explanation of a significant model of metamemory, the definition of the construct and its sub-components becomes clearer. Although metamemory is not as widely-researched as memory, its significance in learning has been established in the literature. This chapter, therefore, outlines the significance of metamemory in learning, particularly in language learning. Moreover, the review provides an overview of how the construct is linked to the other constructs adopted in this study.

2.1. Definition of Metamemory

Although a consensus over the exact definition of metamemory has not yet been reached, researchers have proposed various definitions aiming to fully capture the nature of the construct. Metamemory is defined as an individual's awareness of and beliefs about their memory abilities and processes (Dunlosky & Thiede, 2013). Furthermore, Flavell defines it as an "intelligent structuring and storage of input, of intelligent search and retrieval operations, and of intelligent monitoring and knowledge of these storage and retrieval operations" (Flavell, 1971, p.277). Likewise, Flavell and Wellman (1977) describe the construct as an "individual's knowledge of and awareness of memory, or of anything pertinent to information storage and retrieval" (p.4). Hence, metamemory can include not only knowledge of one's memory abilities, but also knowledge of strategies for improving as well as self-monitoring memory performance (Pannu & Kaszniak, 2005). In sum, the term metamemory can be used to refer to a) the knowledge one has of his/her memory abilities and processes, b) the monitoring and evaluating of such memory

abilities and processes, and c) the use of such knowledge for devising strategies aimed at managing one's memory processes or performance.

2.2. Metamemory versus Memory

While memory is a term used to refer to the processes of storage and retrieval of information, metamemory is a term assigned to any of the set of processes associated with an individuals' "knowledge of, monitoring of, and control of their own learning and memory processes" (Dunlosky & Bjork, 2008, p.11). Hence, metamemory is the knowledge and control of these processes of storage and retrieval of information. It is simply the judgment one makes of one's own memory (Metcalf & Dunlosky, 2008). An illustration of the difference between metamemory and memory can be found in every day learning tasks. When an individual is studying for a test, for instance, s/he may or may not have internalized information from the past few lectures (hence, memory), and s/he may or may not be able to recall them upon being prompted (again, memory). However, once being prompted to remember the information on the day of the test, for instance, s/he may realize that s/he either does or does not have mastery of the information and therefore can recall it or cannot. Hence, this learner's ability or inability to recall the information is an example of a memory process while the act of realizing whether s/he can or cannot remember the information is an example of a metamemory process.

2.3. History of Metamemory Research

2.3.1. Before the Term Metamemory

Contemplation over the nature of human memory and attempts at improving its performance (i.e., metamemory) dates back to ancient times. At around the 6th century BC, Simonides (556 – 468 BC), an ancient Greek poet, was believed to have developed one of the most significant mnemonic devices known to this day. This device is known as the method of loci. As

the legendary tale goes, Simonides was believed to take part in a banquet, when, at some point, he left the room only to have the entire roof of the room collapse behind him. Since everyone in the room except Simonides was crushed, the only individual who was able to identify the victims was Simonides. Surprisingly, he was able to name every victim, and he was able to do so by recalling their position in the table. This gave Simonides the idea that memory performance can be strengthened by using familiar spatial cues to form mental images of things to be remembered in relation to those cues. In Simonides's case, the spatial cue was the place of each individual in the banquet table, and the thing to remember was their names. Hence, he was able to successfully recall and identify each individual by relating their identity with their place at the table (Dunlosky & Bjork, 2008).

This technique that Simonides employed in order to remember the guests became known as the method of loci. Despite its ancient origin, the method of loci came to be one of the most popular and powerful mnemonic techniques employed for millennia. Furthermore, this discovery has had significant implications for subsequent research on the nature of the human memory system as well as on how to improve performance of such a system. Hence, the discovery has had a significant impact on metamemory research. This is because the very use of such a mnemonic device as the method of loci is considered as a metacognitive act (Dunlosky & Bjork, 2008) that is specific to memory. Therefore, it is considered as a metamemory act.

Discussions on the nature of thought, memory, introspection, and self-reflection can also be traced back to ancient philosophers, from Aristotle to Descartes (Dunlosky & Bjork, 2008). Aristotle devised a theory of metamemory and distinguished between the passive recall of information or past events versus deliberate attempts to recall such information. The latter is considered to be subsumed within the realm of metacognitive acts since it requires self-reflection,

a phenomenon that is, according to Aristotle, specific to only humans (Dunlosky & Bjork, 2008). Descartes was another philosopher to discuss the broader concept of metacognition as he emphasized the significance of self-reflection in any cognitive endeavour.

Although theorizing over metacognition dates back to millennia ago, the formal study of the construct only started in the mid-20th century (Metcalf, 2000). The formal study of metacognition and, more specifically, metamemory were not established until the mid-20th century because of the dominance of behaviourism within the field of psychology. According to behaviourist principles, only observable behaviour was deemed capable of being studied systematically. Cognitive and other unobservable phenomena, therefore, had been almost completely disregarded. In the mid-20th century, however, the field of psychology saw a radical shift in perspectives in what became known as the cognitive revolution. Researchers no longer saw learning as a product of stimulus-and-response, imitation and repetition. They no longer viewed learning as simple behaviours to be acquired as they were presented. They no longer viewed humans as passive receptors of information for which they were later responsible for reproducing. Instead, learning came to be viewed as a product of more complex internal processes— otherwise known as cognition. With this shift in perspectives, researchers started to become interested in the internal cognitive mechanisms of humans and how these mechanisms contributed to the learning process (Feldman, 2011).

Subsumed within the broader cognitive revolution was the most prominent of cognitive learning theories— information processing theories. According to information processing theories, the brain is an intricate processor, analogous to a computer, which meticulously selects input, processes it to build understanding, and stores it in LTM. Such theories focus on issues such as perception, attention, and memory (Nodoushan, 2008). Short-term memory, WM, and LTM

processes became a key focus of the movement, particularly regarding processing capacities and limitations among humans (Wildman, 2008). According to information-processing theories, the varying range of learners' capacities is a result of their varying processing levels. Moreover, as learners develop and practise cognitive processing, they gradually become more skilled at processing stimuli (Wildenberg & Van der Molen, 2004; as cited in Feldman, 2011). Metacognition, an individual's knowledge and control of their cognition, is also a crucial facet of information processing theories, and metacognition is what paved the way for an understanding of and systematic research on metamemory.

Systematic research into the construct metamemory started before the term was even coined (Dunlosky & Bjork, 2008). It dates back to 1965, when Joseph Hart conducted what is considered as "the first objective metamemory research" (Bjork, 2016, p.7). At the time, Hart conducted experimental research on the construct of tip-of-the-tongue (TOT) effects, a particular metamemory phenomenon, by examining individuals' feeling of knowing (FOK) judgments (refer to the section 2.5 for a better understanding of FOK and TOT) for certain information that they were responsible for recalling. He found that individuals were well-engaged in self-monitoring and control of their memories. When these individuals were asked general knowledge questions, they were particularly successful in predicting their capacity to accurately select the correct answer from a number of alternatives. Although their predictions were not perfect, they were relatively successful in judging their ability to recall certain information accurately. In accomplishing his task, Hart devised a new task aimed at measuring individuals' recall judgment accuracy, a task that was accompanied with a memory task aimed to establish the level of accuracy of such judgments. One of Hart's findings was that individuals have relatively accurate metamemory

states. That is, when their metamemory judgments suggest that they knew or remembered something, it was likely that they actually knew or remembered it (Hart, 1967).

Not long after Hart's work, Flavell assigned a term to this knowledge, monitoring, and control of one's own learning. He thus coined the terms metacognition and, specifically metamemory, a particular kind of metacognition relative to memory (Flavell, 1971). Flavell (1979) provided a theoretical framework for comprehending and studying metacognition and its more specific constituent metamemory.

2.3.2. Metacognition and Flavell

As outlined in the previous section, the cognitive revolution and the increasing emphasis on the 'individual' in learning led to a proliferating interest in metacognition. Several definitions have been assigned to the term metacognition. Tobias and Everson (2009) describe it as "a higher-order, executive process that monitors and coordinates other cognitive processes engaged during learning, such as recall, rehearsal, or problem solving to name a few" (p.108). Kuhn and Dean (2004) define it as an "awareness and management of one's own thought" (p. 270). Garner (1987) defines metacognition as individuals' knowledge and apprehension of what they know as well as how they think and their ability to regulate their thinking.

Flavell defines the term simply as "thinking about thinking" (Flavell, 1979, p. 906) and stresses the significance of metacognitive processes in learning and development. Flavell (1979) originally stated four crucial elements to monitoring any cognitive task: (a) metacognitive knowledge, (b) metacognitive experiences, (c) goals (or tasks), and (d) actions (or strategies). Some researchers (Brown, 1987; Cross & Paris, 1988; Harris, Santangelo, & Graham, 2010; Jacobs & Paris, 1987; Schraw & Moshman, 1995; Schraw et al., 2006), however, divide metacognition into two general components: knowledge and regulation, along with their sub-

components. Tobias and Everson (2002) (cited in Tobias & Everson (2009)) divide metacognition into three components: knowledge about cognition, monitoring cognition, and control of cognition. Today, two main components are agreed upon: knowledge and conscious regulation of cognition (Brown, 1978; Harris, Graham, Brindle, & Sandmel, 2009; Jacobs & Paris, 1987).

Metacognitive knowledge is considered as an individuals' knowledge concerning their cognitive processes. An example of this component of metacognition is a learner's knowledge that s/he finds learning a foreign language much easier than learning mathematics. Another example is one's knowledge that s/he learns more easily visually than, for instance, through lectures. Flavell (1979) categorizes this component into three types of variables: person, task, and strategy variables. Other researchers have categorized metacognitive knowledge into declarative, conditional and procedural knowledge (McCormick, 2003).

The 'person variable', or declarative knowledge, is considered as the knowledge individuals have about their own as well as others' cognitive processes (Flavell, 1979, Kuhn & Dean, 2004). For instance, a learner may know that s/he has not mastered a target language's grammar well, in contrast to vocabulary or pronunciation. At the same time, s/he may know that others have mastered the grammar more than s/he has while s/he is more accurate at pronunciation. In addition to person knowledge, Flavell (1979) discussed task and strategy knowledge. Task knowledge refers to the knowledge an individual has of the demands of a certain task (Flavell, 1979). A learner, for instance, may be well aware that the cognitive demands for writing an argumentative essay are greater than those for writing a narrative or compare-and-contrast essay. Whereas task knowledge refers to the knowledge of the demands of a learning task, strategy knowledge is the knowledge of how to approach such a task. This includes what strategies are more effective for one task as opposed to another. The same learner who knows that argumentative

essays are more cognitively demanding than narrative essays (task knowledge) may also know the specific strategies available for developing argumentation versus those for developing narration. For instance, s/he may know that s/he should memorize many facts about his/her topic of argument for the argumentative essay whereas for the narrative essay s/he should practice certain techniques for developing a story. This knowledge of strategy variables is what is sometimes labeled by other researchers (Kuhn & Dean, 2004) as procedural knowledge. Some researchers argue that while procedural knowledge is general knowledge of particular strategies, conditional knowledge is needed to know ‘when’ and ‘why’ particular strategies should be used as opposed to others (refer to figure 2.1 for a visual representation of the different constituents of metacognition).

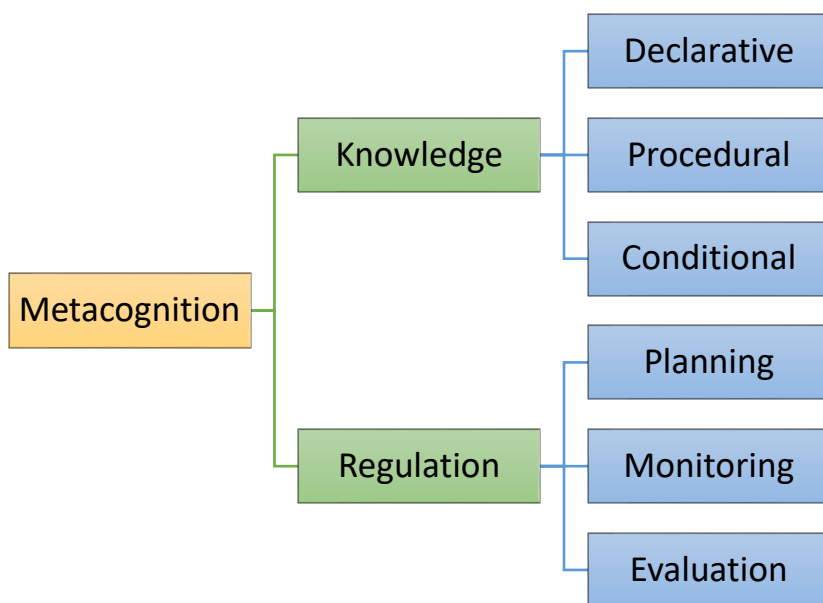


Figure 2. 1. Components of Metacognition (Flavell, 1979)

The second component metacognition is regulation (Harris et al., 2009). Whereas knowledge is considered as an awareness of cognition, or an individual’s knowledge of his/her thinking processes, regulation is considered as a conscious control of those processes (Brown, 1978; Jacobs & Paris, 1987). This component of metacognition is generally divided into three processes: planning, monitoring, and evaluation (Cross & Paris, 1988, Schraw et al., 2006). The

first regulation process, planning, entails goal-setting, time management, and the allocation of resources and strategies to accomplish a learning task and achieve a set objective (Schraw et al., 2006). A learner may set the goal of mastering the different tenses (goal-setting) in a new language, so s/he may devote each week to learning a new tense (time management). S/he may accomplish this by using a combination of books, the internet and asking his/her teachers (allocation of resources). In addition, s/he may devote one hour daily (time management) to practising using the tenses, which s/he may do orally or in writing, either of which would require constructing practical examples from his/her real life (allocation of strategies).

The second regulation process is monitoring. Monitoring entails consciously checking progress being made in the learning task. Flavell (1979) called this process metacognitive experience. The same learner can monitor his/her progress in his/her mastery of the different tenses, in his/her ability to keep up with the set schedule, in the effectiveness of the sources s/he is using, and everything else associated with his/her learning task and what s/he has planned. The ability to monitor learning is a crucial factor in successful learning (Tobias & Everson, 2002; cited in Tobias & Everson, 2009). According to Tobias and Everson (2009), those with high levels of metacognitive monitoring are more apt at accurately filtering stimuli in order to distinguish the new from the familiar; consequently, they invest their study-time more wisely. The authors also argue that monitoring is the foundation for higher-level metacognitive processes.

Evaluation, the final regulation process, entails judging the end-product, or the outcome, of a learning task, particularly how well the task has been accomplished (Schraw et al., 2006). The same learner who has planned for and monitored his/her grammar learning task will most likely assess the extent to which s/he has been successful in accomplishing his/her goals. At the end of his/her allotted time, s/he may evaluate not only his/her success at accomplishing the task, but s/he

may also evaluate the success of the strategies s/he has used as well as time management skills. Meanwhile, the assessment of such a learning task may serve as a basis on which s/he sets new goals and make other changes in accordance with any possible gaps (Schraw et al., 2006).

Accordingly, while metacognition refers to an individual's knowledge, monitoring, and regulation of their cognitive processes, metamemory specifically refers to the individual's knowledge, monitoring, and regulation of their memory processes. Hence, metamemory is considered as a type of metacognition (Nelson, 2001). Flavell (1971) defines metamemory as an "intelligent structuring and storage of input, of intelligent search and retrieval operations, and of intelligent monitoring and knowledge of these storage and retrieval operations" (p.277). Likewise, Flavell and Wellman (1977) defined the construct as an "individual's knowledge of and awareness of memory, or of anything pertinent to information storage and retrieval" (p.4). In sum, the term metamemory can be used to refer to a) the knowledge one has of his/her memory abilities and processes, b) the monitoring and evaluating of such memory abilities and processes; and c) the use of such knowledge for devising strategies aimed at managing one's memory processes or performance.

Like general metacognition, the first category of metamemory is knowledge. This can include not only knowledge of one's memory abilities, but also knowledge of strategies for improving as well as self-monitoring memory performance (Pannu & Kaszniak, 2005). Such knowledge of one's memory system is divided into two broad categories: knowledge of memory function and one's opinion of his/her memory abilities (Hultsch, Hertzog, Dixon, & Davidson, 1988). Weed et al. (1990) adds that this knowledge of one's memory subsumes knowledge of person, task, and strategy variables affecting one's memory. Weed et al.'s (1990) categorization is parallel to Flavell's categorization of person, task, and strategy variables when it comes to general

metacognitive knowledge. An example of person variables is the knowledge that one's memory performance is rather weak compared to others. An example of a task variable is the knowledge that certain information is more difficult to remember than other information. An example of a strategy variable is the knowledge that the use of a certain strategy, like using mnemonics, is more effective for remembering things than maybe other strategies.

Again, like in the case of general metacognition, another category of metamemory is monitoring. Memory monitoring generally refers to the process of supervising or overseeing the process of learning and remembering information. For instance, when language learners are exposed to new information or a list of new vocabulary items, they may frequently monitor their progress in their attempts at remembering such items. This may be, for instance, trying to recall them as a list or intentionally trying to employ them within a certain context. Yet another category of metamemory is evaluation, which is also parallel to general metacognitive evaluation. Hence, once monitoring has taken place, the learner can then evaluate his/her success in completing his/her learning task or attaining his/her goal. Therefore, monitoring and evaluation are complementary in the sense that monitoring takes place at the level of processing while evaluation takes place at the level of the end product, or at the end of a task.

Furthermore, Flavell and Wellman (1977) distinguish between two types of metamemory: declarative and procedural metamemory. The former encompasses knowledge and beliefs an individual has of his/her memory as well as factors that may influence his/her memory performance or processing. The latter, however, encompasses knowledge, beliefs, and judgments that an individual holds about his/her monitoring and control processes. Although it is believed that declarative metamemory is rather automatic, considering that children develop it at a rather young age, the same could not be said about procedural metamemory. Children may have

knowledge and beliefs of their memory abilities, but generally do not possess the knowledge of how to improve their performance (Ornstein, Haden & Elischberger, 2006).

Such knowledge, monitoring, and evaluation of one's memory are believed to be vital for the learning process as well as learning outcomes. For instance, when an individual evaluates his/her success in learning certain information, which is called judgment of learning (refer to section 2.5 for a detailed description), s/he may plan other tasks depending on the outcome of such an evaluation. Without judgment of learning, the individual may not allocate his/her time or strategy use appropriately to the most relevant tasks (Nelson, 1990). Upon monitoring and evaluation, however, a learner can recognize and consequently target gaps or weaknesses in his/her progress via employment of appropriate strategies, some of the most common of which are memory strategies. Memory strategies facilitate the process of storage and retrieval of information from memory (Oxford, 1990). They are consciously employed by an individual to help him/her achieve a desired level of memory performance. Examples of such strategies are mnemonic devices and association between ideas or concepts. The very knowledge and effortful use of memory strategies is subsumed under the category of metamemory. Accordingly, examples of metamemory processes include dividing and allocating time to different learning tasks, deciding on what kind of memory strategies are most suitable for memorizing various items, and deciding on what strategies are most suitable for their retrieval.

Although the formal study of metamemory as a distinct field started with Flavell, researchers before him also included metamemorial processes in their work. For instance, Miller, Galanter, and Pribram (1960) included in their research a mechanism that they believed was responsible for monitoring and controlling their learning; this mechanism is purely metacognitive (Dunlosky & Bjork, 2008). This mechanism became highly influential in subsequent metamemory

theories. Likewise, Atkinson and Shiffrin's (1968) work on memory included a metamemory mechanism, before the construct metamemory was even formalized. Atkinson and Shiffrin's (1968) model of memory assumed a sensory store through which external stimuli are passed before transitioning into a STM store. Afterwards, these stimuli either transition further into the LTM store (via proper reinforcement) or decay. This is the point at which an individual is believed to employ memory monitoring and control (i.e. metamemory) processes. That is, according to this model, metamemory processes are believed to be responsible for enabling individuals to make decisions like either reinforcing such stimuli enough so that they transition into the LTM store, or choosing to allow them to decay for their lack of significance or practicality. This active monitoring and control of stimuli through the memory stores is in itself a metacognitive act, more specifically, a metamemory act. Therefore, this first model of memory included a metamemory mechanism before metamemory as a construct was even established (Dunlosky & Bjork, 2008) (refer back to Section 1.4. for a more detailed explanation of the model).

2.3.3. Metamemory and Other Researchers

While some researchers before Flavell included metamemory in their works and therefore contributed to some extent to the metamemory literature, other researchers after him have significantly contributed to the flourishing metamemory literature in their own ways. Another figure worth mentioning in the metamemory paradigm is Henry Wellman, who was a proponent of metamemory being an independent field of research and was one of the first to contribute to this research. Likewise, Anne Brown was a proponent of metamemory and a major contributor to developing the metamemory-in-education paradigm. She emphasized the need to conduct research on metamemory in a natural educational setting as opposed to the controlled experiments

conducted in a laboratory setting. Furthermore, she called for the need to devise interventions aimed at improving children's metamemory (Tauber & Dunlosky, 2016).

While these researchers all significantly contributed to the growth and understanding of metamemory as a research field, it was not until the 1980's, however, that a theoretical framework of the construct of metamemory was devised by Nelson and Narens (Nelson & Narens, 1990). This was the framework that subsequently paved the way for a wave of research on metacognition and metamemory (Tauber & Dunlosky, 2016). Accordingly, Brown, Wellman, Flavell, and Nelson and Narens were significant contributors to the growth in metamemory research for decades, a growth that has set the stage for the rich field of metamemory research today (Tauber & Dunlosky, 2016).

2.4. Model of Metamemory

2.4.1. Nelson and Narens's (1990) Model of Metamemory

Nelson and Narens's (1990) model is the first in the literature on metamemory. In this model (figure 2.2), Nelson and Narens (1990) present a hierarchy of two cognitive levels: the meta-level and the object level. These two levels are complementary; they exchange information via monitoring and control processes. The lower level, the object-level, sends information to the upper-level, the meta-level, via monitoring. The meta-level then employs information obtained from the object level to exercise control over it via provision of information and necessary alterations. Nelson and Narens (1990) differentiate between monitoring and control by stating that monitoring is "analogous to listening to the telephone handset-is that the meta-level is informed

by the object-level” (p.127), while control “is analogous to speaking into a telephone handset-is that the meta-level modifies the object-level” (p.127).

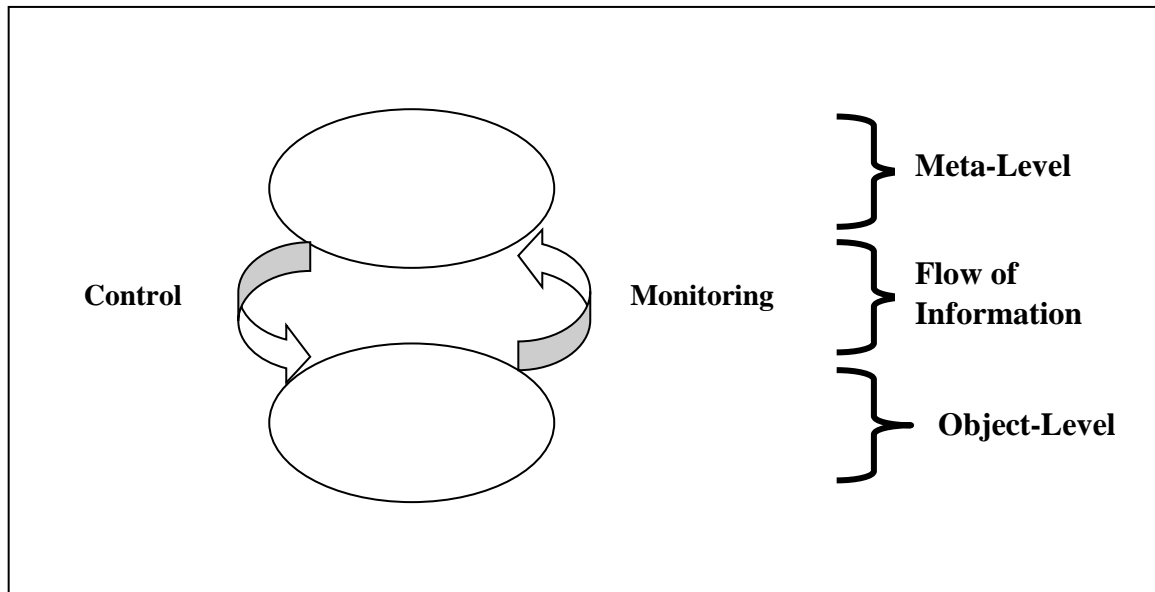


Figure 2. 2. Nelson and Narens (1990) Model of Metamemory

In essence, monitoring evaluates cognitive tasks at the meta-level while control allows coordination or management of cognitive processes and tasks to suit relevant objectives—objectives that had been devised as a result of the monitoring done by the object level. Hence, the exchange of information is cyclic. Nelson and Narens (1990) constructed this framework in order to highlight the interwoven nature of metamemory and memory.

In the context of language learning, one may illustrate monitoring processes with a learner’s decision to evaluate his/her progress in learning the target language. This can be realized in several ways. A learner can evaluate his/her development in terms of comprehending native speakers, or s/he can evaluate his/her acquisition of vocabulary items. Control, on the other hand, is illustrated when the learner decides to alter his/her study habits or strategies when s/he realizes s/he has not acquired the desired amount of vocabulary, or when s/he realizes that s/he has not made enough progress to fully understand native speakers of the target language. Monitoring,

therefore, is employed as a basis on which an individual makes his/her control decisions, which are then monitored again (Tauber & Dunlosky, 2016).

The object level in this model represents memory while the meta-level represents metamemory. Hence, metamemory is responsible for overseeing memory and learning processes at the object-level, after which these processes are regulated, again, via the meta-level. Figure 2.2 illustrates. As an extension of the original model, Nelson and Narens (1990) proposed a second version. In the extended model, the authors elaborate on the two processes of monitoring and control. In doing so, they provide details of the different memory monitoring and as well as memory control sub-processes as they are activated in the acquisition and retrieval stages of memory. Nelson and Narens's (1990) model has been the most influential in the field of metamemory, with researchers continuing to employ it today as a framework for the broad field of metamemory research. The extended model is in the section that follows.

2.4.2. Nelson and Narens's (1990) Extended Model

Nelson and Narens (1990) elaborated on the nature of the elements of metamemory by providing a description of the kind of learning judgments made by learners. The judgments of learning are provided in their extended model, presented in figure 2.3. The model is divided into two dashed panels. The top panel represents the various monitoring judgments while the lower panel represents control sub-processes that occur at the stages of acquisition and retrieval of memory.

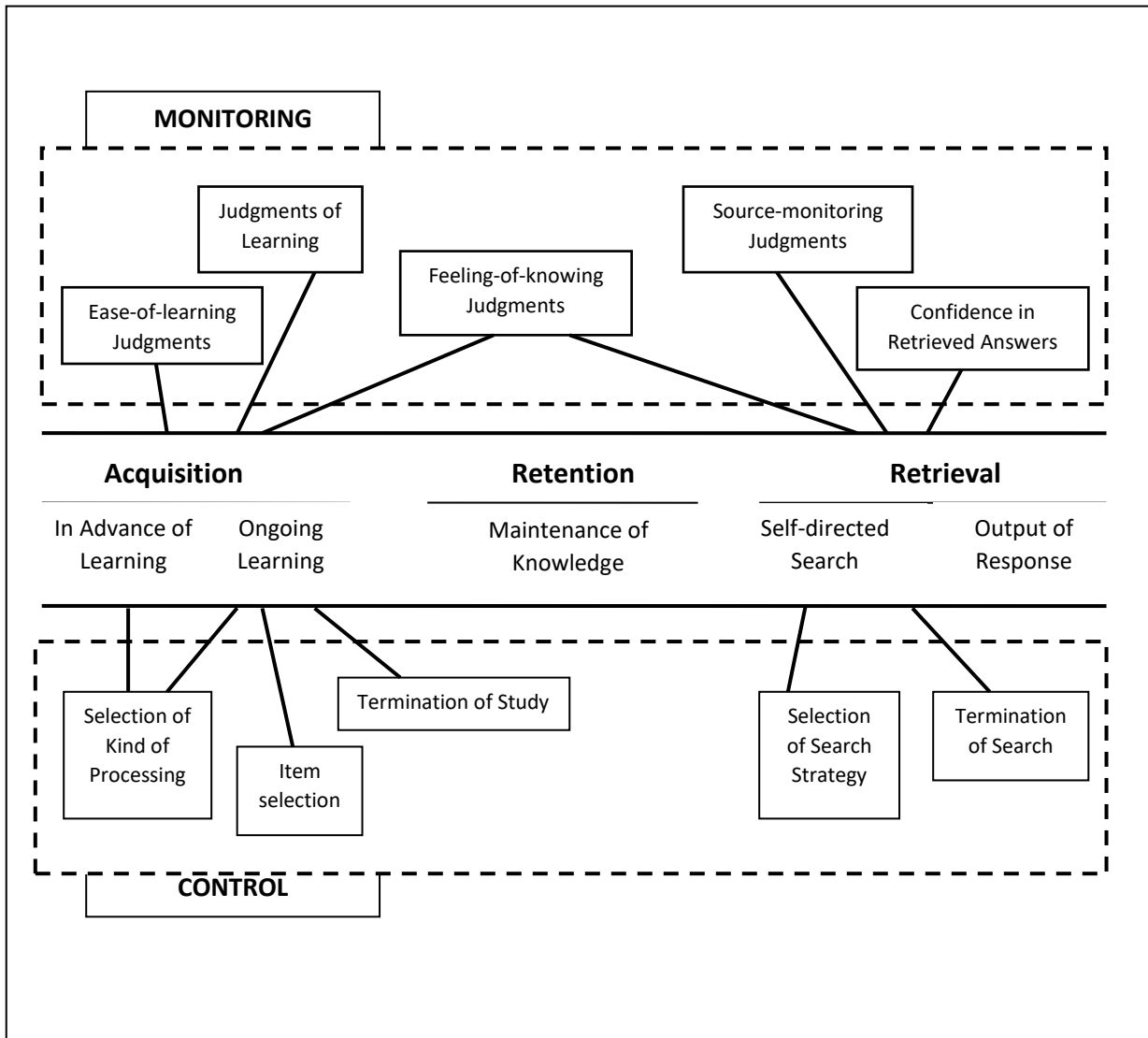


Figure 2. 3. Nelson and Narens (1990) Developed Model

First, the stage of acquisition encompasses that which comes prior to, or in advance of, learning and that which comes during the ongoing learning process. According to the authors, prior to studying, a learner undergoes the process of determining his/her goals. This means the learner develops a sense of what s/he has to remember for a particular learning task such as a test or a presentation. At the stage of acquisition, three monitoring processes are highlighted: Ease of learning judgments (EOL), Judgments of learning (JOLs), and Feeling of Knowing judgments (FOK) (Nelson & Narens, 1990). When an individual develops a sense of what s/he has to

remember, EOL judgment is made about the target task. S/he decides on what s/he believes will be the level of difficulty or ease with which s/he may accomplish the prospective learning task and, therefore, the amount of effort it may require to achieve his/her goal.

Judgments of learning are believed to be made both prior to and during the ongoing learning process. According to Schwartz (1994), EOL judgments comprise a subcategory of JOL. An EOL judgment is one kind of JOL (refer to section 2.5 on metamemory paradigms for more information on JOLs). During the second phase of acquisition, the ongoing learning process, the learner can activate JOL, or judgment-of-knowing, process in order to assess his/her status in the ongoing task (Nelson & Narens, 1990). For instance, the learner can make the judgment that s/he is finding the task rather difficult, which would be either in accordance with or contrary to what s/he had previously expected (Nelson & Narens, 1990). The final monitoring process that occurs in the acquisition stage is the feeling-of-knowing (FOK) judgments. These are judgments about an item that may not be recallable at the current state, is familiar to the individual, and may possibly be recalled later at the retention phase. The authors add that, after attempts to learn a certain item, a judgment is made by the learner about his/her state of learning. If the learner cannot recall the item, a FOK judgment is made; if the item is recallable, however, a JOL is experienced.

In the second stage of monitoring, retention, the learner is solely responsible for maintaining, or storing, a certain amount of the information in his/her memory for later retrieval and use. No monitoring of memory sub-processes has been assigned or associated with this stage.

The final stage, retrieval, encompasses two phases; these are what Nelson and Narens (1990) term self-directed search and the output of response. The former refers to a learner's conscious use of cues to initiate a search for a particular item. For instance, an individual may retrace his/her steps to try and find his/her missing keys, or in the context of language learning, a

learner may use a mnemonic device to remember the order of adjectives in a sentence. The latter phase, output of response, refers to the output produced by the individual. At the stage of retrieval, three processes are highlighted: feeling-of-knowing judgments, source-monitoring judgments, and confidence in retrieved answers. A Feeling-of-knowing is the judgment one makes about the extent to which s/he can retrieve the particular item or information. A source-monitoring judgment is an individual's judgment about the source of a particular memory, like having knowledge that one learned a particular fact from a certain teacher in high school. Confidence in retrieved answers is the learner's judgment about the level of success in retrieval (Nelson & Narens, 1990).

In sum, Nelson and Narens (1990) made a distinction between retrospective and prospective monitoring. The former refers to the judgments made about a preceding recall response while the latter refers to a judgment made about an upcoming response. Prospective memory monitoring processes comprise ease-of-learning (EOL) judgments, judgments-of-learning (JOL), and feeling-of-knowing (FOK) judgments. The EOL judgments take place prior to acquisition. The second process, JOL, can take place prior to or during the acquisition stage and FOK judgments. It has also been stated that FOK judgments, although carrying some degree of accuracy, are not always accurate (Costermans, Lories, & Ansay, 1992).

Furthermore, the meta-level (monitoring) and the object level (control) are in coordination with each other. Based on the monitoring judgments made by the individual at the meta-level, control decisions are carried out at the cognitive, or object, level. For instance, at the retrieval stage, based on the learner's confidence in the retrieved answer, s/he may either choose to terminate the search, or s/he may choose to select a new search strategy. Likewise, at the acquisition stage, the task's perceived difficulty will more likely than not influence the selection of the kind of processing to be carried out. A more difficult or cognitively demanding task may

call for the learner to use more hands on or active processing while a simpler acquisition task may call for more passive or effortless acquisition (Nelson & Narens, 1990).

2.5. Metamemory Paradigms

2.5.1. Feeling-of-knowing Judgments

The literature on metamemory is comprised of an accumulation of various ‘paradigms’ that attempt to account for numerous phenomena related to metamemory. The first of the metamemory paradigms is FOK judgment. This is an individual’s judgment about the extent to which s/he is familiar with certain information. Schwartz (1994) outlines four sub-categories of FOK judgments, one of which is EOL, a significant judgment mentioned in Nelson and Narens’s (1990) model. Interest in FOK judgments dates back to 1965 when Joseph Hart conducted the first experimental study on the phenomenon (Metcalf & Dunlosky, 2008). Hart asked his subjects to answer a range of questions and examined participants’ answers. For each question that was not answered correctly or was not answered at all, the participants were asked to make a FOK judgment. That is, they were asked to judge their ability to select the correct answer if provided in multiple-choice format. Afterwards, the same questions were asked in multiple-choice format in order to measure the participants’ accuracy of FOK judgments. For the most part, those who felt they would recognize the answer in multiple-choice format subsequently did answer it correctly while those who felt they would not recognize the answer subsequently failed to answer correctly. That meant that these individuals’ FOK judgments were significantly accurate in predicting their actual ability to answer the question in a later recognition test, despite having originally answered it incorrectly (Metcalf & Dunlosky, 2008). Hart’s experiment consisted of three different tasks. The first task (directly answering) is known as a recall task. The second task, making FOK judgments, was a judgment task, and the final task (answering multiple-choice questions) was a recognition task.

This is because they were assigned the task of recognizing a correct answer from a range of different answers. Hence, this method that was developed by Hart was called the ‘recall-judge-recognize’ method (Metcalf & Dunlosky, 2008).

2.5.1.1. Theories of Feeling-of-knowing Judgments

Development of the construct of FOK judgments has given rise to an interest in the nature of the phenomenon and how people come to accurately predict their ability to retrieve certain information despite not being able to retrieve it at a current state. Researchers have thus devised a few theories in attempts to account for this phenomenon: the cue-familiarity hypothesis, the partial-target accessibility hypothesis, the competition hypothesis, and the interactive hypothesis.

2.5.1.1.1. Cue Familiarity Hypothesis

Devised by Reder and Ritter (1992), the cue familiarity hypothesis is based on the assumption that an individual can assess his/her ability to correctly answer a question prior to trying to answer it. The question, considered as the cue, is believed to be the element that is critical for making metamemory judgments (Reder & Ritter, 1992). Hence, according to this theory, metamemory judgments are made based on the learner’s familiarity with the question (cue) itself or the content/ domain of the question (Metcalf, 2000; Metcalf & Dunlosky, 2008). An individual is, therefore, more likely to judge that they know the answer to a question for which the topic is more familiar as compared to a novel topic. Moreover, the more familiar the content is to the learner, the more likely the learner will later be able to recognize the answer, even one that s/he initially could not recall (Metcalf & Dunlosky, 2008).

If a learner, for instance, was asked a question in the field of grammar, and this learner knows that s/he has sufficient knowledge in grammar because of all of the books that s/he has been reading and practice s/he has been doing, then, according to the cue familiarity hypothesis, s/he

can make a relatively accurate judgment on his/her ability to answer a certain grammar question before attempting to do so. His/her judgment will more likely than not be an accurate one (Metcalf & Dunlosky, 2008). It is also believed that a cue's higher level of familiarity can serve as a strategy for learners in making accurate predictions. For instance, when faced with a question within a familiar domain, and the learner does not know the precise answer to the question, s/he can use his/her knowledge of the field to narrow down his/her choices, making his/her more likely to make an accurate prediction (Metcalf & Dunlosky, 2008).

2.5.1.1.2. Partial-target Accessibility Hypothesis

The partial-target accessibility hypothesis was devised by Koriat (1993). According to this theory, metamemory judgments are based on recalled information rather than familiarity of the question (Metcalf, 2000). In this respect, partial knowledge about the target information is used as a basis for making FOK judgments (Metcalf & Dunlosky, 2008). Unlike in the cue-familiarity hypothesis, individuals are unaware of the level of accuracy of the recalled information. For instance, when one is asked about a particular lexical item, s/he may know the meaning of an affix (hence 'part' of the target) within the lexical item, and s/he may have come across the root before, so s/he can make a guess as to the whole meaning. Although this learner is not confident in the answer's accuracy, s/he can make a FOK judgment based only on the partial knowledge s/he has of the target, and if presented with a series of answers to choose from, s/he will most likely select the correct answer. Accordingly, this accessibility to the partial target (the affix, in this case) is sufficient for the learner to make a relatively confident FOK judgment (Koriat, 1993; Metcalf & Dunlosky, 2008).

2.5.1.1.3. Competition Hypothesis

According to this theory, learners' metamemory judgments are dependent on the kind of competition available at retrieval. When the target information faces more competitors at retrieval, it would be more difficult to retrieve the target information. On the other hand, when fewer competitors are available, the target information is more easily accessible. These competitors are considered as a source of interference for target retrieval. Contrary to the partial-target accessibility hypothesis, in which the partially accessible target (the affix) is considered as a source of help in retrieving the target information and making metamemory judgments, the competition hypothesis considers this partially accessible target as a hindrance and a source of distraction; i.e., it is considered as competition (Maki, 1999).

2.5.1.1.4. Interactive Hypothesis

The interactive hypothesis can be considered as a hybrid theory, encompassing concepts from both the cue-familiarity hypothesis and the partial-target accessibility hypothesis. According to this theory, both cues (familiarity and accessibility) account for FOK judgments made by learners (Metcalf & Dunlosky, 2008). Initially, cue familiarity is utilized in attempts to make a judgment. Once cue-familiarity proves insufficient to make a judgment or retrieve the target information, accessibility is employed (Koriat & Levy-Sadot, 2001). This, according to some researchers, is what accounts for some time differences reflected in the metamemory judgments made by different learners. Those who make quicker judgments are believed to base their judgments on only cue-familiarity while those who take longer are believed to employ both cue-familiarity and partial-target accessibility to make judgments (Koriat & Levy-Sadot, 2001).

2.5.2. Tip-of-the-tongue State

A tip-of-the-tongue (TOT) state is an experience in which an individual is unable to recall a word even though they have been so familiar with it before that particular attempt (Brown, 1991).

Those experiencing a TOT state are often able to retrieve at least a portion of the word or its features. An individual can remember, for instance, that the word starts and/or ends with a certain letter, or s/he can remember that the word is a long or short one with many or a few consonants or that it is difficult to pronounce (Brown & McNeill, 1966). Interest in TOT phenomena dates back to early psychology with William James (1842-1910). Also a significant metamemory paradigm, a TOT experience is considered to be very similar to a FOK judgment. Some researchers believe that a TOT state is a highly amplified version of a FOK experience. Other researchers have distinguished between a TOT state and a FOK judgment. The latter, FOK judgment, is described as a judgment one makes that s/he will be able to retrieve or recognize currently inaccessible target information if and when this individual is provided with some sort of recognition test, such as multiple-choice questions. However, the former, TOT state, is considered as a current state in which an individual has partial recall of a term, yet the term is inaccessible, and that this individual is so confident of his/her knowledge of the term; the only issue is accessibility (Metcalfe & Dunlosky, 2008).

2.5.2.1. Tip-of-the- tongue Theories

Three main theories have been devised in attempts to account for the TOT phenomenon: the partial-target access (PTA) theory, the lexical-access without phonological-access (LAWPA) theory, and the blocking theory. The first theory, PTA, is similar to the partial-target accessibility hypothesis of FOK judgments. It holds that TOT states are a product of an individual's ability to access only a portion of the target word (Metcalfe & Dunlosky, 2008). Some researchers have found that individuals experiencing TOT states have been able to recall the first letter of the word, its meaning, or the even number of syllables in the target word (Schwartz, 2002). The second theory, the LAWPA theory, posits that the phenomenon occurs as a result of a lack of association

between phonological-level and semantic-level processing. This lack of association is what leads to the accurate retrieval of the meaning or features of the word without being able to construct a full phonological representation or vice versa. Hence, the individual actually does know the answer but has difficulty constructing an articulation for it (Metcalf & Dunlosky, 2008). The third theory, the blocking theory, posits that the appearance of an incorrect answer is what hinders or blocks an individual's ability to retrieve the correct answer (Metcalf & Dunlosky, 2008). This theory is similar to FOK paradigm's competition hypothesis. The incorrect answer serves as the competition that prevents access to the correct answer.

2.5.3. Other Metamemory Paradigms

2.5.3.1. Judgments of Learning

Judgments of learning (JOLs) are assessments made by individuals about a learning process. These assessments are considered of vital importance for an individual. They can be made during or after the learning process and are crucial for the learner when it comes to developing an idea of how well s/he is learning or has learned the material (Metcalf & Dunlosky, 2008). These judgments are therefore considered vital for learners when it comes to making decisions about how they study. If a learner, for instance, sees that s/he is successful in acquiring some target knowledge, s/he may choose to abort the study session so s/he can devote his/her time to something that has yet to be learned; s/he may choose to reinforce the acquired knowledge at a later time, or s/he may choose to continue studying until s/he has completed his/her allotted study time. On the other hand, if a learner sees that s/he has difficulty acquiring certain knowledge even after multiple trials, s/he may choose to devote extra study time for the learning task, or s/he may decide to seek help from someone else, or s/he may decide to take a different action. Hence, study decisions are highly influenced by JOLs that individuals make throughout or after a learning task (Metcalf &

Dunlosky, 2008). These JOLs, however, should be relatively accurate for monitoring and control of learning to be successful (Metcalfe & Dunlosky, 2008). This is because an individual can falsely assess his/her learning as successful and abort the task, or s/he may devote unnecessary time and effort to a learning task that s/he believes s/he has not mastered when s/he actually has (Metcalfe & Dunlosky, 2008).

2.5.3.2. Source Judgments

Another metamemory paradigm is the category of source judgments. These refer to the judgments made about the source(s) of acquired information or memories (Metcalfe & Dunlosky, 2008). An individual, for instance, can make a source judgment when s/he tries to remember from where s/he acquired certain information. Source judgments are also made if s/he tries to remember the subtle details of general information or memories. For instance, s/he may remember that his/her friend called his/her in the afternoon, but s/he may try to backtrack whether it was before or after lunch. An individual's inability to successfully target the source of memory or information may lead to further issues such as unintentional plagiarism, lack of confidence in the reliability of the corresponding information, or even lack of confidence in one's ability to retrieve information effectively (Metcalfe & Dunlosky, 2008).

2.5.3.3. Remember/ Know Judgments

Another metamemory paradigm is the remembering versus knowing judgment. This refers to an individual's ability to differentiate between information and events that they remember versus those that they simply know. Remembering refers to information and events that can be distinctly recalled and those for which an individual can construct a mental image of the time and/or circumstances under which they had taken place. Knowing, however, refers to events or information that an individual simply knows and those with which no distinct recollection is

associated. For instance, an individual can clearly recollect his/her everything s/he learned in his/her first college lecture (remember judgment) and associate such information with that particular lecture in that particular day, under such and such circumstances. However, s/he may know certain other information while not being able to associate the information with any particular memory. For instance, s/he may know information from the same course, but s/he may not be able to associate such information with any particular memory or circumstances, or s/he may even not be sure if s/he actually acquired the information from that course and lecturer or elsewhere (know judgment) (Metcalfe & Dunlosky, 2008). This category of metamemory, the ability to distinguish between remembering and knowing judgments, is believed to be highly significant for individuals and their understanding of their own memories.

Information or events that can clearly be recollected are believed to be ‘true’ and believed to require explicit memories while those that are simply known are considered mere feelings of familiarity that require implicit memories (Metcalfe & Dunlosky, 2008). The actual nature and source of the two distinct memories are questioned in the literature as some believe that the two are a product of two different memory systems whereas others believe they are simply a product of different levels of storage efficiency with more efficiently stored information being distinctly recalled later and less efficiently stored information being merely recognized (Metcalfe & Dunlosky, 2008). Either way, this paradigm of metamemory sheds light on the level consciousness individuals have over their own memory processes.

Accordingly, the aforementioned paradigms represent the various kinds of judgments of one’s memory that are known to be subsumed under the broader category of metamemory. These judgments include, but are not limited to, FOK judgments, TOT judgments, JOLs, source judgments, and remember/ know judgments (Metcalfe & Dunlosky, 2008).

2.6. Measuring Metamemory

Metamemory has been measured using various methods, depending on which aspect is being measured. Flavell and Wellman (1977) distinguish between two types of metamemory: declarative metamemory, which encompasses knowledge and beliefs an individual has of his/her memory as well as factors that may influence his/her memory performance or processing, and procedural metamemory, which encompasses knowledge, beliefs, and judgments an individual holds about his/her monitoring and control processes. In the case of procedural metamemory, it is usually measured via questions accompanied by a memory performance task. On the other hand, declarative metamemory is most often measured using questionnaires (Cavanaugh & Perlmutter, 1982; Khatoon & Roy, 2017).

The first means of measuring metamemory is through questions that are accompanied with a concurrent memory performance task, especially when measuring procedural metamemory (Cavanaugh & Perlmutter, 1982). Most often, this is accomplished via measures of either EOL judgments, FOK judgments, or JOL. Individuals make judgments (as per the type of judgment being measured) about their learning, then they perform the learning task, and afterwards, the judgments are compared to their actual performance. For instance, subjects may be informed of a task that they will be given, like a quiz on famous celebrities, and asked to make FOK judgments prior to being given the actual quiz. After they have made their judgment, they are given the quiz and their actual performance is compared with their predicted performance (Khatoon & Roy, 2017).

The aim of using such a method of measuring metamemory is to gauge the extent to which individuals can accurately predict or assess their memory performance and to weigh in on the link between their predicted performance and actual performance. If individuals, for example, predict

that they will perform poorly and they actually perform poorly as they predicted, or if learners predict that they would perform well and they end up performing well, they are considered to have high metamemory in either case since they have successfully monitored and evaluated their learning/ memory. On the other hand, if learners predict poor performance and end up performing well or vice versa, their metamemory is considered to be rather low because they poorly monitored their memory/ learning. Knowledge of such a link between predicted and actual performance can consequently serve as a basis for researchers in trying to improve metamemory judgments and hence reducing any discrepancies between predicted performance and actual performance (i.e., metamemory).

In contrast to procedural metamemory, which is measured via comparison of predicted judgments and actual performance, declarative metamemory is generally measured via self-report questionnaires (Khatoon & Roy, 2017). The second means of measuring metamemory, using self-report tools, has become the most common method of assessing metamemory. Several self-report measures have been devised in attempt to quantify metamemory.

The Metamemory in Adulthood Questionnaire (MIA) is one self-report measure of metamemory devised by Dixon, Hultsch, and Hertzog (1988). The questionnaire is comprised of 108 items dealing with memory judgments divided among seven subscales. The subscales are general memory processes, memory ability, anxiety over memory, memory strategy use, memory achievement and motivation, judgments of memory stability, and level of control over memory ability. The inventory was found to have good psychometric properties in terms of validity and reliability (Dixon, Hultsch, & Hertzog, 1988).

Another self-report measure of metamemory is the Memory Functioning Questionnaire (MFQ), devised by Gilewski, Zelinski, and Schaie (1990). The questionnaire measures four sub-

scales of metamemory comprised of 64 items. The four subscales are as follows: individual assessments of the rate of forgetting under different circumstances, significance and severity of the effects of such forgetting incidents, evaluation of current and past memory performance, and the application of memory strategies. Like the MIA, the MFQ was also tested and found to have strong psychometric properties. The aforementioned questionnaires are the most commonly employed self-report measures of metamemory available in the literature. Other questionnaires include the Memory Assessment Clinics Self-Rating Scale (Crook & Larrabee, 1990), the Cognitive Failures Questionnaire (Broadbent, Cooper, FitzGerald & Parkes, 1982), the Everyday Memory Questionnaire (Martin, 1986), and the Memory Controllability Inventory (Lachman, Bandura, Weaver & Elliott, 1995).

Although the scales used to measure metamemory seem to be relatively numerous, they seem to have their drawbacks, the most significant of which is their coverage of only a limited focus in terms of metamemory. For the most part, they seem to measure mainly the frequency of individuals' memory mistakes. The Memory Controllability Inventory seems to be the exception in that it focuses primarily on individuals' awareness of their level of control over their memory (Troyer & Rich, 2002). Another drawback of most of these questionnaires is their inclusion of items that may not concern every potential respondent. Hence, researchers using these questionnaires may run the risk of receiving incomplete questionnaires from respondents. In addition, the number of items in these questionnaires is another downside to most of them. Having over a hundred questions or statements to respond to would most probably compromise the respondent's willingness to cooperate and respond reliably (Troyer & Rich, 2002).

Because of the numerous drawbacks associated with these questionnaires, the researcher of the current study has chosen to adopt the MMQ since it has somehow been devised while taking

into consideration these drawbacks (Troyer & Rich, 2002). Troyer and Rich (2002) devised the MMQ to measure individuals' subjective memory assessments. The tool is a self-report questionnaire that aims to measure a few facets of memory ratings: contentment, ability, and strategy use.

The MMQ consists of three major subscales: individuals' level of satisfaction with their memory ability, their evaluation of their memory ability, and their implementation of memory strategies. The first sub-scale, the Contentment subscale, is comprised of 21 items concerning individuals' level of satisfaction over their memory ability. The questions deal not only with positive feelings such as satisfaction and confidence but also negative emotions such as anxiety and humiliation one may feel about his/her memory performance or ability. The second subscale, the Ability subscale is comprised of 20 items addressing different memory-performance situations such as recalling names and phone numbers. Respondents are to rate their memory performance in each of the different situations. The final sub-scale, the Strategy subscale, is also comprised of 20 items addressing respondents' use of memory strategies or aids. Individuals respond by rating the extent to which they employ these strategies. The questionnaire contains a total of 57 items, all of which are based on a 5-point Likert scale, and is predicted to take about 10 minutes to complete. Furthermore, the scale has been tested and found to have good psychometric properties (Troyer & Rich, 2002).

2.7. The Significance of Metamemory

2.7.1. Relationship between Metamemory and Achievement

As the significance of metamemory has become widely acknowledged, researchers have increasingly become interested in knowing how individual's metamemory influences their learning and, specifically, their academic achievement. Successful metamemory processing is

believed to be crucial for efficient learning. When, for instance, a learner believes s/he has mastered most or all of the course content and s/he can remember it when in reality s/he has only mastered a small percentage of it, the learner faces a discrepancy in learning judgments. Such a discrepancy can lead to poor study choices such as not studying at all or, in the case of those who underestimate their learning, over-studying and wasting unnecessary time and effort on content already mastered. Either way, this discrepancy between memory and metamemory most often will lead to negative consequences. Hence, one of the main aims of current research in metamemory is to develop ways of reducing this gap and developing proper means of effective memory monitoring and evaluation so learners can successfully achieve their learning goals (Dunlosky & Bjork, 2008).

Several researchers studied how metamemory processes or strategies contribute to the overall learning habits and achievement of students. For instance, Sinkavich (1991) examined various variables in relation to classroom practice. Findings from this study suggested that metamemory was one of the greatest predictors of subsequent test performance. Likewise, Carr and Borkowski (1987) studied achievement in relation to multiple variables and found metamemory to be significantly related to achievement. Although the significance of metamemory for learning and achievement has been established, scarce information seems to be available on how exactly metamemory can be fostered among learners (Karably & Zabucky, 2009).

2.7.2. Relationship between Metamemory and Language

As the demand for learning languages, especially English, has increased in the past few decades, so have researchers' attempts to discover means of facilitating and enhancing the learning process. Researchers have sought to develop a better understanding of a range of variables they believe contribute to the language learning process, from intrapersonal variables to environmental

and cognitive variables. One factor that has been found to affect language learning is the individual differences in cognitive and metacognitive processes of learners. As a type of metacognition, metamemory has also become of increasing importance for research on L2 teaching and learning.

Although the literature on memory in language learning and the literature on general metacognition and language are both rather rich, research on metamemory in language learning is rather limited. A study conducted by Lockl and Schneider (2007) is one study within the limited literature on metamemory in language learning. The authors examined 183 children for an association between their metamemory and language. The authors found that language competencies are significantly associated with metamemory, with the former predicting the latter. Furthermore, Reza and Nezhad (2001) adopted metamemory-based reading instruction in attempt to examine the difference in reading performance between learners who were subject to metamemory-based instruction and those taught via skill-based instruction. After months of instruction, the researchers examined the 76 college students and found a significant difference between learners taught under the metamemory-based instruction and those taught under skill-based approach. Specifically, those taught through the metamemory approach outperformed those taught through the skill-oriented approach in reading comprehension.

Various researchers have established a link between metamemory and general language proficiency (Ehrman, Green & Oxford, 1995; Mullins, as cited in Magno, 2008). In terms of second or foreign language learning, Ismaiel (2017) examined 250 Saudi Arabian EFL students for the association between metamemory and their achievement. By achievement, the author aimed to find out the extent to which metamemory measurements were associated with each of the four language skills independently: reading, writing, speaking, and listening. Results from his study revealed that metamemory, as measured by a self-report questionnaire, was significantly

associated with achievement in the four language skills. Mall and Ghiassi (2012) implemented a metamemory strategy program in the EFL reading classroom and found that the metamemory strategy training program significantly improved EFL learners' reading comprehension performance. Likewise, Mall and Ghiassi (2012) assert that metamemory is significant for EFL reading. This is because of the demand for reflective thinking placed on EFL learners during the reading process. Learners have to reflect on not only their own thinking but also the reading passage.

2.7.3. Relationship between Metamemory and Memory

Although research on memory has a long history independent of that on metamemory, various researchers have by now contended that the two constructs are inextricably linked. This assertion is rooted in the actual definition and nature of metamemory. As the previous sections have highlighted, metamemory is comprised of, first, an awareness or knowledge component of memory processing and, second, a control or regulation component of memory. For this reason, current research integrates the two constructs in its theorizing. Nelson and Narens's (1990) model (section 2.4) serves as one of the best examples of how memory and metamemory are integrated into a single framework. The framework illustrates how the two constructs are dependent on each other for effective flow and regulation of information and therefore learning (Dunlosky & Bjork, 2008). In essence, "metamemory itself involves monitoring an underlying memory system, but then metamemory processes in turn can act on the memory system"; therefore, "memory influences metamemory, and metamemory influences memory" (Dunlosky & Bjork, 2008, p. 17).

Although the two constructs are believed to be inextricably linked, researchers believe that an understanding of one system does not particularly guarantee a simultaneous understanding of the other. While memory is a necessary constituent of metamemory, the reverse is not necessarily

true. In other words, the monitoring and control of memory (i.e. metamemory) cannot take place without a memory system and memory processes; however, it is possible for memory processing to take place without concurrent metamemory processes (Dunlosky & Bjork, 2008). Despite this, however, it is believed that more often than not the two systems function simultaneously and work to complement each other (Dunlosky & Bjork, 2008).

The assertions of the nature of the association between memory systems and metamemory are supported by various researchers (Koriat, Goldsmith & Panshy, 2000; Short, Schatschneider & Friebert, 1993) as they have found significant correlations between one or more components of metamemory and memory performance. For instance, in a meta-analysis of over 60 studies, Schneider and Pressley (1997) found that metamemory is moderately and positively associated with memory performance. Hence, higher levels of metamemory are associated with better memory performance.

2.7.4. Relationship between Metamemory and Writing

In considering the intricate process of language learning and the various skills individuals are expected to learn, writing can be considered as rather complicated compared to the rest. Various researchers have attempted to gain an understanding of the factors that contribute to the development of writing skills and may affect writing proficiency and achievement. Numerous settings and circumstances have been examined using numerous methods. Some researchers have examined how factors related to circumstances or context of the writing task itself can affect performance (Rezazadeh, Tavakoli & Rasekh, 2011; Salimi, Dadaspour, & Asadollahfam, 2011). Rezazadeh, Tavakoli and Rasekh (2011), for instance, studied how the type of writing task influenced different aspects of written performance. Salimi, Dadaspour, and Asadollahfam (2011) examined how task complexity influenced writing performance. Other researchers, however, have

studied more external variables and their effects on written performance or development. For instance, Zabihi (2018) examined how some cognitive as well as affective factors affect EFL learners' writing performance. Moreover, Sasaki and Hirose (1996) assessed several variables for their influence on L2 writing ability. The authors studied the role of L1 writing ability, experience in writing, meta- knowledge of expository writing, and first as well as L2 writing strategies. Likewise, Lu (2010) examined several variables for their role in L2 writing performance. Among these variables were the role of L2 proficiency, L1 writing ability, and WMC.

The significance of metacognition in writing, however, became recognized with the upsurge of the process approach in the field of writing. Pioneers of the process-oriented approach John Hayes and Linda Flower emphasized this vital role by asserting that “a great part of the skill in writing is the ability to monitor and direct one’s own composing process” (Hayes & Flower, 1980, p. 39). In terms of general metacognition, researchers have thus far established an association between metacognition and EFL writing performance and achievement. For instance, Farahian and Avarzamani (2018) examined EFL learners' writing success in relation to their levels of metacognitive awareness. The authors found that overall metacognitive awareness levels correlated significantly with EFL learners' writing proficiency. Likewise, Ruan (2014) and Victori (1999) examined the role of metacognitive awareness in L2 writing. Findings from these studies echo those of Farahian and Avarzamani (2018). Moreover, Dülger (2011) asserts that metacognition not only affects writing on a holistic level, but also affects individual aspects of writing such as vocabulary and mechanics. Likewise, Angelova (2001) found a direct positive association between writing and EFL students' levels of metacognition and writing output. Baker (2010) found a difference in writers' levels of metacognitive awareness, with better writers having higher levels of metacognition than their less skilled peers.

As a significant type of metacognition, metamemory can be viewed as equally significant in learning and practising L2 writing. However, empirical research into the relationship between the two constructs seems to be rather scarce. One such example of the limited literature on the relationship between metamemory and EFL writing is Magno's (2008) study, which aimed to examine 159 college students of EFL in attempt to see how various predictors affected their English writing proficiency. Among the predictors was metamemory. Results from the study revealed that all of the predictors were significantly associated with writing proficiency. Of the seven predictors, metamemory was one of the most significant predictors, along with reading strategy use and regulation of cognition. When combined, these predictors explained over half of the variance. Further analysis revealed that metamemory was the greatest of the seven predictors explaining 5% of the variance. In addition to the association between metamemory and EFL writing, Magno (2008) also examined any association between apprehension, or anxiety, and writing.

Conclusion

This chapter has served as a review the literature on metamemory. Not only does it provide a thorough explanation of metamemory and its constituents, but it also elaborates on how the two constructs relate, how they are intertwined, and how they are distinct. In sum, metamemory and memory are, in a sense, dependent on each other for more effective flow and regulation of information from the object-level to the meta-level and back. Therefore, when and if there is a deficit in knowledge of and/or control over memory processes, processing efficiency is hindered. The review has also provided some theoretical explanations as well as empirical evidence for how metamemory is related to language acquisition and learning. Although not much research has been

conducted on metamemory in language learning, particularly in writing, the scarce research that has been conducted indicates that there is an association between the two constructs.

Having thoroughly reviewed the literature on memory and metamemory, the next chapter reviews the literature on anxiety. The chapter also reviews the link between anxiety and the variables already reviewed, memory and metamemory, as well as L2 writing.

3. Chapter Three: Anxiety

Introduction

This chapter reviews the literature on anxiety. As a significant factor in language learning as well as memory performance, the broader concept of anxiety is introduced and defined. The review elaborates on the link between anxiety and WM performance. Then, focus is shifted to the more language-learning-oriented anxiety: FLA. In doing so, the review provides an overview the significance of FLA, particularly in writing performance. In relating anxiety, WM, and writing, the link between the three constructs becomes clearer, allowing the study to move one step closer to establishing a sound theoretical foundation.

3.1. Definition of Anxiety

Mussen et al. (1974) define anxiety as: “a necessary and normal physiological and mental preparation for danger... anxiety is necessary for the survival of the individual under certain circumstances. Failure to apprehend danger and to prepare for it may have disastrous results” (Mussen et al., 1974, p. 387). Spielberger (1972) describes it as “an unpleasant emotional state or condition which is characterized by subjective feelings of tension, apprehension, nervousness, and worry” (Spielberger, 1972, p. 482). Some believe that as the perceived threat increases, the level of anxiety rises (Twenge, 2000). Others, however, believe that the intensity of emotions involved in anxiety exceeds the actual threat (Spielberger, 1976). Anxiety is also described as a feeling of confusion along with a feeling of uneasiness and worry. An anxious person is usually worried about an anticipated occasion or event (Seligman, Walker & Rosenhan, 2001). From another perspective, Scovel (1991) defines anxiety as “a psychological construct, commonly described by psychologists as a state of apprehension, a vague fear that is only indirectly associated with an object” (p. 18). Spielberger (1983) also describes it as “The subjective feeling of tension,

apprehension, nervousness, and worry associated with an arousal of the automatic nervous system” (p.1).

Researchers have made a distinction between anxiety and fear (Perusini & Fanselow, 2015; Spielberger, 1976). While Spielberger (1976) contends that fear derives from a real danger or threat posed to an individual, Beck and Clark (1997) believe that anxiety arises from a mere perception of danger. Spielberger (1976) also distinguishes anxiety from fear by pointing out that although anxiety and fear are both "unpleasant emotional reactions to the stimulus conditions perceived as threatening," fear is usually derived from a "real, objective danger in the external environment" while the threatening stimulus of anxiety may not be known. Spielberger also asserts that the “intensity of the emotional reaction is disproportionately greater than the magnitude of the objective danger” (Spielberger, 1976, p.6). Therefore, in most cases, individuals who feel threatened usually do not have something worth fearing.

Furthermore, Spielberger (1980) differentiates between worry and emotionality, each experienced independently as a component of anxiety. Worry denotes a cognitive constituent of anxiety— a constituent arising at the thought of a potential threat and an inability to prevent it. On the other hand, emotionality, also a constituent of anxiety, denotes the affective element of arousal experienced during an experience of anxiety. An individual may be worried at the thought of an upcoming test for lacking preparation to pass it, leading to an experience of physiological arousals including shaking, sweating, nervousness and other reactions reflecting emotionality (Spielberger, 1980). Worry can also be described as a recurring concern about an expected event (Sarason, 1986) or “distressing preoccupations, and concerns about impending or anticipated events” (Sarason, 1986, p.21). Emotionality, however, can be described as a consciousness of physiological reactions to such worry (Sarason, 1986). Such reactions can be faster heartbeat, stomach ache, headache,

sweating, fidgeting, stuttering, as well as a range of other reactions (Gregersen, 2005; Macintyre, 1999).

3.2. History of Anxiety Research

The term anxiety is rooted in the ancient Greek work *angh*, which denotes several similar things: ‘to strangle’, ‘to press tight’, and ‘burden’ (Freeman & Freeman, 2012). These words accurately represent the range of feelings often described as being associated with anxiety. The term *angh*, however, seems to have transferred into Latin in the form of terms such as *ango* and *anxietas*, which also carry meanings associated with tightness and compression (Freeman & Freeman, 2012). Despite its currently clear psychological nature, the term was, for the most part, not studied as a psychological construct until the 19th century and had not been well-established as so until the 20th century (Freeman & Freeman, 2012). Instead, before the psychological study of anxiety, the phenomenon had been approached throughout history from philosophical, theological, sociological, cognitive, and biological perspectives (Crocq, 2015).

In ancient Greek physiology, Hippocrates held that a disproportion of the humours was what caused anxiety (Nardi, 2006). This influential belief led to the association of anxiety with other disorders like insanity and depression (Berrios & porter, 1995). This conceptualization of anxiety continued until the early 18th century when William Battie distinguished anxiety from the more severe disorders to which it was tied. Battie believed anxiety resulted from over-working or triggering of the nerves. A similar perspective was furthered by William Cullen, who classified it under the category of *neuroses* (Coutinho et al., 2010). Likewise, French psychiatrist Bénédict Morel (1809-1973) believed that anxiety was caused by an impairment of the nervous system. The Hungarian physician Maurice Krishaber (1836-1883), however, argued that anxiety was triggered by cardiovascular impairments (Freeman & Freeman, 2012). Overall, the belief that anxiety was

not a separate illness, that it was rooted in some physiological impairment, continued throughout most of the 19th century (Crocq, 2015).

It was not until the 19th century that a psychological perspective on anxiety was initiated by Sigmund Freud (1856-1939). Unlike his predecessors, one major argument Freud made was that anxiety ought to be differentiated from other disorders, particularly those of the nervous system (Freeman & Freeman, 2012). He believed anxiety was ‘felt’ by an individual as a condition in which he or she experiences feelings of stress, uneasiness, concern, and nervousness accompanied by arousal. Furthermore, he distinguished between objective and neurotic anxiety, describing the former as a rational reaction to a perceived threat and the latter as an unconscious response within an individual (Klein, 1948). Freud, like Darwin, believed in the adaptive nature of anxiety since individuals adopt behaviour that help them deal with situations they felt are threatening (Spielberger, 2010).

Although Freud’s theories on anxiety are currently discredited, they played a vital role in shaping the psychology and psychiatry literature. With further research, the term anxiety eventually came to be recognized as an emotion that affects an individual physically and mentally as well as behaviourally (Freeman & Freeman, 2012). Hence, anxiety is believed to be exhibited in a few ways. First, anxiety is believed to be reflected in what individuals say or think, such as when discussing a concern for an issue. Second, anxiety can be shown in individuals’ behaviour, such as when an individual tries to evade a particular situation. Finally, anxiety can be manifested in individuals’ physiological changes, such as experiencing a rise in heart rate.

3.3. Models of Social Anxiety

Although the study of anxiety has been and is still currently approached from various perspectives— psychoanalytical, behavioral, cognitive, and neurobiological are a few examples—

the current study only sheds light on literature from one perspective: a purely psychological one. For this reason, the term has mainly been defined as a psychological construct and will be handled as such for the rest of the literature review. Accordingly, it is worth noting that one of the major forms of anxiety categorized within the psychology research paradigm is social anxiety. This type of anxiety refers to a nervousness experienced when or at the thought of being involved in interpersonal encounters, or all types of anxiety arising from being in a social setting (Leary; cited in Tóth, 2010). Examples of such settings include giving public presentations, participating in discussions, or even writing an essay which one knows will be read or evaluated. Those who experience social anxiety are generally worried about others' judgment of them; specifically, their fear is being negatively judged (Tóth, 2010). Moreover, since language learning mostly takes place in a social setting, and/or it is practised in a social milieu, anxiety that is specific to language learning has been subsumed within the broader category of social anxiety (MacIntyre, 1995). Accordingly, the major theoretical frameworks of social anxiety are briefly discussed below.

3.3.1. The Classical Conditioning Model

Based on behaviourist principles, the first framework of social anxiety is the classical conditioning model. Classical conditioning refers to the elicitation of a certain response through trained association with a neutral stimulus. For instance, a dog can be trained to associate his owner's homecoming (neutral stimulus) with receiving a treat, which would naturally cause him to salivate (desired response) (Gormezano, Prokasy & Thompson, 2014). Likewise, anxiety and fear are believed to be classically conditioned in humans via association of fearful or anxiety-provoking stimuli with an event or object (Watson & Rayner, 1920 as cited in Tóth, 2010). Therefore, individuals may experience anxiety in a particular setting because of the negative association they have constructed with that setting (through past experience, for instance) (Wolpe,

1973). A good example is someone who had an embarrassing experience while publicly presentation something, which led to stress and other negative emotions. Consequently, this experience led to negative emotions and stress arising at all subsequent thoughts of giving a public presentation, not to mention the stress and negative emotions that arising when actually giving the presentation. Likewise, the anxiety associated with the language learning experience may be explained from a behaviourist perspective. Language learner may experience anxiety in one or more domains due to a negative experience with such domains.

3.3.2. The Skills-deficit Model

The second framework, the skills-deficit model, holds that a deficit in one or more skills necessary for the effective execution of a task in front of people is what leads individuals to experience anxiety (Bellack & Hersen, 1979). This anxiety may in turn function as a major impediment in performance, which may again lead to higher levels of anxiety upon future performance (Leary; cited in Tóth, 2010). For instance, the fear of not possessing sufficient knowledge of English pronunciation or grammar to publicly use the language smoothly may, in instances where the individual must use the language, lead to poor performance, which may probably lead this individual to feeling that s/he actually does not possess the ability or necessary skills to use the language, reinforcing his/her initial thoughts and fears. Hence, the individual may become even more anxious to use the language in public again. In some cases, however, despite possessing the necessary skills for executing a task, individuals may fail to properly execute them (Leary; cited in Tóth, 2010), which gives them more reason to be anxious.

3.3.3. The Cognitive Self-evaluation Model

The third framework is known as the cognitive self-evaluation model. The major focus of this model is the discrepancy between what individuals believe their capacities are in a certain skill

compared to what their capacities actually are. The main source of anxiety, according to this model, is individuals' perceived lack of competence, albeit they may actually possess sufficient competence (Leary; cited in Tóth, 2010). It is believed that, many times, socially anxious individuals perceive themselves inadequate while others may perceive them as quite adequate (Clark & Arkowitz, 1975). This may justify why sometimes even advanced learners may experience the same type of anxiety that a beginner may experience. These individuals' negative self-evaluation is what leads to feelings of fear and anxiety. Some link such negative evaluations to excessively high standards for one's self or potentially impractical expectations (Atkinson et al.; as cited in Tóth, 2010).

3.3.4. The Self-presentation Model

The fourth framework is known as the self-presentation model. It aims to integrate key concepts of the aforementioned models into one framework that seeks to explain social anxiety. The rationale behind this integration lies in the belief that each of the previous frameworks explains a portion of the cause of social anxiety, but none are sufficient to fully account for it (Schlenker & Leary, 1985). The self-presentation model holds that social anxiety is a product of two variables. First, individuals are driven by a desire to convey themselves in a certain light to others. Second, learners have a sense of uncertainty that they can effectively accomplish this (Tóth, 2010). According to this model, the more individuals desire to convey themselves in a good light in front of others and the more uncertain they are of accomplishing this, then the higher their levels of anxiety will be. Accordingly, both factors in interaction contribute to the rise in social anxiety. The desired approval and the doubt of succeeding fall into the categories of the various factors mentioned in the other frameworks. For instance, the category of dispositional factors subsumes the factors of fear of negative evaluation, and a desire for approval, which in turn function as

factors in the level of motivation to achieve the wanted approval (Tóth, 2010). In line with this model, a combination of various factors are, therefore, responsible for generating anxiety in language learning.

3.4. Types of Anxiety

In attempts at better understanding the nature of anxiety, psychologists have devised several categories through which they have come to describe the phenomenon. Each of these categories has equally been influential in terms of achieving a better understanding of the nature of the specific kind of anxiety with which this study is most concerned: FLA. Accordingly, the two most recognized categories of anxiety, as devised in the psychology literature, are trait versus state anxiety and debilitating versus facilitating anxiety (Tóth, 2010).

3.4.1. Trait versus State Anxiety

In the process of operationalizing the construct of anxiety, researchers make a distinction between the types of anxiety on several levels. One of these distinctions is between trait anxiety and state anxiety. Some researchers, like MacIntyre & Gardner (1991), also distinguish between three types of anxiety: trait anxiety, state anxiety, and situation-specific anxiety.

The first type of anxiety, trait anxiety refers to a trait or characteristic built within an individual which is unchanging (Spielberger, 1972). Trait anxiety is defined as “stable individual differences in anxiety-proneness” and “the difference between people in the tendency to perceive stressful situations as dangerous or threatening and to respond to such situations with elevations in the intensity of their state anxiety reactions” (Spielberger, 1983, p.1). The anxiety-proneness to which Spielberger (1983) refers is synonymous with a characteristic or predisposition an individual has to feeling anxious. Those with trait anxiety will most likely experience it regardless of the circumstances (MacIntyre & Gardner, 1991). It is believed that those who carry the attribute

of being anxious by nature may become anxious under numerous circumstances and situations with a greater degree of intensity than most others, including those with state anxiety (Woodrow, 2006). MacIntyre and Gardner (1991), however, believe that trait anxiety is meaningless without taking into consideration the situations in which it is provoked. For instance, two individuals may have similar trait anxiety levels, but one becomes more anxious in certain situations than the other and less anxious in other situations. Consequently, another type of anxiety was devised.

The second type of anxiety, state anxiety, varies depending on the state of an individual and what he or s/he is experiencing. State anxiety is defined as “an immediate, transitory and emotional experience with immediate cognitive effects” (Nakata, 2006, p.87). MacIntyre (1999) describes it as a “moment-to-moment experience of anxiety” (p.28) It is believed to be momentary and experienced only at particular instances. It tends to vary depending on experience and through time. This type of anxiety, in contrast to trait anxiety, is not believed to be an inherent part of one’s personality (Gardner, 1991). It is described as something temporary, only evoked by certain situations that would naturally evoke such anxiety, like sitting for an important test (Spielberger, 1983). State anxiety is also described as negative emotions arising upon exposure to threat or danger (Spielberger, 1972, 1983). Trait anxiety, however, is an inter-individual difference in how one handles state anxiety when expecting exposure to situations that may trigger it. MacIntyre and Gardner (1991) believe that those who experience greater degrees of trait anxiety are more prone to experiencing greater degrees of state anxiety.

The third type of anxiety is situation- specific anxiety. The term “situation-specific anxiety” was coined by MacIntyre and Gardner (1991) in reference to a specific feeling of nervousness or unease experienced repeatedly within a given situation, a particular context or setting like performing presentations, taking tests, or participating in class. In other words, state

anxiety reflects the description of someone who is ‘anxious at the moment’. Someone who experiences trait anxiety, however, can be described as an ‘anxious person’. Those with higher levels of trait anxiety are believed to experience state anxiety more and to a greater degree (Spielberger, 1983). The former can be described as a fixed personality trait. The latter can be described as a ‘right now’ occurrence. Situation-specific anxiety was developed based on the belief that anxiety is an individual characteristic that varies depending on situations (Dörnyei, 2005). In other words, it is believed to be a trait anxiety experienced differently in different contexts (MacIntyre, 1999).

In the anxiety research literature, the most reliable and meaningful results are those generated via the situation-specific approach (Tóth, 2010). When one effectively links a learner’s anxiety with a specific situation, like making oral presentations or answering questions about the lesson, language researchers such as applied linguists may have a basis on which they can try to develop solutions to such a problem. They may, for instance, devise possible ways that the oral presentation experience can be made less anxiety-provoking.

3.4.2. Facilitating versus Debilitating Anxiety

Anxiety categorizations are not limited to the distinction between trait and state anxiety. Another distinction that is widely recognized in the literature is between facilitating and debilitating anxiety. Scovel (1978) was the first to make such a distinction. He described the former as a positive form of anxiety, initiating in the learner a sense of motivation to tackle an L2 task. A language learner experiencing facilitating anxiety may handle the task rationally, and may put forth more effort. Scovel (1978) asserts that this type of anxiety motivates the learner to fight and overcome the stressful situation and decrease the negative effect of anxiety. Researchers have found some evidence in support of the facilitative role of anxiety. For instance, Park and French

(2013) report that learners who were more anxious received higher grades than those who were less anxious. Likewise, Bell and McCallum (2012) found a slightly positive correlation between anxiety and grades. In contrast to facilitating anxiety, debilitating anxiety is considered as a negative form of anxiety, initiating in the learner a sense of fear, leading the learner to avoid or abandon an L2 task. Debilitating anxiety is believed to cause avoidance behaviour among those experiencing it (Alpert & Haber, 1960).

3.5. Foreign Language Anxiety

In the mid-20th century, educational psychology saw a radical shift in focus in terms of teaching and learning. A shift of focus from behaviourist principles to cognitive processes involved in learning initiated in the language teaching and learning paradigm an awareness of inter-individual differences in language learning. Consequently, researchers have— for decades— been making attempts to discover individual needs of language learners in attempts to cater to these needs and consequently make the learning process more productive and effective. With growing emphasis on learner-centeredness in the foreign language classroom, inter-individual differences have become a key focus for language educators and researchers. Personality traits like anxiety, introversion, extroversion, self-esteem, inhibition, risk-taking and willingness to communicate play a crucial role in how individuals learn as well as their overall success in learning a foreign language (Dörnyei, 2005).

Accordingly, a range of factors are reported to account for the efficiency of the language learning process: cognitive, metacognitive, and social, among others (Tóth, 2010). In addition to these, one of the most-widely studied factors in foreign language achievement is affect. The affective domain subsumes the categories of motivation, self-esteem, attitudes, and anxiety (Dörnyei, 2005). Attention to the vital role of affect in language learning was drawn by the

American linguist Stephen Krashen in his L2 acquisition theory. Krashen (1981) devised a set of hypotheses that, in combination, made up his theory of L2 acquisition. One of his main hypotheses is the Affective Filter Hypothesis, in which he outlined three affective variables contributing to L2 learning: anxiety, self-confidence, and motivation.

According to Krashen, a learner's affective filter functions as a barrier that prevents input from being successfully retained. The filter is either strengthened or weakened by the three affective variables anxiety, motivation, and self-confidence. The lower the motivation and self-esteem and the higher the anxiety of the learner, the higher the affective filter will be. In his SLA theory, Krashen also highlights the need for comprehensible input in L2 learning. That is, to effectively acquire a language (acquisition in Krashen's sense is natural and subconscious, in contrast to the conscious process of learning), the input to which the learners should be exposed must be comprehensible yet just beyond their current level. Input, however, is not sufficient; according to Krashen, even when the input is comprehensible, it is not fully acquired if the affective filter is high. When learners' anxiety is high and/or their motivation and self-esteem is low, the input is obstructed from reaching what Krashen calls "the part of the brain responsible for language acquisition" (Krashen, 1982, p.31), or what is better known as the language acquisition device (LAD) (Krashen, 1981, 1982). This LAD, a construct coined by Noam Chomsky, is a theoretical representation of a mechanism in the human mind that allows its 'innate' capacity to acquire and use language (Chomsky, 1965). Thus, according to Krashen, although the LAD is an innate capacity and is subconsciously activated upon proper stimulus, when the affective filter is high, this proper stimulus does not properly reach the LAD to enable its activation. Hence, an individual's capability to acquire the language is impeded (Krashen, 1982).

Since Krashen's influential theory, anxiety as an affective variable in language learning has increasingly attracted the attention of researchers and educators (MacIntyre & Gardner, 1989), and research in the field has received increasing attention since its beginning in the 1970s, making anxiety one of the most widely studied variables in L2 learning. Much of this research has been conducted in attempt to construct some form of theoretical framework for illuminating and establishing the role of anxiety in language learning (Tóth, 2010). Consequently, a specific term was devised to denote anxiety that is specific to language learning: FLA, a term pioneered in 1986 by Horwitz, Horwitz and Cope (1986). In their article, they presented the theory of language anxiety as being a form unique to the language learning context.

Horwitz et al. (1986) define FLA as "self perception, beliefs, feelings and behavior related to classroom language learning arising from the uniqueness of the language learning process" (Horwitz et al., 1986, p.128). Scovel (1978) describes FLA "not as a simple unitary construct, but as a cluster of affective states, influenced by factors which are intrinsic and extrinsic to the foreign language learner" (p.134). Price (1991) believes that some symptoms of FLA are alarm, uncertainty, irritation, and reduced personality. Some researchers claim that "approximately one-third of students studying a foreign language experience at least a moderate level of foreign language anxiety" (Horwitz, Tallon, & Luo, 2010, p. 99). It is considered as one type of social anxiety, referring to a nervousness experienced in interpersonal encounters or all types of anxiety arising from being in a social setting (Leary; cited in Tóth, 2010). Moreover, FLA is the fear one experiences when faced with the task of using a language that s/he has not yet mastered and in which s/he can make mistakes (Spielberger & Sarason, 2005). Accordingly, FLA is considered as a situation-specific anxiety. Individuals may feel anxious only within the context of language

learning. Specifically, it is believed to encompass a set of feelings, attitudes and behaviors specific to the language learning situation (Horwitz et al., 1986).

3.5.1. Sources of Foreign Language Anxiety

It is believed that FLA takes place because of the language classroom's "inherently face threatening environment" where learners are expected to implement a "severely restricted language code" (Dörnyei, 2001, p. 91). Spielberger and Sarason (2005) also assert that language anxiety consumes a learner's attention that could otherwise be employed for developing competence in the target language. According to Csikszentmihalyi (1997), a possible source of debilitating anxiety is a significant gap between a learner's actual proficiency level and the proficiency level required to complete a certain task. Another factor, however, is the fear of being judged by others. One may have well-mastered a task or skill, but once s/he is required to perform the same task in front of others, she may fail to do so effectively, and this stems from the need to make a positive impression on others. Some believe that the competitive nature in school is one of the potential sources of FLA since learners naturally compare themselves to each other and set certain standards for themselves (Bailey, 1983). Accordingly, Horwitz et al., (1986) outline three major sources of FLA: fear of negative evaluation, communication apprehension, and test anxiety.

3.5.1.1. Fear of Negative Evaluation

One source of FLA is the fear of being evaluated negatively (Horwitz et al. (1986). A learner may feel like his/her peers or maybe even his/her teacher may judge his/her negatively. Such a learner views his/her mistakes not as a natural part of the learning process but as something to be ashamed of and to prevent. Such an attitude leads those who are completely afraid of using the language in front of others. Fear of negative evaluation leads the learner to communication avoidance (Aida, 1994). This source of anxiety may be rooted in a learner's self-esteem: an

individual with low self-esteem is more likely to feel anxious about others' judgments and their performance in the L2 despite their actual competency in the FL. This assertion is supported by Onwuegbuzie, Bailey and Daley (1999), who found that learners with higher levels of anxiety rated themselves lower on their language proficiency level as well as their self-worth.

3.5.1.2. Communication Apprehension

Another source of anxiety is communication apprehension (Horwitz et al., 1986). This refers to one's fear of communicating with others (Horwitz et al., 1986), usually due to a lack of mastery of the target language. For instance, in Price's (1991) study, language learners (namely those of French) were found to be most anxious about not being able to practice speaking the language without errors. Furthermore, these students are shown to freeze up during their speaking test. This source may also be rooted in of a learners' low self-esteem. Some researchers, like Daly (1997), have established a negative correlation between communication apprehension and self-esteem. Those who exhibit anxiety usually undervalue their own capacities, perceiving themselves as a failure more so than a success in language learning. Furthermore, it is found that learners who exhibit higher levels of apprehension tend to avoid or drop out of foreign language classes demand from them to practise communication (Philips, 1992), opting for larger lectures with numerous students since such lectures do not typically demand from students to speak. It has also been reported that learners generally are more at ease when it comes to practising the receptive skills than productive skills (Kim & Kim, 2004) due to an avoidance of oral communication.

Evidence has shown that those with higher levels of communication apprehension tend to take fewer risks and completely avoid topics on which they are less knowledgeable in order to prevent portraying the image that they are not proficient. They also tend to use strategies like using fillers in an attempt to cope with or hide such anxiety (Schlenker & Leary, 1985). Learners who

experience communication apprehension are afraid to communicate in the foreign language for fear of making mistakes because of their scarce knowledge. This serious fear of communicating in front of peers is likely one of the biggest factors preventing learners from developing their speaking skills.

3.5.1.3. Test Anxiety

Test anxiety is another constituent of Horwitz et al.'s (1986) categorization of anxiety components. It is viewed as a type of anxiety caused by fear of failure (Horwitz et al., 1986). Marlett & Watson (1968) believe that more anxious learners waste a portion of their time on things irrelevant to the actual task while using that time, instead, in worrying and thinking about his or his/her performance rather than devoting that time and effort to focusing on the task. In his/her study, Young (1990) found that half of his/her sample exhibited test anxiety, according to self-report measures. These learners reported having satisfactory or well-developed competencies in the target language but when they knew they would be assessed, they tended to perform poorly. FLA is believed to manifest itself most strongly at the level of test anxiety (Horwitz, Horwitz & Cope, 1986).

The aforementioned categories— fear of negative evaluation, communication apprehension, and test anxiety—are the three major sources of anxiety as highlighted by Horwitz, Horwitz, and Cope (1986). Other researchers, however, proposed other sources of anxiety. Some researchers also reported that a symptom of FLA is over-studying. Anxious language learners will sometimes, despite their mastery of content, feel they have not studied enough, leading to over-studying. Despite the extra time devoted to studying, they seem to perform poorly on exams (Horwitz, Horwitz & Cope, 1986), usually because of their anxiety. As a consequence of their poor performance, their anxiety levels rise even more, leading to a cycle.

The teacher can also be a significant source of anxiety for language learners. Specifically, it is believed that teachers who adopt an authoritarian role in the classroom contribute to learners' anxiety (Young, 1991). One of the most anxiety-provoking features of this kind of teacher is his/her intolerance for errors. Traditional classroom environments, for instance, are believed to provoke more stress because of the authoritative role assigned to the teacher as well as the strictness of learning. The limitations set on individuals' ability to express themselves also serve as a reason for anxiety. This occurs because of insufficient mastery of the target language, even for more advanced students. Scovel (1978) asserts that intrinsic as well as extrinsic factors are to be attributed to FLA. Examples of intrinsic factors are psychological or emotional factors, like an individual's nature of being introverted, extraverted or neurotic (Dawaele, 2002) and personality traits as tolerance of ambiguity (Dawaele & Ip, 2013), and perfectionism (Gregersen & Horwitz, 2002). Examples of extrinsic factors include the nature of the relationship one has with, for instance, his classmates or the teacher.

3.5.2. Approaches to Studying Foreign Language Anxiety

Two approaches have been implemented for studying FLA. The first approach, the transfer approach, holds that anxiety experienced in language learning is simply another form of anxiety merely transferred to the language learning context. Therefore, according to this approach, those who experience general anxiety, or trait anxiety, are more predisposed transferring that anxiety to the language learning situation. However, the second approach, the unique anxiety approach holds that FLA is a phenomenon unique to the language learning process. Hence, FLA is believed to be a situation-specific type of anxiety evoked by specific language learning settings or experiences (Tóth, 2010). The approach with most evidence is the unique approach. In the first approach, the transfer approach, FLA is believed to be linked to other forms of anxiety; more specifically, it is

viewed as resulting from other forms. The second approach, the unique approach, views FLA as a form of anxiety unique only to the language learning context. In such a case, FLA is associated with language achievement, but general anxiety is not.

3.5.3. Models of Foreign Language Anxiety

Tobias (1986) yielded two models of FLA: the interference retrieval model and the interference model of anxiety. According to the interference retrieval model, anxiety impedes, at the output phase, the retrieval of information that has already been learnt. According to the interference model of anxiety, however, anxiety impedes the input and processing phases. This typically occurs when an individual lacks sufficient knowledge of the subject or has poor study habits. It has been stated, however, that evidence exists in the field of language learning to support both theories (Onwuegbuzie, Bailey, & Daley, 2000).

3.5.4. Measuring Foreign Language Anxiety

The measurement tools employed to study FLA can be divided into three main categories: self-report measures, behaviour tests, and physiological tests (Scovel, 1978). In the case of self-report measures, individuals are asked to report information concerning their internal feelings. For instance, they may be asked how they feel when they are required to make an oral presentation, or if they get nervous when taking a test. In the case of behaviour tests, individuals are observed for various symptoms of anxiety such as fidgeting, sweating, shaking, or other symptoms. In the case of physiological tests, individuals are examined for blood pressure levels, heart rate, and other physiological responses to anxiety. Because both behaviour tests and physiological tests are of a rather technical nature and require special equipment to measure, most researchers in the field of language learning adopt self-report tools for measuring FLA. For this reason, only self-report measures will be discussed further in this review.

The most commonly used tool in language learning is self-report measurement (Zheng, 2008). Despite the drawbacks of using self-report measures (like possibly misleading or subjective answers), they are most commonly used because of their convenience. Researchers can easily employ them with large samples and they can perform objective statistical analyses with them (Karabenick et al., 2007). One of the most widely-used FLA self-report measures is the Foreign Language Classroom Anxiety Scale (FLCAS) developed by Horwitz et al., (1986). The questionnaire consists of 33 closed-ended questions based on a five-point Likert scale spanning three spheres of anxiety: test anxiety, communication apprehension, and fear of negative evaluation, the three categories devised by Horwitz, Horwitz and Cope (1986). The FLCAS was criticized, however, for its predominant focus on language elements more so than on anxiety (Sparks & Ganschow, 1995). Regardless of the criticism, it remains one of the most widely-used and accepted scales of FLA for its emphasis on foreign language learning. The scale was employed in numerous studies and was found to have high levels of reliability and validity (Cheng, Horwitz, & Schallert, 1999).

In addition to the FLCAS, however, other FLA measures were devised by various researchers. For instance, as more research on FLA was conducted across different social and cultural contexts, researchers saw a need to adapt such questionnaires or to develop their own versions specific to particular social and cultural contexts. For example, the English Learning Anxiety Scale (ELAS) was developed for ESL learners (Pappamihiel, 2002). Furthermore, different self-report tools were adopted for the different language skills. Woodrow (2006) constructed the Second Language Speaking Anxiety Scale to measure speaking anxiety. Kim (2000) constructed the Foreign Language Listening Anxiety Scale to measure listening anxiety among language learners. Furthermore, Saito, Horwitz and Garza (1999) developed the Foreign

Language Reading Anxiety Scale to measure reading anxiety. In the field of L2 writing anxiety, the Writing Apprehension Test was developed by Daly and Miller (1975). The most widely-used measurement tool for writing anxiety, however, is the SLWAI, which was devised by Cheng (2004). It is one of the most widely-used tools in the writing anxiety literature because of its high reliability coefficient (.94) (Cheng, 2004).

3.5.4.1. Criticism within the Field of Foreign Language Anxiety

Several points related to the field of FLA have been criticized by researchers. Some criticism worthy of note concerns the degree of truth behind the claimed immense negative effects of FLA on achievement or other domains of language learning. First, there remains a dispute over whether FLA is an actual cause of or an effect of the difficulties experienced in language performance or achievement (Kráľová, 2016). Second, some researchers (Kráľová, 2016) argue that more research needs to be conducted on the interaction of other variables and their role in molding the relationship between FLA and language learning. Finally, a point of criticism worth mentioning is that some researchers believe FLA, to some extent, plays a facilitative role rather than a debilitating role in language learning.

One point of criticism concerns the nature of the relationship between FLA and language learning: specifically, whether anxiety is the cause or the effect of, for instance, low achievement. Some researchers (Sparks & Ganschow, 1995) believe in the reverse of the claim that anxiety is the effect rather than the cause of low achievement; that is, low achievement (which may be attributed in most part to language learning aptitude) is what may initiate in the learner a feeling of worry and fear and low motivation. MacIntyre (1995) argues against the perspective adopted by Sparks and Ganschow (1995) by illustrating an instance in which the learner is well-knowledgeable of the content, but when asked to express such knowledge, he or s/he reaches a

block and cannot perform the task. This is MacIntyre's claim of evidence for the causal nature of anxiety. Horwitz (2000) adds that the most competent FL learners also experience such anxiety, supporting the claim that anxiety is a cause and not an effect of lower performance. Furthermore, Marcos- Llinás and Garau (2009) further support Horwitz's (2000) argument; they found that students with higher levels of anxiety were the more advanced students and those with lower levels of anxiety were beginning and intermediate learners. Despite their arguments that anxiety is a cause of hindrances in language learning, Horwitz (2000) and MacIntyre (1995) are also somewhat open to the view that anxiety is developed as a result of poor performance. MacIntyre (1995), for instance, asserts that the anxiety–low performance relationship is cyclic; that is, as learners become extremely anxious, their performance is hindered; in turn, as their performance is hindered, their anxiety levels increase and so on.

A second point of criticism is the call for more investigations into the role of other variables in the relationship between FLA and language learning outcomes (Kráľová, 2016). Anxiety is believed to be influenced by many factors: physiological, social, and biological, among others (Doubek & Anders, 2013 cited in Kráľová, 2016). Research highlights various variables that interact with FLA in the language learning process. Such variables include gender, age, motivation level, and personality type (i.e., introversion versus extroversion). Dewaele and MacIntyre (2016) assert that age is a significant variable that affects the level of FLA. They report that teenagers experience the greatest amount of anxiety while adults and children experience lower levels. Furthermore, personality traits like shyness (Bashosh, Nejad, Rastegar, and Marzban, 2013), willingness to communicate (Bashosh et al., 2013), and introversion versus extroversion have been associated with FLA.

Another point of disagreement in the literature is that some researchers still believe anxiety is facilitative rather than debilitating for language learning. Some researchers claim a positive correlation between anxiety and language learning (Gardner, Smythe, Clement & Gliksmann, 1976; Foss & Reitzel, 1988). Other researchers (Kleinmann, 1977; Scovel, 1978), however, found the relationship between anxiety and proficiency to be a positive one in referring to facilitating anxiety.

3.6. Significance of Foreign Language Anxiety

3.6.1. Relationship between Foreign Language Anxiety and Language Learning

Achievement

Since the significance of affective variables in learning and especially language learning started to become well-established, researchers began investigating the impact of anxiety in language learning achievement. Early studies on the role of FLA in L2 learning, however, had yielded conflicting results (Bollinger, 2017). Scovel (1978) outlined these inconsistencies in an attempt to discern their source. He suggested that the source of such inconsistencies is the nature of operationalization of the concept of FLA, with each researcher adopting a different view and measurement of FLA. Specifically, he believes that the lack of appropriate measurement tools gave rise to the inconsistencies. Researchers were reduced to using available measures, which were those used to study general anxiety. The lack of specification and tailoring of the tool to the context (the language learning context) was an issue, as it threatened construct validity and led to inconsistent results. This, in turn, made it difficult to establish a link between anxiety and language learning. With improvements in methodology and theoretical conceptualizations of the term, researchers have established a relatively consistent relationship between FLA and language learning.

Research has revealed that FLA plays a significant role on the levels of input, processing, as well as output (Tobias, 1986). Learners are believed to devote much of their time to thinking about their stressful situation rather than focusing on completing the task. At the stage of input, anxiety is believed to cause a kind of mental block for the learner, hindering the process of effectively decoding the message. This is believed to happen because of a loss of attention the learner experiences as one of the symptoms of anxiety. This is why those who experience higher levels of FLA tend to have difficulties in understanding the teacher. This assertion is backed by Krashen's Monitor Hypothesis (Krashen, 1985), which proposes that affect regulates the input a language learner receives; more specifically, it proposes that higher levels of anxiety and/or lower levels of motivation and self-efficacy prevent comprehensible input from effectively being processed and acquired. In addition to the level of input, anxiety plays a crucial role on the level of processing. Tobias (1986) believes that when the assignment is relatively simple for the language learner, processing is not affected by FLA. When, however, the task is more difficult, such an effect increases. Finally, FLA affects the learner at the stage of output (Tobias, 1986). This effect is evident in several situations: on a test, oral presentation, classroom participation, etc.

The relatively consistent results all seem to point towards one direction: that anxiety—specifically FLA—is considered as a major hindrance for language learners (Bell & McCallum, 2012; Xiao & Wong, 2014). Not only that, but among the affective factors, FLA is considered as the greatest predictor of performance in language learning (Liu & Huang, 2011). Numerous studies have yielded results that support this assertion. For instance, Hewitt and Stephenson (2012) and Salem and Al Dyyar (2014) found FLA to be negatively associated with L2 achievement. Likewise, Young (1986) also found FLA to be associated with foreign language proficiency.

Not only is FLA associated with general L2 achievement, but it is also associated with performance or achievement in each of the four language skills as well as vocabulary and grammar. For instance, the role of FLA in shaping how language learners learn or practise listening has been examined by various researchers on various levels. Atashehe and Izadi (2012), for instance, assert that FLA and listening comprehension of language learners are negatively, although moderately, correlated. Serraj and Noordin (2013) assert that FLA and listening performance are negatively correlated; that is, the higher the language anxiety is, the lower the scores are on the corresponding listening task. These significant findings are not limited to listening. Sellers (2000) claims a significant relationship between FLA and reading. In his study, Sellers found that learners with high levels of anxiety had difficulty comprehending the task and remembered less of what they had read compared to those with lower levels of anxiety. Similarly, FLA is significantly influential on the level of grammar and vocabulary (Sheen, 2007; VanPatten, & Glass, 1999).

Although researchers have investigated the influence of FLA on several aspects of L2 development, most research on the effects of anxiety on language performance deals with the skill of speaking since oral communication is considered as the most anxiety-provoking for learners. This is because learners may feel threatened when faced with the task of using their potentially insufficient language capacities in front of their peers (Daly, 1991; MacIntyre & Gardner, 1991). Chen (2015) examined the association between ESL learners' speaking anxiety and performance on oral presentations and found that anxiety serves as a significant impediment when performing in the L2. Similarly, Wilson (2006) examined the relationship between FLA and oral performance and found a significantly moderated negative relationship between the two.

Although the association between FLA and various aspects of language learning has been established relatively well, the main concern for this study is the role of FLA in second or foreign

language writing. Hence, the next section provides an overview of the literature on anxiety and its role in L2 writing.

3.6.2. Relationship between Foreign Language Anxiety and Writing

Second/ foreign language writing anxiety (SLWA) is considered as a skill-specific type of FLA (Cheng, Horwitz, & Schallert, 1999). Researchers have established that writing anxiety is a unique form of anxiety, separate from general FLA (Cheng, 2002). Likewise, Cheng, Horwitz, and Schallert (1999) assert that L2 writing anxiety and general foreign language classroom anxiety are associated but not necessarily identical. Although SLWA has been found to be associated with the more general construct of FLA, it is nevertheless considered as distinct. That is, one may experience SLWA but may not experience other forms of FLA, and vice versa. Some researchers described writing anxiety as a particular type of anxiety unique to the language skill of writing (Bline, Lowe, Meixner, Nouri, Pearce, 2001), which means anxiety is experienced only upon exposure or use of one language skill as opposed to the others. This, Cheng, Horwitz, & Schallert (1999) believe, is attributed to the varying experiences of each learner with the different skills. Hassan (2001) describes writing anxiety as “a general avoidance of writing and of situations perceived by the individuals to potentially require some amount of writing accompanied by the potential for evaluation of that writing” (p.4). Bloom (1981) describes writing anxiety as “highly situation specific, seems to be self-limiting, is relatively visible, and more importantly appears to be relatively easily overcome by rational instruction” (p.104)

The actual source or cause of SLWA is unknown, and various researchers have tried to determine some possible sources. Leki (1999) argues that, although writing is the most reclusive (since it is usually performed individually) of the four skills, it is as a significant hurdle for learners. Houp (2009) believes that a lack of practice in writing may be a potential source of anxiety and

stresses the importance of providing early practice in writing for learners. Lui and Ni (2015) report several sources of writing anxiety: the complexity of writing in English, a worry about exam scores, insufficient vocabulary, wanting to write better, and lack of practice among other sources. Also, it is believed that writing anxiety is less among students with more experience in writing, or more writing practice (Lee & Krashen, 2002), suggesting, again, that experience may play a role in anxiety development. Tsui (1996) believes that the anxiety that comes from writing in a non-native language is potentially derived from a lack of support during the complicated writing process, which may lead to an avoidance and dislike of writing itself. In examining learners' reports of sources of anxiety, Choi's (2013) study revealed that the most common source of writing anxiety was the fear of making grammatical mistakes, after which came a lack of vocabulary stock and lack of confidence.

One of the first studies conducted on writing anxiety was that of Daly and Miller (1975), which focused on L1 writing apprehension, and which paved the way for subsequent research on writing anxiety not only in the field of L1 writing but also in the field of L2 writing. Daly (1977) reported that the written products of more anxious learners were significantly different from those of less anxious learners. In their essays, the anxious learners used fewer adjectives and adverbs, made more punctuation mistakes, and wrote less, overall, compared to the non-anxious learners. Daly and Miller consequently proposed what they called "writing apprehension", which is currently used synonymously with writing anxiety, and they developed the WAT, which has become a widely-employed measurement tool for SLWA.

In terms of SLWA and second/ foreign language writing achievement and/ or performance, numerous studies have provided support for the negative association between the two. For instance, Lee and Krashen (2002) and Onwuegbuzie, Bailey, and Daley (2000) examined the role

of writing apprehension in writing achievement; the studies revealed that writing apprehension was the strongest predictor of writing achievement among various other predictors. More specifically, the more anxious the learners were, the lower their writing scores were. On the same line, Faigley, Daly, and Witte (1981) also mentioned that highly anxious writers produced shorter and less fluent writing than writers with low anxiety. Likewise, Singh and Rajaligam (2012) reported that in their study, more anxious learners procrastinated, produced low quality papers, and avoided writing tasks more than with their less anxious peers. Numerous other researchers (Al Asmari, 2013; Lui & Ni, 2015; Khelalfa, 2018; Rezaei, Jafari, & Younas, 2014) have also yielded significant negative associations between SLWA and writing performance.

Mixed results have been found on the association between writing anxiety and writing performance, with some studies reporting no significant relationship between the two (e.g., Madigan, Linton, & Johnson, 1996) and many others observing a significant correlation (Lee & Krashen, 2002). For instance, Choi (2013) investigated the effect of writing anxiety on writing performance as well as sources of anxiety from the learners' perspective. Results from the study revealed a non-significant relationship between writing anxiety and writing performance measuring writing anxiety. Madigan et al. (1996) and Choi (2013) also found no significant relationship between anxiety and writing performance.

The relationship between writing anxiety and performance, however, seems to be a complicated one since it can be affected by other variables (Cheng, 2002). For instance, some believe that anxiety negatively affects writing only when the writers are under time pressure (Kean et al., 1987). Others believe the type of essay plays a role; i.e, those that elicit more personal feelings or experiences are to cause more anxiety (Kean et al., 1987). Gkonou (2011) asserts that WA is influenced by non-linguistic factors such as self-esteem and self-efficacy. Gkonou also

suggests that being cautious of how to correct students' errors may help students overcome their WA. In support of Gkonou (2011), Cheng (2002) found that learners' perceived level of writing competence was a better predictor of writing anxiety than their actual writing achievement, meaning that SLWA was influenced by non-linguistic factors. Hence, the mixed results that have been reported may potentially be attributed to the complexity of the relationship between the various constructs.

3.6.3. Relationship between Anxiety and Memory

3.6.3.1. Anxiety and Working Memory

From a theoretical standpoint, cognitive perspectives on anxiety hold that anxiety is a significant source of hindrance to performance on such tasks as learning because individuals who are anxious generally tend to be so fixated with their fears, worries, and other negative thoughts that these thoughts eventually consume a significant amount of WM space and processing capacity. Once WM is consumed or, in a sense, 'wasted' on these irrelevant thoughts, individuals are left with limited capacity to use on the actual learning task, which leads to poor performance. They engage in distracting thoughts such as how they will be evaluated or judged and how their performance will be poor, all of which consume WM resources. Because of this, learners with an already-limited WMC find it more difficult to successfully complete certain learning tasks. In turn, those with WM shortages experience more anxiety due to their inability to meet the demands of the task. This rise in anxiety consequently places more demands on WM, and it becomes a cycle. Hence, higher levels of anxiety influence WM processing and capacity and vice versa (Eysenck & Calvo, 1992).

The most influential cognitive perspective on the role of anxiety in memory and vice versa is the processing efficiency theory (PET) developed by Eysenck and Calvo (1992). In essence,

PET holds that worry and anxiety lead to a diminished WM storage and processing capacity. At the heart of PET lies the distinction between processing effectiveness and efficiency. The former refers to the end-product or result of a completed processing task. Hence, when processing is effective, the product is completed well. The latter, however refers to the ongoing-processing aspect or ‘how’ a process is carried out. Hence, when a process is efficient, the process has been completed rather quickly or smoothly with little resources and difficulties. In essence, effectiveness refers to the task performance quality while efficiency refers to the resources or effort used during task performance (Eysenck & Calvo, 1992).

Anxiety, according to PET, significantly hinders processing efficiency more so than performance effectiveness. According to PET, the major source of hindrance, whether it is in processing efficiency or performance effectiveness, is the actual worry associated with anxiety. The theory is based on a few major assumptions. First, worry is what leads to the pre-occupation with assessment or failure or judgements. Worry is believed to have two major effects: hindering processing and storage capacity of WM because that preoccupation with being judged or assessed consumes the already-limited resources of WM, leaving less resources for performing the task. Secondly, anxiety mostly affects certain components of WM (components as per Baddeley’s multicomponent model of WM). As outlined in section 1.4, according to Baddeley’s model, the main constituents of WM are the CE, the PL, and VSS. According to PET, anxiety mainly affects the CE, more so than the other two constituents. Hence, anxiety would mostly have an effect on tasks associated with the CE— mainly the self-regulatory component of processing and storage. Some adverse effects of anxiety, however, are also believed to take place in the PL because, according to PET, worry is associated with inner verbal thoughts as opposed to visual representations (Rapee, 1993). The VSS is believed to be less affected by anxiety.

Processing efficiency theory, however, has yet to account for which functions of the CE are most affected by anxiety (Eysenck). As a result of the limitations of PET, Eysenck and Calvo (1992) devised the attentional control theory (ACT). The ACT was devised as a development of PET in that it aimed to better clarify the nature of the role of anxiety in the functioning of the CE. It is concerned with attentional control in the context of anxiety and cognitive performance. The assertion that anxiety significantly hinders attentional control is grounded on the belief that there are two attentional systems: the goal-directed attentional (top-down) system driven by an individual's motives, expectations and goals, and the stimulus-driven (bottom-up control) system, which functions as the response to significant stimuli (Corbetta & Shulman, 2002). Hence, anxiety causes disequilibrium between the two systems, evoking the stimulus-driven system and decreasing the goal-directed system. This is why an individual, when faced with anxiety, sometimes loses sight of his goal and focuses only on the stimulus. In essence, what this means is that anxiety blocks an individual's attention, attention that should be devoted to his/her goals, while leading an individual to devote more attention to an external stimulus (i.e., a preoccupation with whatever is causing the worry or anxiety; hence, the perceived threat). This is because two of the key functions of the CE, inhibition and shifting (the former of which is supposed to be responsible for blocking external distractions irrelevant to the task or goal and the latter of which is supposed to be responsible for shifting attention from and to stimuli), are impaired (Miyake et al., 2000). Hence, when the inhibition function is impaired, and an individual cannot properly block irrelevant stimuli and the shifting function is impaired, making an individual unable to shift attention to relevant stimuli, then task performance is affected.

That attentional control of anxious individuals is hampered is supported within the literature. From an empirical standpoint, for instance, Hadwin, Brogan, and Stevenson (2005)

tested the PET by investigating the relationship between anxiety (state anxiety) and three components of WM (the CE, the PL, and the VSS). Results from this study, however, revealed that WM performance of those with higher levels of anxiety was not significantly different from those with lower levels of anxiety in terms of task accuracy but they were significantly different in terms of task efficiency, with the more anxious group taking longer to complete the task than the less anxious group. Likewise, Darke (1988) carried out an empirical study in which highly anxious and less anxious individuals were compared in terms of WM storage and processing capacity. Results from the study revealed that those with higher levels of anxiety displayed significantly lower measures of WM and vice versa, which suggests that WM is significantly affected by anxiety levels.

As further support for the PET and ACT, Owens, Norgate, and Hadwin (2008) examined 50 children for the relationship between anxiety (trait anxiety), WM (verbal and spatial), and academic achievement. Results from the study revealed that this/here was a relationship between anxiety and achievement, which was significantly mediated by one measure of WM (verbal). Hence, these results support the assertion that higher levels of anxiety lead to reduced WM functioning, which in turn leads to lower levels of achievement. In another study, anxious individuals were asked to recall a set of stimuli with which they had been provided; these anxious individuals recalled more of the negative stimuli, those associated with threat, than the positive ones. Such anxious individuals sometimes even interpreted neutral stimuli as negative (Mitte, 2008). Thus, this study lends support to the belief that anxiety facilitates the flow of negative stimuli (those which they perceive as threatening) into WM while neglecting other stimuli, including the task they should be completing (Grant & White, 2016). When examining high and low trait anxiety individuals in terms of performance on various concurrent WM tasks, Eysenck,

Payne, and Derakshan (2005) found that high anxiety individuals performed worse than their counterparts on the primary task when it was accompanied by a secondary task requiring the use of the CE. However, this is not the case when the secondary task required either the PL or the VSS. Furthermore, this/here were negative effects on overall performance only when the secondary task required the use of the CE. Again, these findings serve as evidence that anxiety minimizes resource availability of the CE rather than the other two components.

Ashcraft and Krause (2007) examined the association between WM, anxiety, and performance within the domain of math and found a significant association between the two. According to the authors, one's pre-occupation with his fears is what causes his/her to use up WM resources and perform poorly. Moran (2016) conducted a meta-analysis of 177 samples and 22,061 participants. The meta-analysis revealed a significant negative correlation between anxiety and WMC. With certain levels of anxiety, WMC or processing is be hindered by anxiety, and hence the task will be hindered as well. Like Moran (2016), Deffenbacher et al. (2004) conducted a meta-analysis on the effects of anxiety on memory, albeit it was a review of a different nature. In their meta-analysis, Deffenbacher et al. (2004) investigated the effects of anxiety on the memory of eyewitnesses of crimes. The researchers included 27 studies on the effects of stress on subjects' recall of details of the perpetrator and 36 studies on the effects of anxiety on details of the crime and found that heightened stress (anxiety) significantly hindered the accuracy of eyewitness testimonials. Hence, stress significantly affected their memory.

Although a significant portion of the literature supports the assertion that anxiety and memory are associated, some studies have failed to yield the same results, others have only yielded partial support, and yet others have yielded contradictory findings. For instance, when investigating the effects of anxiety (trait anxiety) on WM, Eysenck, Payne, and Derakshan (2005)

found that anxiety negatively affects performance of the CE of WM but not the PL or the VSS. Ikeda, Iwanaga, and Seiwa (1996), however, investigated the effects of anxiety (test anxiety) on WM performance and found that less anxious subjects outperformed the more anxious subject on a verbal WM task. Some researchers, however, found no significant association between anxiety and memory. Waldstein, Ryan, Jennings, Muldoon, and Manuck (1997). Kizilbash, Vanderploeg, and Curtiss (2002) examined 3999 participants for the effects of anxiety and depression on memory. They found that depression negatively affected certain components of memory. Anxiety, however, did not seem to affect memory performance. The greatest effect on memory was the combination of anxiety and depression. Other studies have even yielded a positive association between anxiety and performance. For instance, Dombrowski (2016) examined college students to see whether anxiety had a significant effect on WM and found that WM performance for the anxious group actually improved for both anxious and non-anxious groups. According to the ACT, however, the reason for the contradictory findings is that worry hinders process efficiency more than performance effectiveness. Anxiety is believed to hinder the level of effectiveness only when the amount of resources it consumes surpasses the amount needed to achieve successful performance. Hence, the end-product may not always be affected by anxiety (Eysenck et al., 2007).

Despite all of the studies conducted and the available support for the association between anxiety and WM, some unresolved issues still remain in the literature. For instance, the actual component of WM associated with anxiety seems to be unsettled. Ikeda, Iwanaga, and Seiwa (1996) claim that anxiety interferes with the articulatory loop of WM. Eysenck, Payne, and Derakshan (2005) claim that anxiety only affects the CE. Shackman et al. (2006) found that anxiety affects the spatial component of WM while Moriya and Sugiura (2012) found it to be positively

associated with visual WM. Also, as mentioned earlier, not all studies reported reduced WMC, and various researchers claim anxiety to affect different functions or components of WM (Moran, 2016). While some reported significantly strong associations, reported none, and still others have even found enhanced WMC as a result of anxiety.

3.6.3.2. Anxiety and Metamemory

Studies have shown that trait anxiety is associated with lower confidence in memory responses, i.e., changes in metamemory judgments (Ridley & Clifford, 2006; Valentine & Mesout 2009). Confidence is found to be significantly associated with accuracy of memory (Nolan & Markham, 1998). Nolan and Markham, however, reported a significant association only in the high-anxiety group, not among participants with low anxiety. That is, those with higher levels of anxiety seemed to be more aware of their memory capacities or performance. Ridley and Clifford (2006), however, reported that those with higher levels of anxiety seemed to have less confidence in their memories, and that this lack of confidence did not justly reflect their actual performance. A possible explanation for their inaccurate memory judgment is that anxiety invoked negative thoughts and perceptions of easy tasks as being difficult, leaving them to feel like they performed poorly when they actually performed well. Hence anxiety affected their confidence also. Likewise, Delleman (2014) found, via experimental manipulation, that anxiety plays a significant role in confidence in memory abilities, i.e., metamemory, like Valentine and Mesout (2009). Furthermore, she found evidence that anxiety significantly hinders memory performance.

Conclusion

This chapter has aimed to provide a comprehensive review of the literature on anxiety. It first provides a brief history of anxiety research. It then provides an overview of the different types of anxiety, focusing on FLA. The review has focused mainly on the debilitating role of anxiety,

both in WM and in language learning. The effect of anxiety on WM seems to be indisputable; one's preoccupation with his/her fear or worries consumes a significant amount of WM resources that would otherwise be used on the task at hand. This inevitably leads to poor performance on WM and, consequently, the task. The effect of anxiety on language learning, however, has been disputed. While many researchers believe that anxiety is often facilitative in the process of language learning, notably in writing, others believe it is debilitating. This study has adopted the latter viewpoint. After reviewing the literature on WM, metamemory, and anxiety, the coming chapter provides a review of the literature on EFL writing, which represents the independent variable in the current study.

4. Chapter Four: Writing in English as a Foreign Language

Introduction

This chapter reviews the literature on EFL writing. Particularly, the writing literature is viewed from a cognitive perspective, which helps in establishing a link between the writing processes and WM processes. Writing is one of the most critical skills to master for language learners, so its significance is briefly outlined, and its complexity is explained in detail. An understanding of the complexities associated with writing also helps establish a link between such complexities and WMC. In reviewing both the theoretical and empirical literature, the review comes to an end by drawing a link between writing, WM, metamemory, and anxiety. Hence, all pieces of the puzzle are put together, establishing the necessary theoretical and empirical background for the foundation upon which this study should be built.

4.1. Definition of English as a Foreign Language Writing

When an individual learns a language, s/he is not just concerned with learning one dimension; rather, s/he is faced with the task of learning a compilation of various micro as well as macro skill, from speaking and listening to vocabulary and grammar. As one of the four major language skills, writing has attracted the attention of researchers and practitioners for decades, mainly in attempts to gain a better understanding of the nature of the skill, how it is learned and practised, and how it can be improved. In order to effectively do so, however, researchers first devised various definitions of the construct of writing. According to Byrne (1979), writing is, in essence, the act of constructing graphic symbols. Flower and Hayes (1981), from a cognitive perspective, define writing as a set of mental operations encompassing planning, generating knowledge, translating it, and editing it. This set of operations demands from an individual to be like an “operator to juggle a number of demands on his/her attention and constraints on what s/he

can do” (Flower & Hayes, 1981, pp.31-33). Penny Ur (Ur, 1999), on the other hand, defines it from a somewhat social perspective. She argues that the function of writing is to communicate a certain meaning to the reader; this meaning is the most crucial element of writing. She adds, however, that other significant elements must be considered: organization, mechanics, and word choice, among others. Similarly, Leki (2001) describes it as a means of communication. Weigle (2002) views writing as a combination of social, cultural, and cognitive tasks.

The construct has been defined differently from a range of perspectives because of its perceived complexity; hence, it is difficult to capture the essence of the term in a single all-encompassing definition. According to Nunan (1999), of the four skills, writing is the most difficult for language learners to learn because it requires explicit systematic instruction and implementation, unlike the other skills, which are, in a sense, natural to practice. Likewise, Bell and Burnaby (1984) highlight the difficulty of practicing the skill in emphasizing that the demands placed on an individual when writing are far greater than when practising the other skills. The learner is expected to execute numerous elements- from grammar and vocabulary to spelling and punctuation- simultaneously in order to construct a coherent and cohesive piece. In discussing effective text-construction, Henry (2000) outlines the following criteria: grammatical accuracy, selection of appropriate words, clarity, style, spelling, punctuation, coherence, and content, among others. Likewise, Raimes (1991) outlines several key criteria for effective communication of ideas in writing: syntax, content, grammar, mechanics, organization, word choice, and meeting the expectations of the prompt as well as the audience.

4.2. History of Writing Research in English as a Foreign Language

4.2.1. Language Teaching Methods

For decades, researchers and practitioners have been investigating the best possible means of making the language learning process effective. Consequently, language teaching research has undergone numerous phases in theorizing about how language learning should be taught. As a reflection of the various phases, numerous teaching methods and approaches have been adopted into the language learning classroom, each with its own focus, viewpoint and characteristics. Consequently, language skills were taught differently with each method. Hence, this review briefly covers the most prominent methods and how writing was viewed in each method.

4.2.1.1. Grammar Translation Method

The language learning process was initially viewed as parallel to learning the classical, ‘superior’ languages, Greek and Latin. Hence, the same procedures were used to teach all languages. This set of procedures was known as the Grammar Translation method, the first known method adopted for language teaching and the method that dominated language teaching methodology until the mid-20th century. In this method, primacy was given to the translation from- and to- the mother tongue as well as the teaching of explicit grammar rules and morphology (Richards & Rodgers, 2001). This was accomplished mostly through written exercises, memorization, and translation. As Richards and Rodgers (2001) describe it, the Grammar Translation approach is “the language first through detailed analysis of its grammatical rules, followed by application of this knowledge to the task of translating sentences and texts into and out of the target language” (p.3). Furthermore, literary language was seen as superior to all other forms; hence, reading and writing were given prominence at the expense of aural/oral skills. The product of this method was language learners who possessed strong writing and reading skills, especially in literature yet extremely weak speaking skills (Richards & Rodgers, 2001).

4.2.1.2. The Direct Method

The overarching emphasis of the grammar-translation method on writing was a major point of criticism from researchers. Its complete negligence of aural/oral skills contributed to producing language learners who were not able to communicate in the target language. In order to overcome this major weakness of the Grammar-Translation method, a new method, called the Direct method, was adopted in the language classroom. The main aim became to prepare students for real-life language use; i.e, communication. It was believed that the best way to accomplish this was to mimic the process of L1 acquisition in L2 learning. Hence, the following were some key principles: only the target language should be used in the classroom for exposure similar to that of the L1 upon its acquisition; practical language should be taught; communication is key (hence, oral communication is given prominence), and most importantly, writing should only be introduced later in the writing process — after learners have become comfortable with speaking and listening. Hence, in this method, writing was of secondary importance (Richards & Rodgers, 2001).

4.2.1.3. Audio-lingual Method

The proliferation of behaviourist principles of learning, accompanied by demands of world war two, led soldiers to quickly learn foreign languages. This had instigated in language teaching methodologists a new set of procedures for teaching foreign languages: the Audio-Lingual method. This method was marked by its monotonous non-contextualized drills of repetition, substitution, and expansion, among other forms. The aim was to get students to, instantly and as accurately as possible, reproduce the language modeled by the teacher, in attempts to develop ‘good’ language habits while getting rid of the ‘bad’ ones (Richards & Rodgers, 2001). A result of this ‘conditioning’ approach to teaching, language learners mostly produced a set of pre-constructed and memorized language forms— forms that they could barely implement spontaneously in real-life communicative situations. In contrast to the Grammar Translation Method and like the Direct

method, this method emphasized first aural/oral skills, with writing and reading being secondary. When writing was taught, it was done so in the same way speaking and listening were taught: via conditioning. Models of ‘ideal’ written products were provided for learners to reproduce in terms of structure, organization, style, and grammar, among other aspects. Hence, this form of imitation led to learners who (re)produced relatively accurate texts, but these learners failed when it came to creating their own texts that deviated from the models they had been imitating (Richards & Rodgers, 2001).

4.2.1.4. The Communicative Approach

The 20th century was marked by social views on learning. Hence, language learning, according to social constructivism, was a social phenomenon. Researchers began to realize that language is not learnt in isolation. Rather, linguistic input was thought to derive its true meaning from the social context in which it occurs. Knowledge of the linguistic system itself was not enough to perform competently in the target language. According to Dell Hymes (1972), successful language learning is dependent on learning not only linguistic elements such as syntax, morphology, semantics, and phonology —along with other elements, but also extra-linguistic aspects (i.e. socio-cultural, discourse, and strategic competences) (Hymes, 1972). This groundbreaking insight into the demands of language learning initiated a new —and the most recent — approach in language teaching methodology —the Communicative Approach.

The aim of language learning, in the communicative approach, is to prepare learners for real-life communicative tasks —the kind of tasks they may face when submerged within the target community. Consequently, one major weakness of the audio-lingual method was being targeted; this weakness was the failure to produce communicatively-competent language learners. In terms of writing, the main aim was to teach learners the skills required to produce communicatively-effective compositions or to produce texts spontaneously depending on the context, instead of providing

them with models for them to simply imitate. Writing was again given importance in this method, and it was being introduced right from the beginning (Finocchiaro & Brumfit, 1983) with a shift of focus from accuracy to fluency (Byrne, 1979). Hence, rather than aiming for grammatically and structurally accurate texts, learners are encouraged to aim mostly for effective communication of their thoughts and ideas. While accuracy is considered important, mistakes are tolerated, and learners are encouraged to focus on communication. Attention is devoted mostly to mistakes that interfere with effective communication of the message (Richards & Rodgers, 2001).

4.3. Approaches to Teaching Writing

One may often read an academic essay, a report, or a simple description of a recipe that is grammatically perfect. It suffices in terms of content. It follows formal rules of its corresponding genre. Everything seems to be done correctly, yet something is still missing. This phenomenon is the product of the complexity that lies behind the composition process— a complexity that has long been the source of attention of many practitioners. Consequently, various theories and approaches have been proposed and applied in an attempt to find a means of resolving, or at least counteracting, the numerous demands of a writing task. The product approach, the process approach, and the genre approach are the most influential approaches adopted for the teaching of writing.

4.3.1. The Product Approach

The product approach is rooted in stage-based theories of writing. Flower and Hayes (1981) claim that these theories see the writing process as a set of linear processes “separated in time, and characterized by the gradual development of the written product”. These theories, therefore, see writing as being composed of separate stages, the overall aim of which is the final product. Furthermore, stage-based theories have a specific emphasis on language accuracy, especially

grammatical correctness. As Pincas (1982) pointed out, the product approach gives prominence to appropriate use of syntax, vocabulary, and cohesive devices. To assure accuracy, learners are provided with models of ideal texts that they are responsible for imitating. These learners' final product, hence, is expected to be accurate as it is, in a sense, a replica of the model text. These models are to be imitated from the phrase-level to the paragraph level and beyond. Furthermore, because accuracy is of such importance in this approach, mistakes are taken seriously and corrected immediately. Creativity in writing is also limited; learners are only expected to reproduce what they have been provided (Badger & White, 2000). While this approach is believed to have some advantages, it has received significant criticism. One major point of criticism is that learners may be able to produce grammatically accurate sentences but may not be able to go beyond that and produce a meaningful text as a whole, especially when in a task in which they are left to improvise or in a task different from the original task they had imitated (Hyland, 2003; Raimes, 1991).

4.3.2. The Process Approach

As a reaction to some of the weaknesses of the product approach, Flower and Hayes (1981) argue that writing is an active, recursive and interwoven process involving great mental effort from the writer. This focus on cognition, resulting from the cognitive revolution of the mid- 20th century, led Flower and Hayes (1981) to devise their groundbreaking cognitive model of writing, which set the stage for all subsequent process theories (a detailed description of the model is provided in section 4.4). In the process approach, prominence is no longer given to the final product; rather, emphasis is placed on the various interconnected phases of writing that a writer must go through to get to the final product (Badger & White, 2000). Such phases include planning, drafting, editing, and writing the final draft (Richards, 2002). Hence, strategies are developed for each phase in order to facilitate the process and achieve a better final product.

Planning is the stage in which the writer thinks about what s/he will write. Some writers may use certain strategies to plan, such as using graphic organizers, while others may write down everything that comes to their mind, yet others may write down key words. Richards (2002) assert that, in this phase of writing, individuals should keep in mind the purpose of writing, the type of language that will be used, their audience, and the appropriate structure for the prompt, among other things. The second phase, drafting, is the phase in which an individual writes down the first version of the composition. In this phase, the writer is not so pre-occupied with making the text perfect, but his/her aim is to organize his/her thoughts into a preliminary draft (Richards, 2002). In the next phase, editing, this preliminary draft is read by the writer for possible alterations. These alterations can be on the level of organization, content, language, structure, style, or anything else. Any modification that the writer believes should be made is noted. Finally, in writing the final draft, these alterations are made and the composition is finalized in the sense that the writer will not make further modifications (Richards, 2002). The stages of writing, however, have been divided differently by different authors. For instance, White and Arndt (1991) divide the process into the following phases: generating ideas, structuring, drafting, focusing, evaluating, and reviewing. Another key feature of the process approach is that, in line with Flower and Hayes's (1981) framework, the writing phases are recursive and interwoven. Hence, the writer is not tied to a specific operation that must be rigorously followed. Rather, a writer proceeds through the writing process in a manner that allows his/her to improvise in accordance with his/her goals (Harmer, 2002). While writing the first draft, the writer can, for instance, make modifications or generate ideas.

4.3.3. The Genre Approach

The third major approach to writing is the genre approach. In this approach, students deal with forms specific to certain genres. They analytically study generic texts, particularly for the format, before they proceed to writing their own version in that genre (Nunan, 1999). Typical genres students deal with are business letters, newspaper articles, and — particularly in the case of English for Specific Purposes students- scientific reports, or the like. Therefore, students are prompted to collect certain data from the texts, taking notes of language as well as formal features, after which they discuss their findings with the rest of the class. Kalantzis and Cope (2001) outline three phases of genre-based writing. First, learners are provided with models of the target genre. Second, after studying the text for its particular characteristics, learners and teachers co-construct its replica. Third, the learners construct the text without the aid of the teacher. Like the product-approach to writing, this approach also relies on behaviorist principles of imitation and conditioning (Badger & White, 2000). Like in the product approach, this approach is mainly criticized for the passive nature of students.

The aforementioned approaches have been devised in an attempt to target the complex demands of the writing task. Nonetheless, each approach comes with its own drawbacks, which serve as further evidence for the intricacy of the composition process. First, the product approach is seen as just another realization of behaviourist principles of learning, particularly imitation; learning, though, involves a combination of numerous factors: mental factors, affective factors, social factors, and more. Second, the process approach is a time-consuming method; learners are not always granted hours to write and reflect as they want. The genre approach also carries with it the issue of imitation and prescriptivism. Consequently, many classrooms have come to teach writing using a combination of the three approaches. The next section provides an elaborate

explanation of the cognitive perspective on writing, that which is most essential for building a rudimentary understanding of the background of this particular study.

4.4. Cognition and Writing

4.4.1. A Cognitive Model of Writing

Because the literature in the field of writing is extremely broad, this review is limited in scope as it provides an overview of writing mainly from a cognitive perspective with only a brief reference to the most essential additions from other perspectives. Hayes and Flower (1980) devised the first cognitive model which, in essence, aimed to outline the most essential mental processes involved in writing. Accordingly, their revolutionary framework became the groundwork for most subsequent research on writing. Flower and Hayes developed the model as a reaction to previous stage-based models such as that of Rohman (as cited in Harris et. al, 2009). They argue that the earlier stage-based models saw composition as a set of linear processes, “separated in time, and characterized by the gradual development of the written product” (p.367), arguing that this emphasis on the written product at the expense of mental processes was a significant weakness. They assert that, contrary to previous beliefs, there is no definitive line separating the different stages; instead, the ‘stages’ of writing are actually interwoven, recursive, and driven by the writer’s momentary decisions throughout the process. Not only that, but these processes are hierarchal with sub-processes being subsumed within processes. Goal setting, for example, is a sub-process of planning (Flower & Hayes, 1981; Hayes & Flower, 1980).

According to the Flower and Hayes, writing is comprised of three principal components: the task environment, the writer’s LTM, and the writing processes (Flower & Hayes, 1981; Hayes & Flower, 1980). The first component of the cognitive model is the ‘task environment’, which refers to the setting or conditions under which the writing task takes place. In the model, this

component is comprised of two subcomponents: the ‘writing assignment’ and the ‘text produced so far’. Hence, these are factors external to the writer. The first sub-component, the writing assignment, is also known as the ‘rhetorical problem’; it is the prompt to which the writer is supposed to respond; it is the actual question or aim of the task. This sub-component consists of three other sub-components: the topic, the audience, and motivating cues. The topic is, again, the theme or subject of composition, and the audience refers to the individuals for which the writer is aiming his/her writing. The second sub-component of the task environment is the ‘text produced so far’. This is the developing text. As an individual proceeds with the writing task, the writer is tied to the ongoing text. That is, more pressure is placed on the writer to adhere to the limitations set by the previous words and sentences. For instance, the thesis statement provides an outline for the rest of the essay and the topic sentence of each paragraph is an outline for the rest of the paragraph; so as the writer is developing his/her ideas, s/he is tied to these outlines and must constantly keep them in his/her mind as the text is developing (Flower & Hayes, 1981; Hayes & Flower, 1980).

This first component of Hayes and Flower’s model, the task environment, is only one facet of what a writer is faced with when juggling the demands of writing. Accordingly, the learner is expected to predict and meet the demands of the intended audience, the demands of the topic or the prompt, and the demands of the written or ongoing text itself. The writer must constantly try to meet the needs of the audience in order to retain their interest and attention while keeping in mind that s/he must not deviate from the original question or prompt, all while constructing the piece in a coherent and cohesive manner. Failure to meet one of the demands may result in an ineffective written product (Flower & Hayes, 1981; Hayes & Flower, 1980). The cognitive

processes model, however, is not limited to just the task environment. Another significant component of the model is the writer's LTM (Flower & Hayes, 1981; Hayes & Flower, 1980).

The second component of the cognitive processes model of writing is the writer's LTM. This component refers to the writer's mental store that is necessary for drawing on information or knowledge needed to complete the writing task. This knowledge can be knowledge of the audience, knowledge of the topic of discussion, or knowledge of linguistic conventions or rules of composition (Flower & Hayes, 1981; Hayes & Flower, 1980). In the process of text construction, the writer is expected to, either consciously or unconsciously, draw on such knowledge from their LTM store, and based on this knowledge s/he is expected to properly construct a network of objectives for effectively executing the task. For instance, when a writer recalls from his/her LTM the correct structure of an essay, s/he therefore is expected to set the objective of adhering to this structure the whole time s/he is executing the task (Flower & Hayes, 1981; Hayes & Flower, 1980).

The final component of the cognitive processes model of writing is the set of writing processes involved in carrying out the composition. This set of processes includes the sub-processes of planning, translating, and reviewing. The first sub-process, planning, subsumes the tasks of generating ideas, organizing them, and goal-setting. The writer is expected to generate ideas that are also expected to be in line with the demands previously mentioned: the demands of the task, those of the audience, and those of the ongoing text. This process of generating ideas, however, would be effectively executed only if the writer sets certain goals — goals of meeting the aforementioned demands. Once the writer effectively accomplishes this, s/he would organize his/her ideas into coherent and cohesive sets (Flower & Hayes, 1981; Hayes & Flower, 1980). Planning, however, is insufficient for writing a composition. Hence, a crucial process of writing included in the model is translation. Once the writer has gathered and organized what s/he wants

to write, s/he must put these thoughts into a readable and comprehensible text. Hence, the writer translates his/her abstract ideas into a written text. This, however, is not as easy as it seems. The writer would have to accomplish this while adhering to syntactic, lexical, and other demands such as effectively elaborating on the ideas. These processes cause writers to be torn between devoting their attention to language accuracy on one hand and successfully representing abstract thoughts on the other (Flower & Hayes, 1981; Hayes & Flower, 1980).

As mentioned above, the final component of the cognitive processes model, the set of writing processes, subsumes various sub-components, of which planning and translating have been discussed above. Once a writer has gathered their ideas, organized them, and translated them into written form, s/he should start executing another writing process: reviewing . When reviewing the already written material, the writer first reads and evaluates what s/he has written in light of his/her goals and demands. Afterwards, s/he revises or edits whatever s/he feels is irrelevant or impedes any effort to fully meet any goals or demands. Another significant element included within the writing processes component of the Hayes and Flower's model is the monitor. The monitor is believed to function as a guide by which the writer makes momentary decisions. The monitor, for instance, prompts the writer to transition from the process of translation to reviewing or from the process of generating ideas to translation (Flower & Hayes, 1981; Hayes & Flower, 1980).

While these components and processes are mentioned in a particular order, and while they seem to be distinct from one another, Flower and Hayes stress the recursive, hierarchal and interwoven nature of the processes. Sub-processes are embedded within processes, and processes overlap with each other. That is, writers may activate a certain process or sub-process and imbed it within an already-operating process. For instance, reviewing does not necessarily mean the end of the writing task, and idea generation does not only happen in the beginning of the writing

process. Writers may review their progress at any point of the composition process and choose to alter their plans and goals and therefore generate new ideas. Likewise, when reviewing, writers may dig into their LTM store in order to revisit their previous goals or to double-check information they have included for accuracy. Accordingly, the whole process of composition is driven by the hierarchy of goals which, influenced by external variables such as the task environment and content available in LTM, have been set and have been accumulating from the moment of exposure to the question (Flower & Hayes, 1981; Hayes & Flower, 1980).

Some researchers criticized the original Hayes and Flower model, drawing on some of its shortcomings. The model was criticized for failing to account for the writing medium or channel (eg, paper versus computer), inter-individual differences, potential writing partners, and other social factors (Brandt, 1992; Hartley, 1991). As a reaction to the criticism, Hayes (1996) attempted to account for certain other factors in his ‘Individual-Environmental Model’. He accomplished this by incorporating a new element, ‘the individual’, and updating an element that had already existed in the old model— the task environment. In incorporating ‘the individual’, Hayes (1996) accounts for the intra-individual factors of motivation and other affective variables. In updating the task environment, Hayes (1996) incorporates the social and physical environment, elements that were not accounted for in the original Hayes and Flower model. Another major update in the new model (presented in figure 4.1) is an elaboration of the role of memory in writing. While the original model already accounted for an individual’s LTM store, it did not account for or mention anything related to WM. The updated model, however, did include a WM component (figure 4.1).

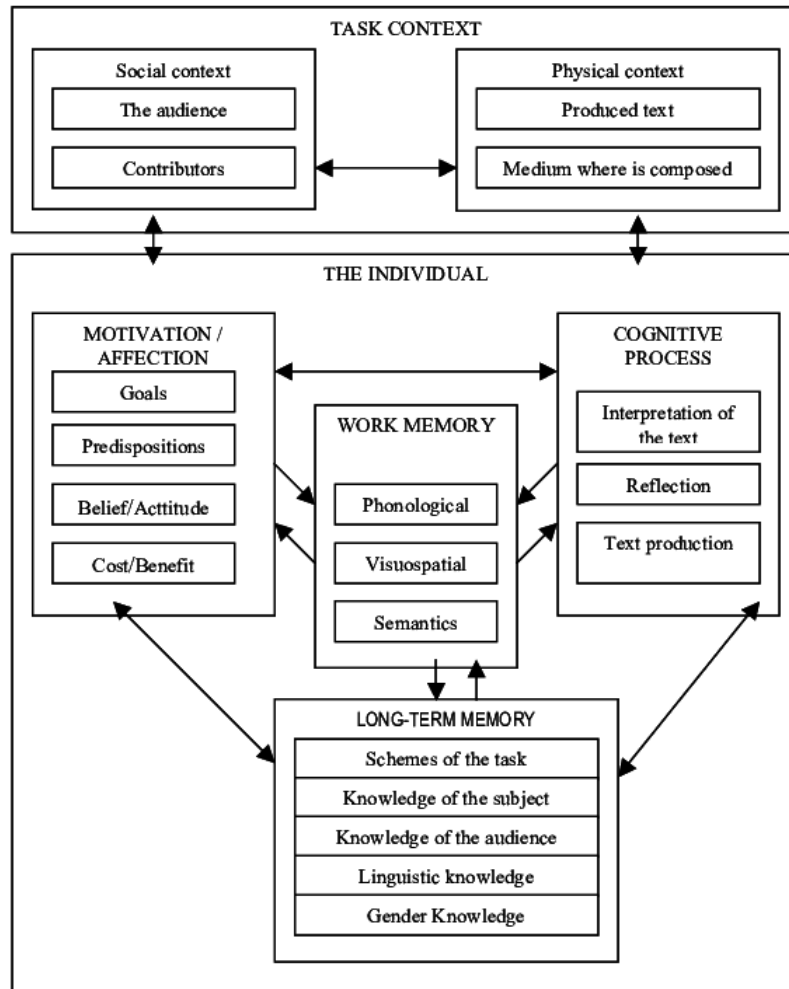


Figure 4. 1. Hayes's (1996) Individuo-environmental Model

Hayes's (1996) model was divided into two main constituents: the task environment and the individual. The first component, the task environment, is comprised of two sub-components, the social environment and the physical environment. The former sub-component, like in the old model, includes the audience and a new element, potential partners or collaborators in the writing process. The second sub-component, the physical environment, includes the ongoing text being produced by the writer and the medium of composition. The new sub-components within the task environment, the contributors and the medium of composition, are added as a response to some of the weaknesses that had been pointed out by critics.

The second major component of the model is the individual, which subsumes the sub-components of motivation/affect, WM, cognitive processes, and LTM. Hayes (1996) accounts for affect and motivation by discussing several key points. First, he discusses the significance of motivation in terms of goal-setting. These are the series of goals discussed in the first model. They are goals that writers set for themselves throughout the writing process and that are driven by other factors such as the ongoing text and the audience's expectations. Second, Hayes discusses the writers' predispositions or role. These are the choices (mostly in terms of strategy selection and use) that one makes in order to effectively achieve his/her goals. Third, Hayes discusses the writers' attitudes and beliefs about themselves during the composition process. The writer, for instance, may feel that s/he is a poor writer and that s/he may not execute the task well or vice versa. These beliefs, however, may or may not be true, but they do have a significant influence on the writer and the process of composition. Finally, within the sub-component of motivation, a writer weighs his/her costs and benefits; i.e, what the writer benefits or loses from task. A writer may be more motivated to execute the task while s/he is writing for an exam as compared to when s/he is writing as part of a simple classwork task because of the significance associated with the costs and benefits of exam performance.

The second sub-component of the 'individual' component in Hayes's (1996) individual-environmental model is the set of 'cognitive processes' involved in writing. Within this sub-component, Hayes included an individual's interpretation of the text, reflection, and text production. The first element, the writer's interpretation, refers to the internal representations that s/he constructs of the words and ideas s/he has written. The second element, reflection, is similar to interpretation, but with the added aim of producing more internal representations. Hence, one may construct mental representations (interpretations) of a sentence or a passage, but s/he must

aim to do so for the purpose of creating more mental representations and hence ideas, or re-creating the same idea in a modified form because the original form was unsatisfactory (reflection). The third element, text production, is synonymous with the writing sub-process translation in the original Hayes and Flower model. Hence, it is the transformation of these mental representations into a written form (Hayes, 1996).

Accordingly, the elements discussed thus far are not too different from the elements included in the original Hayes and Flower model. For instance, the same constructs of planning, translating, and reviewing of the original model are discussed in the updated Hayes (1996) model as the constructs of interpretation, reflection, and text production and goal-setting. In the updated model, however, Hayes (1996) incorporates a completely new element, WMC. Due to the growing interest in memory processes and specifically the growing interest in understanding the nature and function of WM processes, researchers in various fields have become interested in how WM as a system and its different components contribute to learning and performance on tasks in that field. Researchers in the field of writing, like Hayes, were no exception. His attempt to integrate WM into a writing framework is further discussed in the following section.

4.4.2. The Role of Working Memory in Writing

The previous section presented Hayes and Flower's (1980) original model of writing and Hayes's (1996) updated model. The new model, which retained most of the original elements, incorporated an additional component that is of a major concern for this study. This additional element is WMC. Although LTM had been a major component of the original model, the new model presented a clear distinction between LTM and WM systems and the role of each in the composition process. Hayes (1996) preserved the original function of LTM, which is the storage of various types of knowledge relevant for executing the composition process. Examples of such

knowledge include knowledge of the task and its demands, linguistic knowledge (which includes the rules and conventions of composition) content knowledge, and knowledge of the audience.

In terms of the WM, Hayes (1996) included three significant components from Baddeley's (1986) WM model (refer to the section 1.4., WM models): the phonological component, the visuospatial component, and the semantic component. According to Baddeley (1986), WM is a system responsible for both storage and processing of on-line information. Furthermore, this system is comprised of several components, two of which are the PL and the VSS, each responsible for storing and processing a particular type of information. A third major component, the CE was not integrated by Hayes (1996) in the WM component because the functions associated with the CE, like planning and decision making, have been accounted for in the other constituents of the writing model, mainly within the component of cognitive processes. According to Hayes (1996), all of the writing processes have access to WM, but Hayes did not elaborate on how exactly this is accomplished.

Accordingly, the significance of WMC in writing was repeatedly highlighted in early cognitive models of writing. Specifically, researchers focused on potential cognitive overload. That is, the discrepancy between the demands placed on the writer during the writing process and the limited WMC available to meet such demands. For instance, the demands placed on the writer to translate thoughts into written form consumes a significant amount of WM resources, so much that the resources available for planning and other processes are limited. Hence, performance is likely to be hindered (Bourdin & Fayol, 1994).

One of the most prominent models of WM in writing was devised by Ronald Kellogg in 1996 but was later revised in 2001. Like Hayes (1996), Kellogg (1996) adopted Baddeley's (1986) original model of WM and integrated into a writing framework. Kellogg's (1996) model of WM in writing is presented in figure 4.2.

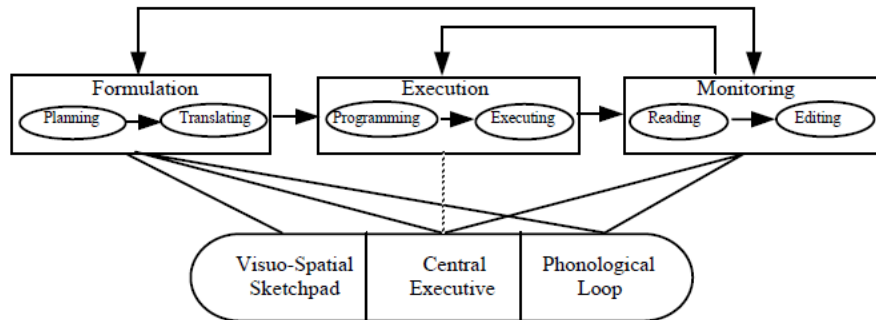


Figure 4. 2. Kellogg's (1996) Model of Working Memory in Writing

The model devised by Kellogg (1996) consists of three major writing processes and three components of WM. The three processes of writing are formulation, execution, and monitoring. Each of these three processes are comprised of two sub-processes. Formulation subsumes planning and translation, execution subsumes programming and executing, and monitoring subsumes reading and editing. These processes and sub-processes are not too different from the constructs discussed by Hayes (1996). First, a writer 'plans', which involves the conceptual generation of ideas in the writer's mind. This is before the writer generates a linguistic translation. The second process, execution, entails the actual 'putting into practice' of this translation. Hence, after the writer translates his/her ideas into full, grammatical sentences in his/her mind, s/he executes by writing them on paper. Kellogg (1996) makes a distinction between programming and executing sub-processes. He describes programming as the mental programming of the hand and how it should write the particular letters and words it responsible for writing. Execution, however, is the physical execution done by the muscles of the fingers, hands, and arms that make the programming a reality.

The final writing process included in Kellogg's (1996) model is monitoring, which contains two sub-processes: reading and editing. The former sub-process refers to simply reading the text in an attempt to detect any flaws or discrepancies between what is written and the set goals. The latter sub-process, editing, refers to the actual modification of anything written in attempts at correcting such flaws or discrepancies. Like Hayes and Flower (1980) and Hayes (1996), Kellogg (1996) emphasizes the recursive and complex nature of these writing processes. A process or a sub-process can overlap with another process or sub-process. For instance, a writer can 'finish' a writing task only to read it and decide it needs further elaboration, after which s/he may, again, undergo the process of planning. This is probably accompanied by more translating, programming, and executing.

In terms of WM processes, Kellogg (1996) incorporates the VSS, the CE, and the PL from Baddeley's (1986) WM model. As a brief reminder, the two 'slave' systems, the VSS and the PL are responsible for storing and processing visual/ spatial information and auditory or language-related information, respectively. The CE, however, is an executive control system responsible for steering information to and from the two slave systems and LTM, controlling attention, and overseeing the system as a whole. Accordingly, Kellogg (1996) argues that the planning process of writing places demands on the VSS and the CE but not on the PL because the planning phase constitutes generating abstract mental representations or ideas (a visual/spatial task), which requires a certain degree of attention (a task of the CE) and most likely retrieval of information from LTM (also a task of the CE). However, because in this phase of writing these ideas are still abstract/ conceptual, they have not taken a linguistic or verbal form that would demand processing from the PL. Conversely, the second sub-process of writing, translation, demands processing from the PL because this is the phase in which abstract thoughts are transformed into linguistic form,

albeit still merely in a mental form. Furthermore, the attention and decision-making required to translate these ideas from an abstract form into a linguistic form requires the CE (Kellogg, 1996; 2001).

The second writing process in Kellogg's (1996) model, the physical execution of ideas into written form, also places demands on WM. This demand, however, is believed to be limited to the CE only and even more limited for those who practise writing more often because of the sense of automaticity gained from the practice. Moreover, the demands placed on the CE from execution are believed to derive mainly from the sub-process of programming rather than executing. The third and final process of writing, monitoring, is believed to place demands on all three components of WM. Reading relies on the PL mainly for language-related processing and the CE mainly for focus of attention. Furthermore, editing is believed to rely on the VSS for constructing and maintaining a mental image of what needs to be edited and where this text is in relation to the rest of the text on the page (Kellogg, 1996; 2001).

According to Kellogg (1996) every one of the writing processes is dependent on WM with the exception of the executing sub-process since executing is attributed to the purely physical (and mostly automatic) rather than cognitive nature, although it is believed that for less experienced writers, like children, for whom the executing sub-process is not automatic and requires a degree of mental effort, the CE is involved in executing (Kellogg et al., 2013). Unlike the CE, however, the storage components (the VSS and the PL) are believed to be specific to only certain sub-processes. For instance, the only sub-process that is believed to rely on the VSS is planning (Table 4.1 summarizes the writing processes the components of WM tapped by each process).

Table 4. 1. *Working Memory Components Required for Writing Processes (Kellogg, 1996)*

Writing Sub-processes	WM Resources		
	<i>VSS</i>	<i>CE</i>	<i>PL</i>
<i>Planning</i>	✓	✓	
<i>Translating</i>		✓	✓
<i>Programming</i>		✓	
<i>Executing</i>			
<i>Reading</i>		✓	✓
<i>Editing</i>	✓		

The literature on WM in writing is not limited to theoretical descriptions; rather, various empirical studies have been carried out in attempts to establish a relationship between writing and WM processes, and WM has been found to be associated with writing on various levels. For instance, Vanderberg and Swanson (2007) studied the relationship between WM components and various writing processes. The researchers found that the CE was significantly associated with the writing processes of planning, writing, and revision. In support of Kellogg’s assertion that writing processes are most dependent on the CE, the authors found that writing processes were most dependent on attentional control of WM (a function for which the CE is responsible) when compared to the two slave systems (the VSS and the PL).

In studying the effect of WMC on writing, McCutchen, Covill, Hoynes, and Mildes (1994) claim that WMC influences the quality of texts produced by writers. Specifically, those with higher WMC wrote better than those with lower WMC. Likewise, Bergsleithner (2010) examined the relationship between WM and writing performance and discovered a direct and significant causal relationship between the two, specifically on accuracy and complexity. Yi and Luo (2013) also associated WM with writing accuracy. In addition, Swanson and Berninger (1996) studied the

relationship between WM and the writing performance of 200 children; the study revealed that WM is significantly correlated with multiple measures of writing. In support of Kellogg's (1996) model, the authors did not find significant correlations between measures of physical transcription and WM, which may be, as Kellogg suggested, due to the automatic nature of transcription. Likewise, Berninger, Cartwright, Yates, Swanson, and Abbott (1994) studied how children's writing performance related to their WM capacities. Their study revealed that WM performance is significantly and positively associated with various measures of writing performance. Similarly, Hoskyn and Swanson (2003) examined whether WM measures correlated with structural complexity during writing; results revealed that even after controlling for other variables, WM is a significant predictor of structural complexity of written products.

Accordingly, various empirical studies as well as theoretical underpinnings suggest that writing ability and performance are significantly affected by WMC. The extent and nature of this effect, however, is rather vague and undetermined. Some researchers (Kellogg, 1996) suggest that the association between the two is rather strong while others (Berninger et al., 1994; Swanson & Berninger, 1996) believe the association is weaker than actually believed. Furthermore, while some researchers (Kellogg, 1996) believe that all three of the major components (the CE, the VSS, and the PL) of WM are associated with writing performance, other researchers believe that only a limited portion of WM plays a role in writing ability (Vanderberg & Swanson, 2007). For instance, Vanderberg and Swanson (2007) examined the three major components of WM in relation to various measures of writing performance and found that only the CE played a major role in predicting writing, albeit it was a predictor of multiple measures of writing, such as the processes of planning, revision, and translation as well as various other writing measures such as vocabulary and punctuation.

Like Vanderberg and Swanson (2007), Olive, Kellogg, and Piolat (2008) examined how different components of WM each contributed differently to text composition. College students were expected to complete a writing task and a concurrent visual, verbal, and spatial task. The researchers found that spatial WM was least affected in comparison to visual and verbal WM, suggesting that the latter two are more affected by the process of composition than the former. Likewise, Kellogg, Olive, and Piolat (2007) examined how the three WM measures contributed to writing at the level of sentence production. In short, the authors found that visual WM was most affected at the planning phase while verbal WM was most affected at the translation phase, a finding that is consistent with Kellogg's (1996) theory as well as various subsequent empirical studies (Chenoweth & Hayes, 2003; Mueller, Seymour, Kieras, & Meyer, 2003).

Some researchers (Hayes, 1996) suggest that visual WM resources are required for reading the text and therefore for the monitoring or revision phase of writing (Piolat, Roussey, & Thunin, 1997). Passerault and Dinet (2000) found that descriptive writing tasks, which rely predominantly on visual imagery, are more dependent on the VSS than other forms of writing tasks such as argumentation. These findings support the claim made by Kellogg (1996) that more figurative planning is more dependent on visual WM resources.

In sum, both the theoretical as well as empirical literature seem to strongly suggest that the CE, a main executive control component of WM, is essential for most, if not all, of the writing processes individually, transitioning between processes, and juggling the demands of writing throughout the whole process of composition. Likewise, the literature seems to provide an abundance of evidence that visual-spatial WM (the VSS) is essential for planning processes while verbal WM (the PL) is essential for translation processes. These findings all support Kellogg's

(1996) original theoretical proposition of how different WM resources are used by different writing processes.

The idea that WM plays a role in writing was initially introduced by Flower and Hayes's (1981) cognitive theory of writing in which they draw attention to the overwhelming demands placed on the writer throughout the writing process, which may subsequently result in poor performance. A proposition, made by Flower and Hayes (1981), which sets the foundation for a better understanding of the role of WM in writing is that individuals, when in the process of text composition, may face a cognitive overload. This overload has later been understood as a product of the numerous demands placed on an individual's cognitive system throughout the writing task (Kellogg, 2008; Olive, Kellogg, & Piolat, 2002). McCutchen (1996) pointed out that limited capacity of WM limits the processing capacity devoted to writing. This is echoed by Olive (2012), who states that "when processing requires more working memory capacity, less capacity is available for storing information, and vice versa" (p.486). He also describes how competent writers must switch back and forth between the various writing processes, which would demand more WMC. This increase in demand would be a disadvantage to those with lower WMC. Hence, the various demands placed on WM compete for scarce WM resources (Kellogg, Olive, & Piolat, 2007).

On the simplest level, WM can be defined as the system responsible for storing on-line information (Baddeley & Hitch, 1974). This on-line information is the information that is 'currently' being processed or must be placed temporarily on hold for later processing. For example, in the context of writing, an individual may be in the process of translating an abstract idea into written while s/he suddenly gets another idea or piece of information that s/he wants to add to another part of the composition. In this case, the writer must place one of the two ideas on

hold. The writer must either temporarily halt the original translation process, retaining it as ‘on-line’ information in his/her WM system while s/he adds the new idea to a different part of the text, or place the new idea in his/her WM store until s/he has finished the original translation process. Whichever information s/he chooses to place in his/her temporary store, this writer would have to go back and retrieve it for further processing. If s/he halted the original translation process to add the new idea that has been generated, s/he would have to go back and proceed with translating. Likewise, if s/he placed the new idea on hold until s/he has completed his/her current process of translation, s/he would have to go back and process the new idea that has been generated. In either case, this is the kind of on-line processing and storage that the WM system is responsible for carrying out.

This kind of on-line storage and processing, however, is not limited to one task. Typically, a writer is faced with juggling numerous tasks at once. For instance, s/he is faced with transcribing his/her ideas into written form while making sure his/her spelling, handwriting, and grammar are up to standards. At the same time, this writer is faced with the task of trying to predict and meet the expectations of the readers as well as constantly making sure s/he is not deviating from the task or the prompt; hence, what s/he is writing is at par with what is being asked of his/her to write. Added to this, the writer is most likely faced with the task of juggling any newly-generated or unexpected ideas. Hence, s/he is faced with making the decision of either delaying this newly-generated information until s/he has finished his/her current task, or finishing his/her current task at the expense of maybe losing fresh ideas. Other demands, which may be seen as constraints, are external factors such as time management or environmental distractors. All of these demands, simultaneously being juggled, are the responsibility of the WM system, a system already limited in both storage and processing capacity. Hence, activating and coordinating the various writing

processes and controlling attention devoted to the various demands, all of which are the function of WM, leave writers, especially those who already have less WM resources, to experience a cognitive overload. In most cases, this is what is believed to be responsible for ineffective written products, and this is the reason writing is considered such a difficult task (Olive, 2012).

Accordingly, all of this seems to be even truer for those writing in a non-native language. These learners are not only faced with all of the cognitive load and strain already associated with the writing task, but they are also faced with the added strain of managing it in a language that is not their native tongue. Writers writing in an L2, regardless of how well they have learned the language, seem to be faced with the extra task of translating information or thoughts from their native language to the L2. Lu (2015) states that “language learners, when they are writing in their L2, they must use part of their cognitive resources to focus on the language so that other functions, such as higher-order functions for organization and discourse cannot be engaged at full capacity” (p.176).

Language learners may put forth more effort to retrieve lexical items or generate grammatically or stylistically effective sentences or even paragraphs. Sometimes, especially in the case of less advanced learners, they may even be faced with cultural barriers that may prevent them from effectively writing to a certain audience. For instance, a learner of English as an L2 responding to a prompt intended for an audience of English natives may fail to write a piece that is fully effective in terms of meeting audience expectations. This is especially the case of less proficient writers or individuals who are less knowledgeable of the target culture or expectations. Such discrepancies may occur simply because of a single word or expression with special connotation, which is misinterpreted by the non-native writer, or they may occur at the broader level of cultural misunderstanding.

Olive (2012) points out how limited WM resources function for both storage and processing of information and how this/here is a kind of ‘trade-off’ between the two tasks. Hence, once a task demands more storage capacity from WM, less processing resources are available. Likewise, when a task demands more processing resources, less WM resources are available for storage. In addition, Olive (2012) reviews the significance of the interaction between WM and LTM in writing. WM functions as a means through which information in LTM is accessed (Ericsson & Delaney, 1998; Ericsson & Kintsch, 1995). Hence, limited or consumed WM resources may have an effect on the efficiency of LTM retrieval, a task that is vital throughout the writing processes.

While significant improvements in various domains have been reported after WMT, to the knowledge of the researcher, no WMT has been reported in the domain of writing in general or EFL writing specifically. However, with the overwhelming evidence for the link between WM and the writing processes, it seems that an improvement in WMC may lead to an improvement in writing performance. Hence, assuming that WMT is effective in improving WMC, WMT may be effective in improving writing performance. The current study, therefore, aims to test this assumption by applying a WMT in the EFL classroom to see whether it leads to a significant improvement in learners’ writing performance.

4.5. The Relationship between Working Memory, Metamemory, Anxiety, and L2 Writing

This review has thus far covered the literature on memory (with a special focus on WM and metamemory), anxiety (with an emphasis on FLA), and writing (mainly from the cognitive perspective). The review has also covered how each of the constructs is linked to the other. How all of the constructs are related, however, has not been covered. This section, therefore, aims to

gather and integrate the various links that have been established throughout the review in order to draw some sort of assumption about how the four constructs of WM, metamemory, anxiety, and writing may be associated. Accordingly, theoretical coverage and assumptions of how the four constructs can possibly be associated is the basis upon which the researcher devises a reasonable rationale for going through with the study.

The two primary variables of this research are WM and writing. A conclusion that can be drawn based on the reviewed literature is that WMC plays a crucial role in writing performance. This conclusion is based on various theoretical (Hayes, 1996; Hayes & Flower, 1980; Kellogg, 1996) as well as empirical (Bergsleithner, 2010; McCutchen et al., 1994; Swanson & Berninger, 1996; Vanderberg & Swanson, 2007; Yi & Luo, 2013) works that have been carried out over the past few decades. First, Hayes and Flower (1980) devised their groundbreaking cognitive processes model of writing, which set the foundation for most, if not all, subsequent research in writing. Although Hayes and Flower did not explicitly account for WM, one of the key points in their theorizing is that cognition is the backbone of writing, and once an individual experiences a cognitive overload, his/her writing efficiency is diminished. This cognitive overload later became recognized as WM overload, which takes place when processing demands exceed resources. In revising the model, however, Hayes (1996) explicitly incorporated WM as a major contributor to the writing process. While the author did not elaborate on the nature of this contribution, he did set the stage for other researchers to research and develop a better understanding of the relationship between the two constructs. While Hayes (1996) revised the original cognitive processes model, Kellogg (1996) devised a writing model that specifically sought to explain the role of WM in writing. His model of WM in writing somehow filled in the gaps of Hayes's proposition as it provided a detailed explanation of the contribution of WM in the various writing processes.

These theoretical assertions of the role of WM in writing have been tested and confirmed by various empirical accounts. Bergsleithner (2010), McCutchen et al. (1994), Swanson and Berninger (1996), Vanderberg and Swanson (2007), and Yi and Luo (2013) have all provided different yet complementary empirical results that support the aforementioned theoretical propositions. Furthermore, on the level of second/ foreign language writing, this/here is available (albeit scarce) empirical evidence of the role of WM. For instance, Zabihi (2018) found that WM measures were significantly and positively associated with writing performance in the L2. Furthermore, in studying the effects of WM on Chinese EFL learners' argumentative writing performance, Yi and Ni (2015) found a significant positive effect of WM on the level of syntactic fluency and complexity of writing. Moreover, since the limited nature of WM resources is believed to contribute to the negative consequences of the multiple demands of the composition process, the current study adopts the viewpoint that an even greater negative effect may be encountered for those writing in an L2. This is because L2 writers experience the extra demand of having to write in a non-native language— a task that may make the process more tedious and consume more resources.

As mentioned above, the two major variables of concern in this study are WM and L2 writing performance. The current study, however, assumes this relationship to be a rather complex one, mediated and moderated by other unknown variables. Specifically, the study assumes that the relationship between WM and L2 writing is moderated by two major variables: metamemory and anxiety. As far as the first variable, metamemory, is concerned, this study assumes that it moderates the relationship between WM and L2 writing because, as the review suggests, metamemory does seem to contribute to WM as well as writing measures. The link between metamemory and memory seems to be well-established in the literature because of the reliance of

metamemory on memory processes (Dunlosky & Bjork, 2008). Various studies have yielded significant results that support the assertion that metamemory measures are significantly and positively associated with memory performance (Koriat, Goldsmith & Panshy, 2000; Short, Schatschneider & Friebert, 1993). Hence, higher metamemory measures are believed to be associated with better memory performance and lower metamemory measures are believed to be associated with worse memory performance. For this reason, this current study assumes that metamemory affects WM performance. Likewise, metamemory and writing measures have been found to be significantly associated (Magno, 2008). Although studies that specifically studied metamemory measure in relation to writing are relatively scarce, metacognition in general has been found to be significantly associated with writing by various researchers (Angelova, 2001; Farahian & Avarzamani, 2018). In sum, higher metamemory measures were found to be associated with better memory performance as well as better writing performance. Hence, based on the reviewed literature, this study adopts the viewpoint, and thus the hypothesis, that metamemory is a significant moderator in the relationship between WM and writing. In other words, individuals' metamemory levels affect the relationship between their memory and writing performance.

The second variable adopted as a potential moderator in this study is anxiety. Like metamemory, anxiety is revealed by the literature to be as a significant predictor of not only memory performance but also writing performance. Strong theoretical explanations (Corbetta & Shulman, 2002; Eysenck & Calvo, 1992) as well as empirical evidence (Darke, 1988; Hadwin, Brogan & Stevenson, 2005; Mitt, 2008; Owens, Norgate, & Hadwin, 2008) have been presented in the literature review for the debilitating role of anxiety in WM resources. Likewise, the debilitating role of anxiety in writing, especially L2 writing, has been supported in the form of theoretical (Krashen; Leki, 1999) as well as empirical (Al Asmari, 2013; Khelalfa, 2018; Lee &

Krashen, 2002; Lui & Ni, 2015; Onwuegbuzie, Bailey, & Daley, 2000; Rezaei, Jafari, & Younas, 2014) research. Based on the aforementioned evidence, this study predicts that anxiety significantly hinders performance in both memory and writing. Hence, with a presumed negative effect on both of the main variables, the study has adopted anxiety as a moderating variable. Anxiety levels are, therefore, predicted to affect the relationship between WM measures and L2 measures.

In sum, the review for this study has thus far covered the literature on two major variables: WM and L2 writing. Based on the literature, the two variables seem to be directly associated. The review proceeded by reviewing the literature on two assumed moderating variables: metamemory and anxiety. Based on the findings, these two variables are believed to affect the relationship between the original independent (WM) and dependent (L2 writing) variables. The former (metamemory) is assumed to moderate the relationship positively; hence, higher measures of metamemory are assumed to positively affect the relationship. The latter (anxiety), however, is assumed to negatively affect the relationship.

Conclusion

This chapter has aimed to review the literature on L2 writing. It has introduced the topic of L2 writing, along with a brief history of research in the field. It then focused on writing from a cognitive perspective and its significance in this study. The review then proceeded by highlighting on the significance of WM in writing. Most importantly, this chapter draws on research from all four domains—WM, metamemory, anxiety, and L2 writing—in order to present evidence for the hypothesized associations between the four variables and provide a sound theoretical foundation upon which the study is built. Overall, this chapter has helped the researcher gain a more thorough understanding of the intricacies behind the writing processes and how other variables interact with

them, leading to a difference in the final written product. The current chapter also concludes the review of literature. Therefore, a transition into the fieldwork is made in the upcoming chapter.

5. Chapter Five: Research Methodology

Introduction

The current chapter presents an overview of the methodology implemented in this study. This chapter, therefore, provides details of the research design, the sample, the data gathering tools, the treatment, and the means of data analysis adopted by the researcher in aims of effectively answering the research questions. In providing a detailed description of all aspects of the study, the researcher aims to facilitate replicability of the study.

5.1. Research Design

In order to answer the research questions and test their corresponding hypotheses the researcher adopted an experimental design. The essential elements of this experiment are as follows (Kirk, 2012):

- **The variables:** Every experiment has at least two key variables: the independent and the dependent variable. This experiment is comprised of these key variables, along with two others. The independent variable, that which is manipulated by the researcher, is dual N-back WMT. The dependent variable being measured is L2 writing performance. The two other variables introduced into this study are metamemory levels and anxiety levels. These two factors are adopted as potential moderators in the relationship between the independent and dependent variable.
- **The pretest and the posttest:** The pretest, a measurement of the dependent variable prior to the intervention, is administered in order to gain an understanding of the subjects' initial scores in comparison to each other. The posttest, a measurement of final scores of the dependent variable, is administered after the treatment to gain an understanding of the

effect of the treatment via comparison of the two groups from pre- to post-intervention performance.

- **The treatment:** The treatment, also considered as the main independent variable, is essential for an experiment. In other words, one variable must be manipulated in order to effectively track changes of another variable.

While the researcher opted for an experimental design, she could not effectively carry out a true experimental design. To effectively carry out a true experiment, the design must meet certain conditions. If and when one of these conditions is not met, the design is no longer considered a true experiment; rather, it is considered a quasi-experiment. The term *quasi* means resemble; hence, a quasi-experiment resembles a true experiment. Accordingly, one of the conditions for a true experiment is randomization. However, since the randomization condition has not been met in this study, the design is considered a quasi-experiment. Particularly, the type of quasi-experimental design in which randomization is missing is called nonequivalent groups design (Price, Jhangiani, & Chiang, 2015). This is because when subjects are randomly assigned to groups, the groups will most likely be similar. Any differences between the groups happens by chance and not by selection. However, with a lack of random assignment, the groups will probably be dissimilar (hence the term nonequivalent) (Price, Jhangiani, & Chiang, 2015)

Accordingly, this study has adopted a quasi-experimental nonequivalent-groups, pretest-posttest design in which two groups have been selected, one assigned to treatment and the other to control, after which they were both administered a pre-intervention writing test and a post-intervention writing test. The researcher could not possibly achieve random assignment because of several constraints, the most prominent of which is administrative. As Price, Jhangiani, and Chiang (2015) assert, a quasi-experiment is often implemented in real-world research contexts,

such as those in educational contexts. Therefore, with pre-existing administrative groups and teachers, the researcher was reduced to settling for what was already available as the potential research sample distribution rather than re-allocating students to different groups for randomization.

Like any other form of research, experimental research has its disadvantages and its advantages (Price, Jhangiani, & Chiang, 2015). Despite its drawbacks, the researcher opted for experimental research because she believes the advantages outweigh its disadvantages. Particularly when dealing with human beings, it can be somewhat unpredictable and may introduce a variety of extraneous, unexplained, and uncontrollable variables that may interfere with treatment implementation, data gathering, or data interpretation. Nevertheless, the robustness of experimentation in allowing the researcher to draw cause-and-effect conclusions is the primary reason for which the researcher opted to use it. Gay, L R (1992) asserts that

The experiment method is the only method of research that can truly test hypotheses concerning cause-and-effect relationships. It represents the most valid approach to the solution of educational problems both practical and theoretical, and the advancement of education as a science (p.298).

By introducing a treatment to some subjects and controlling for certain extraneous variables, the researcher can, to some extent, establish causation between the treatment (the independent variable) and the dependent variable.

5.2.Population and Sample

The research population is the collection of individuals to which the researcher aims at generalizing her findings. In this study, the population of interest is 280 second year students of EFL registered at the University of L'arbi Ben M'hidi in Oum El Bouaghi for the academic year

2018-2019. All of the students share relatively the same academic background. All of the participants had studied English for about seven years prior to the academic year in which the study was conducted, and they had all been studying under the same general curriculum.

In selecting the sample, the researcher opted for a convenience sampling method since she could not implement randomization because of a number of circumstances and constraints. The researcher chose to work with second year students; she believed that second year students would be most suitable of the three levels in terms of data collection and application of the treatment. In terms of data collection, the study calls for measurement of students' writing performance, which the researcher intended on doing by having them take writing tests, responding in the form of an essay. This, however, is not possible to achieve with first year students, who only study sentence construction in the beginning of the school year and paragraph construction towards the end of the school year. Therefore, to test first year students in essay writing would be highly unfeasible. In terms of application of the treatment, the researcher felt like third year students would be uninterested and therefore uncooperative since, by their third year, many students appear to be experiencing a sense of burnout. This lack of interest, the researcher believed, would significantly impeded efforts at progress in terms of treatment implementation as well data collection.

Second year EFL students at L'arbi Ben M'hidi University during the academic year 2018-2019 were divided into seven administrative groups. The researcher asked to be assigned as the teacher of Oral Expression for three of the seven groups. One of the three groups was later assigned the pilot study, and the remaining two of were assigned the treatment, making them the EG. In assigning a CG, the researcher selected two other groups that were taught by a different teacher. These decisions can be justified as follows:

- The researcher had already decided she would integrate the treatment into their Oral expression course rather than their writing course (although the dependent variable being measured is writing). This is because the treatment, which is applied via listening and not via writing, would be impractical to implement in their writing course. Moreover, in applying the treatment in oral expression, the researcher could receive consent from participants to participate in the experiment while still managing, to an extent, to achieve blinding of participants. They were orally asked for consent to participate in the study, to be subject to the treatment, and to be assessed in their various skills, but they were not explicitly told that they were being assessed in writing. Therefore, they most likely assumed they were being assessed in speaking or listening. Participants provided the researcher with oral consent to participate in the study with all of its conditions. Furthermore, in deciding to implement the treatment in oral expression, the researcher chose to be their oral expression teacher rather than their writing teacher. The researcher could not possibly be the teacher of five groups (one pilot group, two EGs, and two CGs) for both oral expression and written expression.
- As far as allocation is concerned, the researcher chose to allocate the groups to which she was assigned as teacher to the pilot and treatment conditions since they were the groups that needed to be manipulated. As far as the CG, she decided it would be most practical (although not ideal) to use groups to which she was not assigned as the teacher. All of the groups were studying under the same general syllabus objectives, so the CGs were already following the set syllabus, which would remain that way even if the researcher was their teacher. The researcher would not add or change anything about their objectives or the course lessons. Therefore, in having to choose between groups,

the researcher allocated her groups to treatment and pilot conditions, selecting two other groups to be the control groups.

- In opting to use two CGs and two EGs, the researcher took into account attrition. Although each group consisted of over 40 students, the teacher predicted that, by the end of the study, she would not be left with 40 students; rather, each group would be reduced to nearly half. Therefore, if this was the case, the researcher thought, data from each set of groups would be combined and treated as one group. For instance, if the two CGs and the two EGs were each left with 15 participants, then the researcher would combine the data of the two CGs and end up with one group of 30 participants, and she would do the same for the EGs and end up with one EG of 30 participants. Instead of having four groups, she would have one set of data for the CG and one set for the EG. The researcher later saw that this was a good decision because, to her expectations, the sample underwent major attrition.

The sample for this study originally consisted of four groups (again, two CGs and two EGs) consisting of a total of 155 participants. After administering the pretest, the sample was reduced to 130 participants because some subjects were absent on the day of the pretest. As the weeks progressed, the researcher carried out the experiment and collected data, and a significant number of participants were dropped again because a number of participants were uncooperative and did not complete the task as instructed. For many of these participants, the researcher did not even receive any of the data that was needed to consider them as participants in the experiment. The sample size was later reduced again after some participants did not attend the posttest. Finally, more participants were excluded from the sample after the questionnaires were administered. Some did not attend class that day, and others did not answer seriously, which was assumed by the way

they were answering the questions; for instance, some finished the survey in two minutes, others left half of the questions or more blank.

Because of the significant loss in the number of participants in each group, the researcher combined the data from the two CGs into one CG and the data from the two EGs into one EG. By the end of the study, the sample was reduced to 80 participants, 42 of which were in the CG and 38 of which were in the EG. Of the total number of participants, 15 are male and 65 are female. This predominance of females over males reflects the same predominance across the entire faculty and department.

5.3. The Treatment

Dual N-back training is a WMT program in which individuals are responsible for memorizing and matching stimuli presented on a screen. The training program is pre-designed and implemented through either a computer program or a phone application. The intervention phase was divided into two sub-phases: the pilot study and the main study.

5.3.1. The Pilot Study

The first sub-phase of the intervention is the piloting sub-phase. The pilot study, also known as a feasibility study, is the execution of a smaller version of a research study prior to its major execution (In, 2017). The aim of a pilot study is to improve the design of the main study by detecting and preventing any potential complications, deficiencies, or unforeseen extraneous variables (In, 2017). After the pilot study, a researcher typically alters any inadequate or problem-causing elements in the execution of the major study in accordance with what was experienced or observed in the pilot. Some examples of what can be improved are unclear instructions, potential causes for uncooperative behavior, inefficient data collection procedures, and ineffective time-management, among other things (In, 2017).

The pilot phase of the study began the first week and ended the last week of October, 2017. In selecting the sample for the pilot study, the researcher made sure it reflected the sample of the main study. For instance, since the researcher had intended on using second year students of English, the pilot group comprised second year students of English. Since the researcher had intended on carrying out the main study in their oral expression course, the researcher carried out the pilot study in their oral expression course. Accordingly, the pilot group consists of 24 students, some of whom were absent for most of the study.

The first step was introducing the game to the students. The researcher had initially decided to devote about 25 minutes to explaining the game to the students in the pilot group, intending to allot them time to try the game and ask any questions. However, the researcher had encountered some unexpected discipline problems. Specifically, the students were more noisy than expected. So, a significant amount of time was wasted on trying to establish a calm environment and explaining the game. Second, students seemed to find it difficult to understand how the game was to be played, mainly due to the researcher's method of explanation. Instead of explaining the most basic principles of the game first then gradually building on those principles, the researcher started by explaining more difficult concepts. The researcher had expected 25-30 minutes to be sufficient for explaining and allowing students to try the game in the classroom. However, this was not the case. The researcher ran out of time and had to dismiss the students without having them practice the game. This meant that they had to practice it the following session, which was after a week. This, the researcher saw as highly inconvenient for the main study because it could potentially lead to too much time wasted and maybe a loss of interest from the learners.

The second issue concerns time allocation of the treatment. In dividing the course into two 90-minute sessions for each group, the researcher had initially intended on trying to get a bit closer

to meeting the recommended four-times-per-week application of the dual N-back task. In dividing the session into two different days of the week, the intervention could be applied two different days instead of one. This was to be accomplished by devoting about 30 minutes of each session to the dual-N back task and about 45 minutes for the various listening or speaking activities that had been planned for the course. The other 15 minutes would be devoted to getting students to settle down and wrapping up the session. This plan seemed to be highly inconvenient for two main reasons. First, listening and speaking activities seemed to demand more time than expected, so 45 minutes per session were insufficient for students. Second, in planning to allot 30 minutes for the dual N-back task, the researcher intended to do so for every session, which would mean that by the end of the semester, the learners would have practiced the recommended eight hours of training. However, because the training program started later than the researcher had planned (about 2 weeks later), the 30-minutes-per-session plan would mean the students could not complete the recommended eight hours.

A final point of concern was the various vacations and breaks students had. Several of these breaks were on the day of their listening session; hence, that week's listening session and consequently the N-back session were cancelled. With these cancellations, it became nearly impossible to make up for the significant amount of time lost. Hence, they were not provided with sufficient time to complete the recommended eight hours of training.

In response to these issues, the researcher decided to make some changes to the main study. First, instead of the 30-minutes-per-session plan, the researcher decided to devote several 90-minute sessions and several half-sessions for the game. In devoting the entire 90-minute sessions for the task, the researcher would be able to recuperate some of the missed time and meet the goal of completing eight hours of training. Second, instead of initially devoting 25-30 minutes to

introducing and explaining the game, an entire 90-minute session was devoted. This provided enough time for the students to become familiar with the game, try it in class, and ask questions in case of any misunderstandings. Furthermore, the researcher avoided making the same mistakes in the instructions she provided the first time and found a much better means of explaining and illustrating the game for the students. Instead of explaining the game initially at the 2-back level, the researcher explained the most basic level first, which was the 1-back level, then used it as a reference point for explaining the 2-back level. Finally, to compensate for the various cancellations of lessons, the researcher asked students to complete whatever time lapse they had at home. Nearly a month before-hand, they were provided instructions to complete the eight hours of training at home before the end of the semester (the next section describes the procedures in detail).

The pilot study was not limited to piloting the intervention only. It also included piloting of measurement tools. The survey used in the study, which aimed to measure metamemory and L2 writing anxiety, was piloted prior to administering it to the main sample. The researcher randomly selected five students from the pilot group to answer the questionnaire. They were asked to answer it while taking note of anything they thought was unclear, inappropriate, misleading, or awkward. They were also asked to mention anything else that came to their mind when filling out the questionnaire, like any questions or suggestions to the wording or formatting of questions. In doing so, the researcher gained a better understanding of what elements from the questionnaire had to be adapted to meet the needs of the subjects.

In piloting the survey, the researcher gained tremendous insight into how it could be adapted for the particular context of this study. The pilot subjects highlighted several points of concern. The main point of concern was the relatively advanced terminology; they drew attention to numerous words they found difficult to comprehend, which led them to not understanding the

whole question. The second point of concern was the wording of some of the questions. Some questions contained double-negatives, which the students found a bit confusing, and other questions were vague overall, and the students could not figure out what they were referring to.

To counter some of the issues raised by the pilot sample, the researcher slightly adapted the survey. First, the researcher replaced the difficult terms with simpler, more comprehensible synonyms. Second, she changed the wording of some questions by removing double-negatives and removing or changing anything else that caused such confusion. Finally, the researcher changed any questions or statements that were vague overall to make them clearer for the L2 reader. For instance, in the original SLWAI, one of the statements was “I tremble or perspire when I write English compositions”. The researcher reformulated the statement into “I shake (when your whole body moves uncontrollably usually because of fear) or sweat when I write English compositions under time pressure”. Another example is the statement “I feel my heart pounding when I write English compositions under time constraint”, which the researcher changed to “I feel my heart beating when writing English composition (like paragraphs or essays) under a time limit”.

5.3.2. The Main Study

5.3.2.1. Description

The second sub-phase of the intervention phase is the main study. Again, the treatment was presented in the form of a game, the dual N-back task, which was assigned to the subjects to play during the course oral expressions.

In the game, the participants were presented with a large square that is divided into nine smaller inner squares (three rows and three columns of inner squares. All of the squares are active with the exception of the middle square. At each trial one of the squares flashes, which represents the visual stimulus (VS) and, at the same time, a letter is uttered, representing the auditory stimulus

(AS). The participant is responsible for remembering both stimuli n positions back so that they indicate when the current position matches. The figure below illustrates how the game progresses when playing for two positions back- hence the 2-back level. Figure 5.1 is an illustration of the game at the 2-back level. It presents three arrows of five screens each. The five screens represent progression of the game; it is the same screen representing different stimuli, but for the sake of clarification, the different stimuli are presented by different screens.

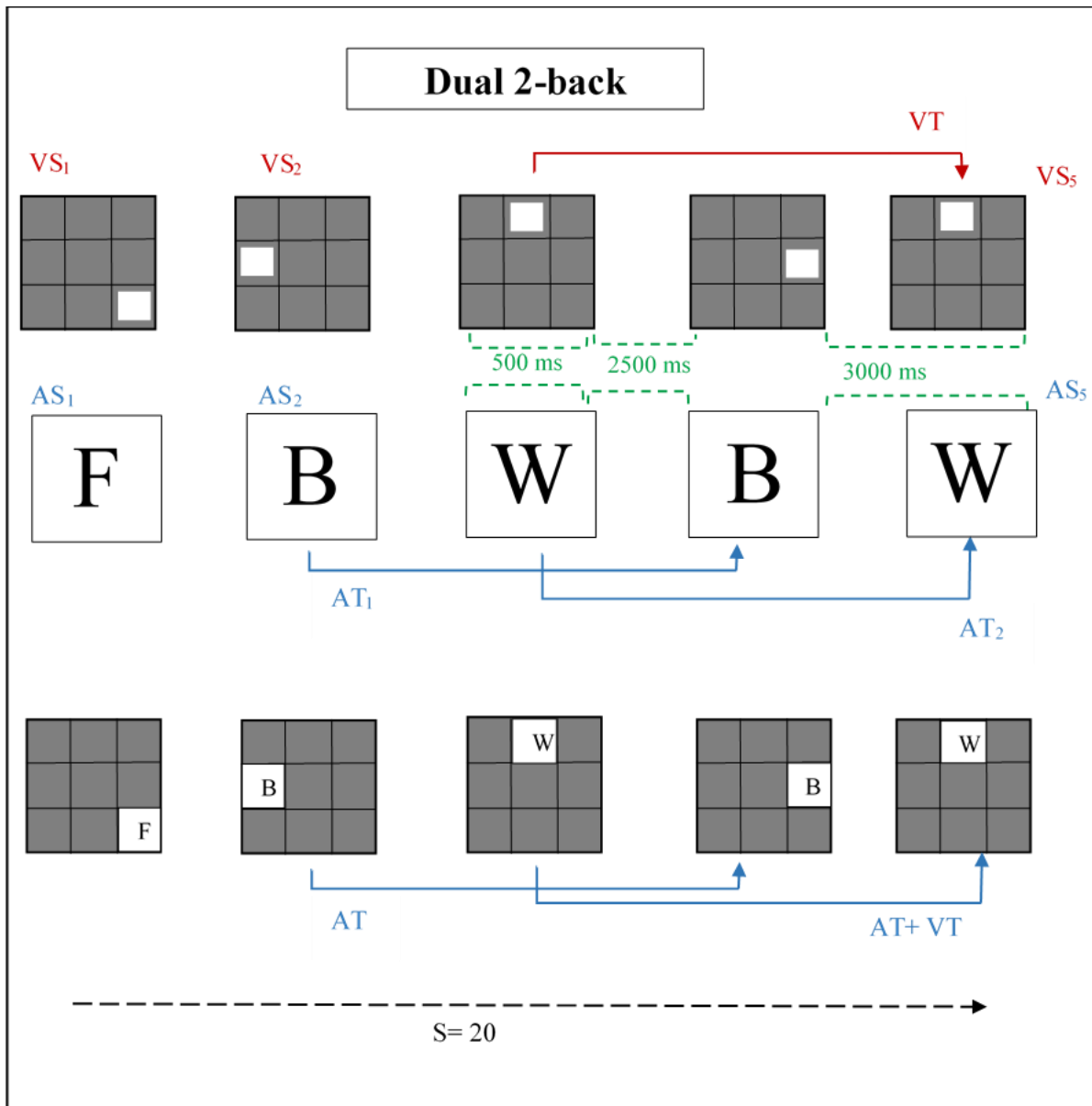


Figure 5. 1. Illustration of Dual N-back, 2-back Level

The first row represents the visual stimuli, denoted by VS₁, VS₂, etc. until VS₅. As the figure shows, each VS is presented in a different position in the screen. For instance, VS₁ is in the bottom right position, and VS₂ is a flash in the middle left position. The player is responsible for memorizing at least the last two positions, not including the current position, so she can effectively indicate when there is a visual target (VT). When the current position of the VS matches the position of the VS two positions back, then the player indicates a VT. In the case of the VSs in this row, there is only one VT, which is at VS₅ since VS₅ is a match with the stimulus presented two positions back, which is VS₃. While the first row illustrates only the progression of the VSs, in the game there is a simultaneous presentation of AS. The same principles for the AT are applied for the AT. The player is responsible for memorizing at least the last two positions, excluding the current position of the AS in order to indicate when there is an AT. The progression of AT is represented by the second row. As the figure shows, there are two AT, one at AS₄ and one at AS₅. The letter uttered at AS₄ matches that of AS₂, and the letter uttered at AS₅ matches that of AS₃.

Although the two kinds of stimuli (VS and AS) are presented in two separate rows for the sake of clarification, in the game they are presented simultaneously. Hence, the player is responsible for memorizing at least three VS and three AS at the same time. For instance, if the screen is at the fourth stimulus, the player must remember the position of the second and third VS and the sound of the second and third AS in order to compare those of two positions back (second-position stimuli) with the current (fourth-position) stimuli to determine whether they match. The reason that the third stimulus would need to be memorized is because it is required for comparison with the position that follows the current one (fifth-position stimuli).

This combination of VS and AS is illustrated in the third row in figure 5.1. In this row, the VS and the AS from the rows below it are combined for an all-encompassing illustration. As the

figure illustrates, the player would have to indicate at the fourth position that there is an AT and at the fifth position that there is both an AT and VT. Furthermore, as the figure illustrates, the time-lapse between the presentation of each stimulus is 2500 milliseconds (ms), and the duration of the presentation of each stimulus is 500 ms. Hence, the total amount of time provided for the player to process each stimulus or update previous processing is three seconds. Each session that the player completes consists of 22 trials, or sets of stimuli.

The same principle holds for the other levels. In the dual 3-back level, players are responsible for remembering two sets of four stimuli at one time: the set of VSs (current stimulus included) and the set of ASs (current stimulus included). They are then expected to indicate when there is an AT, a VT, or both. Figure 5.2 illustrates the dual 3-back (top half of the figure) and the dual 4-back (bottom half of the figure) levels. As the illustration of the 3-back level demonstrates, within the five trials, there are two sets of targets. First, at S_4 the player would have to indicate that there is an AT because the letter uttered matches the one uttered three positions back (at S_1). Second, at S_5 the player would have to indicate that there is both an AT and a VT because the sound uttered as well as the position of the VS match those three positions back at V_2 .

Likewise, the bottom half of Figure 5.2 illustrates the 4-back level. Unlike in the 3-back level, which requires the player to memorize four total positions (including the current position), and unlike the 2-back level, which requires the player to memorize three total positions, in the 4-back level, the player is expected to memorize five positions in total, including the current position. Hence, at the 4-back level in the figure, there is only one target. The player would indicate that there is a VT at S_5 since there is a match in positions four positions back at S_1 . Therefore, the player is expected to recall, after every single trial, the position and letter uttered four positions back in order to indicate whether they match with the current position and/or letter. Because the player is

expected to do this at every single trial, s/he is responsible for memorizing not only the letter and positions 4-back, but also those that come after it since they would be needed for the trials that follow. Again, this constant update of information needs to be accomplished at three seconds intervals. Accordingly, because of the difficulty of the levels beyond 2-back, most individuals choose to stay at the 2-back level to play at a comfortable pace without the strain and extra load associated with the other levels.

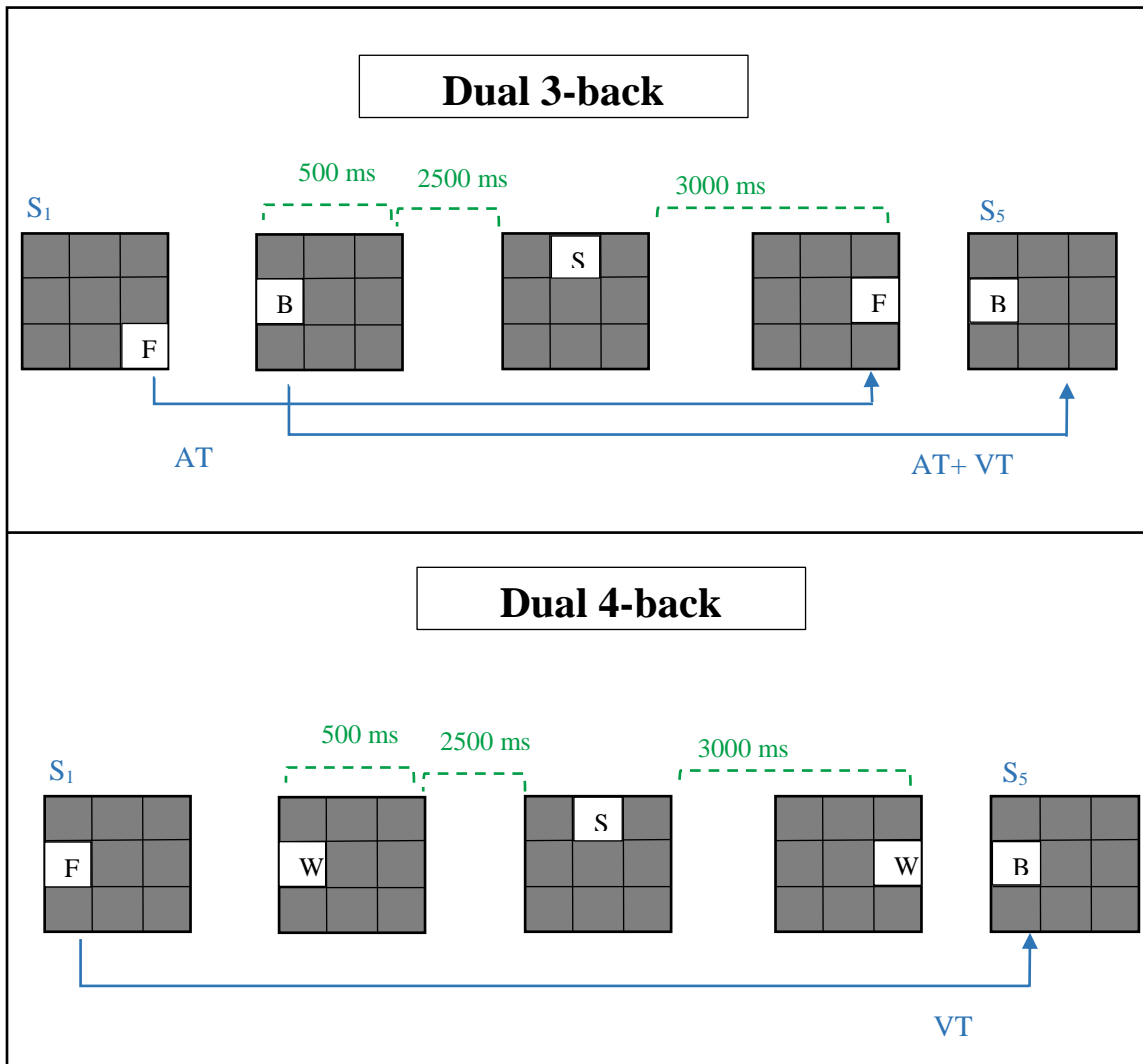


Figure 5. 2. Illustration of Dual N-back, 3-back and 4-back Levels

Figure 5.3 presents screenshots from the game at the fourth trial of the 2-back level. As the figure shows (on the left), there are two buttons for the player to click on when there is a target; one is for the AT (sound button), and another one is for the VT (position button). When there is an AT, the player clicks on the ‘sound’ button. When there is a VT, the player clicks on position. When there is both an AT and a VT, the player clicks on both buttons. Meanwhile, score is kept below the two buttons. At the end of each game session (after 22 trials/ stimuli), the score for the completed session appears on the screen (the right figure). It provides a score for the percentage

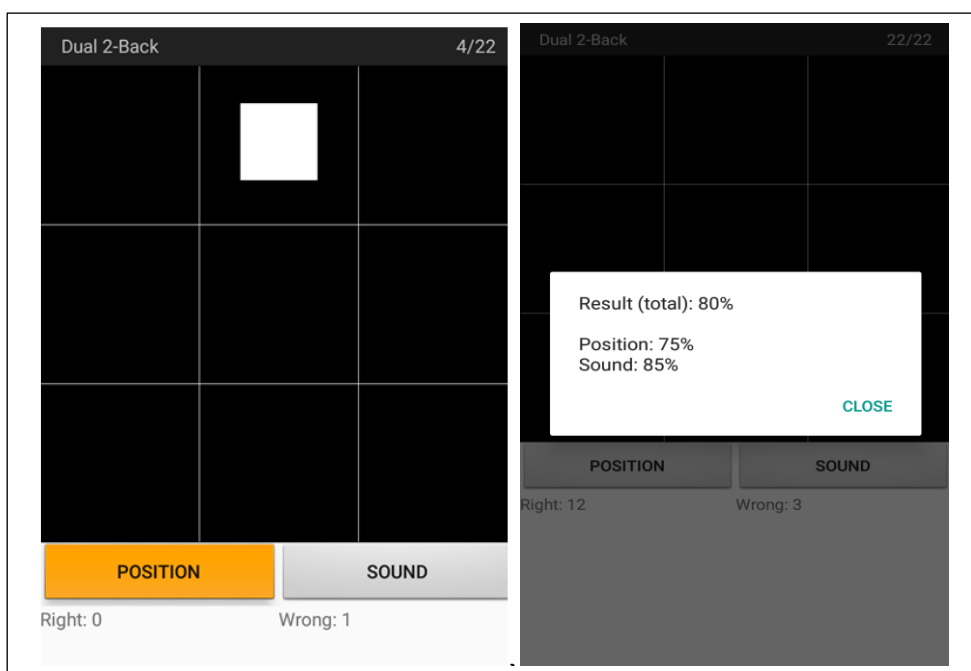


Figure 5. 3. Screenshots of Dual N-back Game

of correct position targets (VT), the percentage of correct AT, and the total percentage, which is the average of the two.

5.3.2.2. Intervention Procedures

The treatment was applied in the students’ oral expression course. The course was typically three hours each week. The researcher divided the course into two 90-minute sessions per week, devoting the first session to listening and the second session to speaking. As a result of the issues found in the pilot study, the researcher allotted several whole 90-minute sessions to the dual N-

back task. These sessions were assigned in the listening half of the course; the researcher believed it was most suitable to implement the task in the listening half because students carried out the task in the form of listening. Hence, the task was incorporated into the course itself

The subjects were asked to download the application on their smart phones. One student did not have a smart phone, so he was asked to do other work during the N-back session. Afterwards, subjects were asked to set the game's settings in accordance with the criteria of the traditional dual N-back task. For instance, in the game, players have the option of choosing between four stimuli: position, shape, color, and sound. However, in the traditional dual N-back task, there are only two stimuli: position and sound, so subjects were asked to select only these two stimuli. Other examples are the duration for which the stimulus is shown and the duration between each stimulus. In the traditional task, the stimulus is shown or heard for 0.5 seconds, and the time-lapse between each stimulus is 2.5 seconds. The game provides the option of selecting a duration of 0.5 seconds to 2.5 seconds for both the duration of the stimulus and the delay between stimuli. Students were asked to set everything in accordance with the traditional task.

After all of the settings were fixed appropriately, the researcher started to explain the task to the subjects. The researcher explained what the game/task is, some of its potential benefits, and the reason they were being asked to play it. They were told that it was part of a research experiment designed in an attempt to determine whether WM training would have any effect on their language skills and were asked for consent to participate, which was provided by all students. They provided consent to be assessed in their language performance overall, without any reference to any specific language skill. Although the aim of the study was to determine whether the training program affected their writing skills, they were not informed that it was their writing that was being evaluated; rather, they were left to assume that it was speaking and listening that was being

evaluated. This was done for the purpose of blinding and therefore avoiding any potential Hawthorn effect.

Afterwards, the subjects were provided with about 30 minutes to practise the game. To simplify things and to avoid confusing or overloading the subjects, the researcher started by explaining only the 1-back level. This was the simplest form of N-back to learn and barely any participants had trouble understanding it. So, they tried the 1-back level, and when most participants gained a good understanding of how it was played, the researcher explained the two-back level and again asked them to practise playing it. While some participants immediately gained a grasp of the level, a significant number of participants were confused and could not apply the verbal explanation. The researcher, therefore, attempted to explain the game more elaborately and with more examples, after which she gave the subjects an opportunity to ask questions. Once most subjects understood well the 2-back level, the researcher asked them to apply the same principles to the 3-back level and what comes after it. Once they fully understood the game, the researcher provided them with a grid and asked them to fill out their scores after every single session they completed. The grid is shown in figure 5.4. Each participant kept the grid with him/her throughout the semester and used it to record his or her performance after each game session. In accordance with the results presented, such as those in figure 5.3, each subject records the level that had just been completed, her performance on the VS, her performance on the AS, and her total performance (refer to Appendix G for samples of students' grids).

Name _____												Group _____												
Day 1	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Level																								
Total																								
Position																								
Sound																								
Day 2	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Level																								
Total																								
Position																								
Sound																								
Day 3	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Level																								
Total																								
Position																								
Sound																								

Figure 5. 4. Students' Grid for N-back Scores

They were also shown where in the settings they could view the graphs of their progress and were asked not to erase them because the researcher would need them at the end of the intervention. Figure 5.5 shows samples of two subjects' graphs. The left graph is a three-in-one visual representation. It represents the subject's performance on the VS (in green), their performance on the AS (in red), and their total performance (in blue). As it shows on the top left-hand corner of the figure, it presents the progress for the dual 3-back level. Moreover, the top right-hand corner presents the time played by the subject in hours, minutes, and seconds, so this subject played for five hours, 25 minutes, and 57 seconds. The right graph, however, does not show performance in terms of the different stimuli. It shows performance in terms of the n-back level and how the subject has progressed from and to 1-back, 2-back, 3-back, and/ or other levels. As the graph shows, this subject started at the 3-back level but dropped to the 2-back level, and has consistently been going back and forth between the two levels. The graphs can be shown interchangeably by changing the settings.

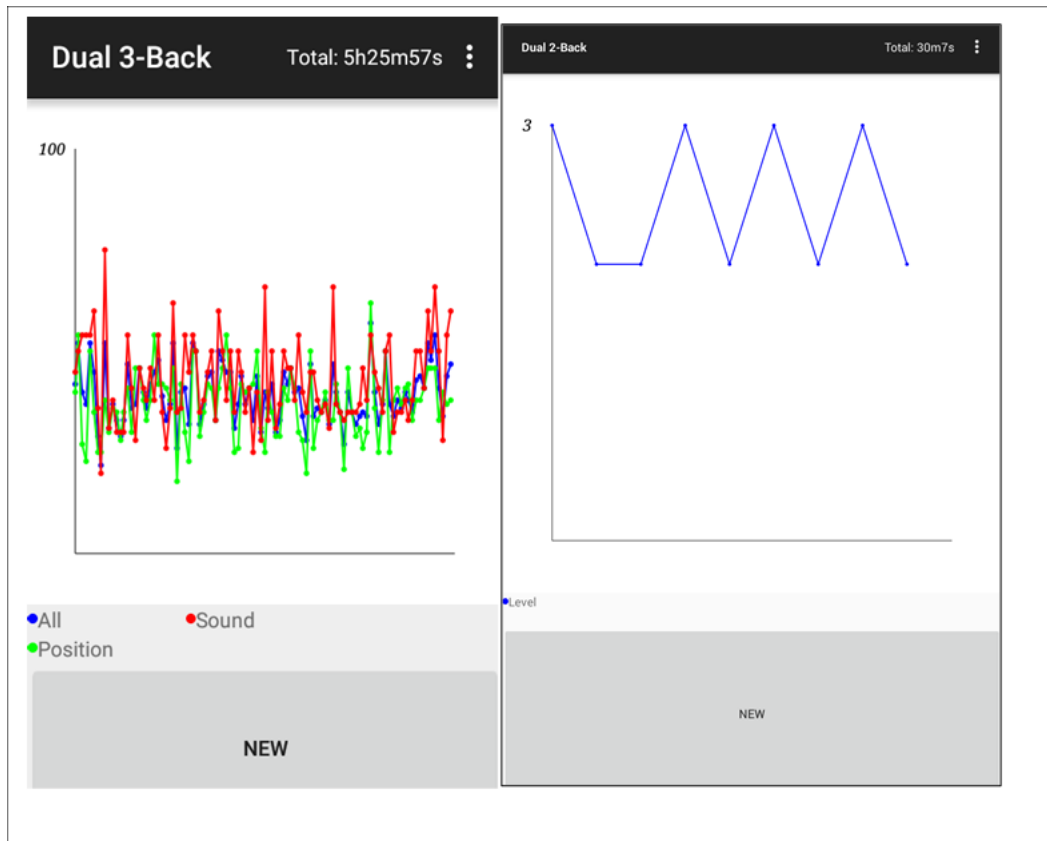


Figure 5. 5. Screenshots of Dual N-back Scores

In following the aforementioned method, the researcher was relatively successful in getting the students to stick to the task. The grids that they were responsible for filling out were rather helpful. Because they were informed that their grids would be collected at the end of the semester and would be compared against the graphs to see if they matched, the students had no way to circumvent completing the task. They had no means of foraging their grids because they had no means of foraging their graphs. This was confirmed at the end of the semester when the researcher compared all the tables against their respective graphs and found them to match. The researcher also monitored the subjects during every session to make sure they were completing the task and not simply using their phones for something else.

Accordingly, the treatment groups were subject to the intervention for a span of about 11 weeks. Although the in-class sessions were done for only about eight weeks, the students had their

winter break and weekends to play the game and fill out the form at home, which most students did accordingly. They were instructed to try to reach the eight-hour target since significant effects of dual n-back WM training have been reported after three weeks of training (a total of eight hours of training) (Jaeggi et al., 2008; Klingberg, 2010). Although with the in-class sessions none, of the participants were able to meet the eight-hour target, by the end of the semester, many met the target, and some even completed more than eight hours of training.

At the end of the semester, the researcher collected the subjects' tables and asked them to take a screenshot of their graphs, which were also collected. The participants who played the game for an extremely low amount of time were excluded from the sample (refer to the Appendix F for more students' graphs).

5.4. Data Gathering Tools

5.4.1. The Writing Tests

The primary aim of this study was to measure the extent to which an intervention of WMT training affects L2 writing performance. In order to effectively accomplish this, the researcher was required to measure participants' writing performance before and after the intervention in order to test for their progress. For the sake of validity, the researcher opted

to use essay writing to test their performance. The researcher believed that paragraph writing would not appropriately reflect their writing competence. The choice of essay writing as a means of measuring their writing performance is based on the rationale that, in writing an essay, they would have an opportunity to expand on their ideas and language use since they are limited to just several lines. In his systematic review of assessments of writing ability, Cooper (1984) reported that essay writing is, overall, a more valid measure of writing ability than other measures such as multiple choice tests. He asserts that "essay tests may sample a wider range of composition

skills, the variance in essay test scores can reflect such irrelevant factors as speed and fluency under time pressure” (p.i). The author also highlights the significance of using multiple assessments to ensure reliability of essay scores.

In an attempt to achieve reliability and validity of writing assessment, the researcher took a few measures. First, rather than using paragraph writing, multiple choice questions, or any other form of measure, the researcher opted to use essay writing. Second, in order to yield the most reliable scores, multiple assessments were used for each essay. Third, these multiple assessments were based on the same standards. Hence, an evaluation rubric was employed by the assessors when scoring each essay. After this, the researcher employed statistical measures of reliability to ensure that the two assessors did not significantly deviate from each other in the scores they provide for each essay.

Accordingly, for both the pre-test and the post-test, subjects were provided with a prompt to which they responded in the form of an essay (refer to Appendix H for the writing prompts and Appendix I and J for sample essays). Each essay was then corrected by two raters in attempt to achieve inter-rater reliability. The researcher attempted to blind the raters and prevent bias by combining and mixing up the papers from all the groups and by covering the names of each participant. Therefore, raters did not know to whom each paper belonged and to which group each paper belonged. Both raters are doctoral candidates of EFL; the first is specialized in didactics EFL, and the second is specialized in didactics of literary texts. Once the raters finished scoring all essays, they discussed the scores. Mainly, they discussed the scores that were significantly different. When there was a significant difference in an essay score, that essay was re-read by both raters and the score was negotiated. However, when scores were not significantly different, they were neither discussed nor altered.

Inter-rater reliability analysis measures the extent to which the two raters or judges agree. In case two raters significantly deviate from each other, then scoring of the particular variable is considered unreliable. Lange (2011) asserts that it tackles the potential problem of lack of consistency in the use of the rating scale. While, inter-rater reliability analysis comes in various forms, the researcher ran an intra-class correlation coefficient statistical analysis. This choice was based on the type of data that needed to be processed. Some forms of inter-rater reliability can only be used with categorical or rank-order data, but when ratings are in the form of continuous data, like in the case of this study, then intra-class correlation coefficient should be used (Mandrekar, 2011). Results from the reliability analysis yielded a coefficient of .94, which indicates strong inter-rater reliability.

In terms of the scale used to score essays, the researcher used an evaluation rubric comprised of five categories that reflect five essential criteria, or subskills, for effective writing. These categories are organization, development, sentence structure, usage, and mechanics (refer to appendix E for the full evaluation rubric). Each category is based on a six-point scale. Hence, the score the essay as a whole is based on a 30-point scale.

The first category, organization, mainly refers to the structural organization of the essay. This includes whether the writer accurately followed the paragraph structuring of an essay, whether there is logical order, and whether transitions are used accurately and effectively. The second category, development, mainly refers to the development of ideas/ content. This includes whether the writer has effectively answered the prompt, whether the thesis statement and supporting ideas have effectively been developed, and whether the essay contains enough support with illustrations, analogies or the like. The third category, sentence structure, contains the criteria for effective sentence structuring, like the level of control the writer has over his/her sentences,

whether there is a variation in sentence and phrase types and structures, and the level of accuracy of her sentence constructions. The fourth category, usage, refers to grammatical usage as well as word choice/ vocabulary. The final category, mechanics, comprises punctuation, capitalization, indentation, and spelling. The rubric was adapted from West Virginia Writing Rubric (2018).

5.4.2. The Questionnaires

To recapitulate, the primary aim of this study was to examine the extent to which L2 writing performance is affected by WMT while taking into account potential moderator variables, which are anxiety and metamemory. While the intervention of WMT was manipulated by the researcher, the two moderating variables were simply measured using a cross-sectional survey. For the sake of convenience, the researcher combined into one longer survey two questionnaires, each of which measured one of the variables. The two questionnaires employed in this study are the SLWAI, devised by Cheng (2004), and the MMQ, devised by Troyer and Rich (2002).

The first questionnaire, the SLWAI (Cheng, 2004), is a standardized self-report scale developed in order to measure the extent to which English learners feel anxious when writing in the L2. It covers various aspects of L2 writing anxiety, from emotional to physiological responses to situations in which they are faced with writing tasks. The original questionnaire was statistically proven to have strong psychometric properties (i.e., strong validity and reliability) (Cheng, 2004). This was the primary reason for choosing to use this questionnaire in this study. The SLWAI originally contained 22 statements based on a five-point Likert scale ranging from strongly disagree (0) to strongly agree (4), albeit some of the questions were reversed, with strongly disagree taking a value of 4 and strongly agree taking a value of 0. In this study, the researcher slightly adapted the questionnaire. This is because when piloting the questionnaire the researcher found that the students quickly became uninterested with the lengthy survey. When combined with

the MMQ, the survey became overwhelming for the subjects. Hence, instead of including all 22 questions, the researcher reduced the questions to 15, so participants' total anxiety scores ranged from 0 to 60. In addition to shortening the questionnaire, the researcher replaced some of the more advanced vocabulary words with simpler synonyms because some students in the piloting phase did not understand the meaning of several terms. For instance, one statement in the original SLWAI is "My thoughts become jumbled when I write English compositions under time constraint". When piloting the questionnaire, several students did not know what "jumbled up" meant, so the researcher changed the statement to "My thoughts get mixed up when I start writing under a time limit".

The data retrieved from the SLWAI was coded into both a continuous scale and a categorical scale. The continuous scale reflects simply the sum of all the answers. For the categorical scale, however, the researcher assigned each respondent to one of four categories of anxiety based on their continuous scores. For instance, those with a score of 0 to 14 were categorized as 'low anxiety', those with a score of 15 to 29 were placed under the category 'low-mid anxiety', those with a score of 30 to 44 were categorized as 'mid-high anxiety', and those with a score of 45 to 60 were categorized as 'high anxiety'. This was done for data analysis purposes. While tests of correlation call for continuous data, tests of interaction effects call for categorical data (Refer to section 5.5 for a more detailed explanation). After administering the questionnaires, the researcher ran a reliability analysis, which yielded a Chronbach's alpha of .92, suggesting strong internal consistency.

The second questionnaire used in this study is the MMQ (Troyer & Rich, 2002). This self-report questionnaire was developed to measure individuals' memory ratings; i.e., their metamemory. The questionnaire measures three categories of metamemory: memory contentment,

memory ability, and memory strategy use. Metamemory levels, as a whole, cannot be measured via self-report questionnaires. Hence, this questionnaire mainly measures declarative metamemory, which is an individual's knowledge and belief of her memory and factors that may affect their memory performance. In contrast to procedural metamemory levels, of which the measurement requires the use of memory performance tasks in order to gauge their performance on such tasks with respect to their self-report ratings, declarative metamemory is usually measured via self-report questionnaires.

The original MMQ contains a total of 57 items. However, the researcher adapted the questionnaire for the same reasons she adapted the SLWAI. She omitted several statements from each sub-section of the questionnaire, reducing the number of statements to 25. This is a major reduction due to the length of the questionnaire, especially since it would be administered together with the SLWAI. Each item in the questionnaire is based on a 5-point Likert scale ranging from 0 to 4, with 0 denoting strongly disagree and 4 denoting strongly agree. Therefore, the total possible score for each respondent is 100, inclusive of the three categories measured by the questionnaire. The category of Satisfaction measures an individual's level of contentment with his/her memory or lack thereof. The Ability scale measures one's perception of his/her daily memory performance via statements prompting them to rate how often, within the past two weeks, they have committed the various memory mistakes mentioned. The final category measures the rate of respondents' use of memory strategies on a regular basis.

The MMQ was used for this study because it was found to have strong reliability and validity. In terms of internal consistency, it originally yielded a high Cronbach's alpha for all three categories of Satisfaction (.95), Ability (.93), and Strategy use (.83). Like the SLWAI, the MMQ was coded into continuous and categorical scales for data analysis purposes. Coding, however,

was done differently for each of the sub-scales. This is because the three subscales of strategy-use, contentment, and ability were scored and interpreted differently. For instance, for the subscales strategy-use and contentment, higher scores meant higher metamemory levels, and lower scores meant lower metamemory levels; for the ability subscale, however, higher scores meant lower metamemory levels and vice versa. Subjects were classified into the categories “low contentment”, “low-mid contentment”, “mid-high contentment” or “high contentment” based on their scores. Likewise, they were classified into the categories “low-ability”, “low-mid ability”, “mid-high ability”, or “high ability”, and the same classification was applied for strategy-use.

5.5. Data Analysis

In order to answer the research questions and their corresponding hypotheses, the researcher implemented specific statistical methods of data analysis using the software SPSS (Statistical Package for the Social Sciences) 25 and Microsoft Word. Statistical analysis took two different forms: descriptive statistics and inferential statistics. In terms of descriptive statistics, the researcher ran the fundamental statistics like mean, median, mode, frequency distributions, and search for outliers. In terms of inferential statistics, for each research question the researcher ran a different test statistic based on the needs of the question and the distribution of data. Accordingly, each research question, along with the method of data analysis used to answer the question, is outlined below.

- Research question 1: To what extent is EFL learners’ writing performance associated with their writing anxiety levels? This research question was answered by first testing for the assumptions of parametric statistics. Specifically, the research question calls for the use of the Pearson product-moment correlation coefficient, which tests for the relationship between two continuous-level variables. However, since Pearson’s correlation coefficient

is a parametric test, in order to use it the data must meet certain conditions or assumptions (Hauke & Kossowski, 2011). After running tests of assumption and finding that the data does not violate the assumptions, the researcher proceeded by running Pearson's correlation coefficient analysis.

- Research question 2: To what extent is EFL learners' writing performance associated with their metamemory levels? In order to answer this research question, the same steps were taken as those for the first research question.
- Research question 3: How does dual N-back WMT affect EFL learners' writing performance? To answer this question, the researcher first tested for the assumptions of ANCOVA, another parametric test statistic. The reason behind the choice of ANCOVA to answer this question is that it allows one to test for the difference between two means while controlling for any other variable (the covariate) (Huitema, 2005). Therefore, the researcher was able to test for the difference between the CG and EG's final writing scores while controlling for their initial writing scores. This is because their initial (pretest) scores could be different to begin with, and this difference could easily be carried onto their post-test scores, giving the impression that their development/improvement rates were different. Accordingly, in controlling their pre-test scores, the final results would accurately reflect their progress rather than being confounded with their initial test scores (Huitema, 2005).
- Research question 4: To what extent is there a two-way interaction effect of each of the two moderating variables (metamemory and anxiety) on dual N-back WMT in its effect on L2 writing performance? In answering this research question, the researcher ran several test statistics separately. The first statistic tested for any treatment-anxiety interaction effect. Three other statistics tested for any potential treatment-metamemory interaction

effect, one test for each of the three metamemory sub-scales. In testing for two-way interaction, the researcher had the choice between two test-statistics, two-way ANOVA, and multiple regression analysis. Although both accurately test for interaction effect of two or more variables, multiple regression analysis is employed when the researcher only has observed variables measured on a continuous scale. Two-way ANOVA, however, is employed when there is manipulation of a variable and variables are measured on a categorical scale (McDonald, 2009). For this reason, the researcher opted for two-way ANOVA. Again, before proceeding with the analysis, the researcher tested for the assumptions and found that the data did not violate the assumptions of parametric testing.

- Research question 5: To what extent is there a three-way interaction effect of the two moderating variables on the intervention in its effect on L2 writing performance? To answer this research question, the researcher ran several tests: each testing for any three-way interaction between one of the three subscales of metamemory and the other variables. To accomplish this, the researcher used three-way ANOVA after ensuring the data did not violate the assumptions of parametric testing (Three-way ANOVA, 2019).

Conclusion

The current chapter aimed to provide a thorough explanation of the methodology implemented throughout this study. To accomplish this, it presented a detailed explanation of the research design, the sample and population, the data gathering tools, the treatment (both the pilot study and the main study), and the means of data analysis adopted by the researcher in aims of effectively answering the research questions. The upcoming chapter presents the results yielded by the multiple means of data analysis, along with a discussion of the results in light of the broader literature.

6. Chapter Six: Results and Discussion

Introduction

This chapter presents the results yielded from the various forms of analyses carried out in attempts to answer the multiple research questions. Data analysis takes two main forms: descriptive statistics and inferential statistics. In order to effectively answer the research questions, the researcher ran both forms of statistics, each presented in a separate section. The first section presents the descriptive statistics for the questionnaires employed in this study and certain data from the intervention. The second section presents inferential statistics. In the third section, the researcher interprets that data from the test statistics in light of the research questions and contextualizes the findings within the broader literature.

6.1.Descriptive Statistics: Frequency

Descriptive statistics function as a means of simply describing the data collected from a sample, which is intended to reflect the target population. They are often divided into three categories: measures of frequency, central tendency, and dispersion. The measure of frequency, in cases such as this study, is simply the number of times a particular response occurs. A measure of central tendency is considered as the central location or typical value within a distribution of a data set. Examples are mean (the average), median (the middle point), and mode (the most common point) (Descriptive and Inferential Statistics, 2019). Finally, a measure of dispersion describes how dispersed or spread a set of data is. Examples of statistics that measure dispersion are variance, standard deviation (SD), and interquartile range (Descriptive and Inferential Statistics, 2019). This section presents the results yielded for the first category of descriptive statistics, measures frequency, and the section that follows presents the other statistics.

To fully contextualize the results, the measuring tools adopted for this study are recapitulated. First, the MMQ was used to measure metamemory levels. Second, the SLWAI was employed as a measure of L2 writing anxiety levels. Third, writing performance was measured with a writing test in the form of an essay prompt. Finally, the intervention of WMT was implemented in the form of the Dual N-back program. Accordingly, this section presents descriptives yielded from each measuring tool. Measures of frequency were calculated using SPSS, and graphs for all frequency distributions were constructed using Microsoft Word.

6.1.1. The Multifactorial Memory Questionnaire

As previously stated, the MMQ is a self-report questionnaire devised for the purpose of measuring certain aspects of metamemory. Therefore, subjects responded to statements classified within three subscales: contentment, ability, and strategy-use. The frequency of participants' responses to each statement, along with a graphical representation of the frequency distribution, are presented in various tables.

6.1.1.1. Contentment

The first category presented is the contentment subscale, which contains 10 statements. The first statement is "I am generally pleased with my memory ability". To this statement, a plurality of participants indicated that they agreed (30 participants, 40.5 % of the sample) or strongly agreed (seven participants, 9.5%). The second statement is "There is something seriously wrong with my memory ability". This statement, along with a few others, have been reversed (from positive to negative statements) by the original authors of the questionnaire in order to calculate reliability and validity coefficients. The frequency table (table 6.1) presents participants' responses to this question, but in analyzing the data, the researcher reversed the coding values.

Table 6. 1. MMQ Contentment Descriptives: Q1-Q4

MMQ- Contentment subscale			Graphical representation
1. I am generally pleased with my memory ability.			<p>Frequency of answers</p> <p>■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	4	5.4 %	
1	9	12.2 %	
2	24	32.4 %	
3	30	40.5 %	
4	7	9.5 %	
Total	74	100%	
2. There is something seriously wrong with my memory.			<p>Frequency of answers</p> <p>■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	11	14.9 %	
1	24	32.4 %	
2	20	27.0 %	
3	9	12.2 %	
4	10	13.5 %	
Total	74	100%	
3. If something is important, I will remember it.			<p>Frequency of answers</p> <p>■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	1	1.4 %	
1	2	2.7 %	
2	5	6.8 %	
3	16	21.6 %	
4	50	67.6 %	
Total	74	100%	
4. When I forget things, I worry that I may have a serious memory problem, like Alzheimer's disease.			<p>Frequency of answers</p> <p>■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	35	47.3 %	
1	13	17.6 %	
2	13	17.6 %	
3	4	5.4 %	
4	9	12.2 %	
Total	74	100%	
0= strongly disagree, 1= disagree, 2= mutual/undecided, 3= agree, 4= strongly agree			

Participants who stated strongly disagree were given a rating of 4; those who stated that they disagreed were given a rating of 3; those who stated that they agreed were given a rating of

1, and those who stated that they strongly agreed were given a rating of 0. Therefore, in the table and graph, their responses should be interpreted like the rest, not reversed since the researcher already reversed their coding for the sake of convenience and understanding. For example, when more students indicate that they disagree (such as in the second statement), that means that more students are discontent with their memory. With that being said, in the original responses to the second statement, the majority of respondents either disagreed (24 participants; 32 % of the sample) or that they were neutral (20 participants; 27 % of the sample), indicating that they were discontent with their memory.

For the third statement “If something is important, I will remember it”, the majority (66 participants; 89 %) either agreed or strongly agreed with the statement. These responses indicate that the majority of participants were content with their ability to remember important information or events. The fourth statement is “When I forget things, I worry that I may have a serious memory problem, like Alzheimer’s disease.” Responses to this statement indicate that the majority of participants (48 participant, 65% of the sample) do not worry about their memory ability; 35 (47.3%) strongly agreed, and 13 (17.6%) agreed, when asked whether they worried about their memory when they forget things.

The above answers are only a few examples of the statements from the MMQ contentment subscale. Overall, answers to four of the ten statements (statement 1, 3, 6, and 9) are skewed to the left, indicating that, in regards to the memory performance mentioned in those statements, more students were content. However, for six of the ten statements (statement 2, 4, 5, 7, 8, and 10), responses were skewed to the right, indicating that the majority of the sample seems to be discontent with their memory. All response rates are presented in Table 6.1, 6.2, and 6.3,

Table 6. 2. MMQ Contentment Descriptives: Q5- Q7

MMQ- Contentment subscale			Graphical representation
5. My memory is worse than most other people my age.			Q5 <p>Frequency of answers</p> <p>■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	27	36.5 %	
1	17	23 %	
2	19	25.7 %	
3	6	8.1 %	
4	5	6.8 %	
Total	74	100%	
6. I have confidence in my ability to remember things.			Q6 <p>Frequency of answers</p> <p>■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	3	4.1 %	
1	14	18.9 %	
2	18	24.3 %	
3	25	33.8 %	
4	14	18.9 %	
Total	74	100%	
7. I feel unhappy when I think about my memory ability.			Q7 <p>Frequency of answers</p> <p>■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	17	23 %	
1	25	33.8 %	
2	12	16.2 %	
3	16	21.6 %	
4	4	5.4 %	
Total	74	100%	
0= strongly disagree, 1= disagree, 2= mutual/undecided, 3= agree, 4= strongly agree			

Table 6. 3. MMQ Contentment Descriptives: Q8- Q10

MMQ- Contentment subscale			Graphical representation
8. I worry that others will notice that my memory is not very good.			Q8
Answer	Number of responses	Percent of responses	
0	35	47.3 %	
1	16	21.6 %	
2	10	13.5 %	
3	9	12.2 %	
4	4	5.4 %	
Total	74	100%	
9. When I have trouble remembering something, I'm not too hard on myself.			Q9
Answer	Number of responses	Percent of responses	
0	4	5.4 %	
1	12	16.2 %	
2	14	18.9 %	
3	33	44.6 %	
4	11	14.9 %	
Total	74	100%	
10. I am concerned about my memory being bad.			Q10
Answer	Number of responses	Percent of responses	
0	16	21.6 %	
1	26	35.1 %	
2	18	24.3 %	
3	11	14.9 %	
4	3	4.1 %	
Total	74	100%	
0= strongly disagree, 1= disagree, 2= mutual/undecided, 3= agree, 4= strongly agree			

6.1.1.2. Strategy-use

The second subscale of the MMQ is strategy-use. The subscale contains a total of 15 statements addressing how often the subjects use various memory strategies. Responses again range from 0 (never) to 4 (always). Frequency of responses for the 15 statements are presented in Table 6.4, Table 6.5, and Table 6.6. The first statement is ‘I use a timer or alarm to remind me to do things’. To this statement, a plurality of participants (29; 39% of participants), answered that

they never use a timer or alarm as reminders while another considerable number said that they rarely (17; 23%) or sometimes (18; 24.5%) use a timer or alarm for reminders. For the second statement, “I ask someone to help me remember to do something”, the majority of participants answered rarely (30 participants; 40.5 %) or sometimes (22 participants; 30 %). In both statements, participants’ frequency of negative response outweighed their positive responses, indicating that fewer participants use such memory strategies as using an alarm as a reminder or asking others help them remind them to do something.

Table 6. 4. MMQ Strategy-use Descriptives: Q1-Q3

MMQ- Strategy-use subscale			Graphical representation
1. I use a timer or alarm to remind me to do things.			Q1 <p>Frequency of answers ■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	29	39.2 %	
1	17	23 %	
2	18	24.3 %	
3	3	4.1 %	
4	7	9.5 %	
Total	74	100%	
2. I ask someone to help me remember to do something.			Q2 <p>Frequency of answers ■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	10	13.5 %	
1	30	40.5 %	
2	22	29.7 %	
3	6	8.1 %	
4	6	8.1 %	
Total	74	100%	
3. I use strategies to help me remember things.			Q3 <p>Frequency of answers ■ 0 ■ 1 ■ 2</p>
Answer	Number of responses	Percent of responses	
0	13	17.6 %	
1	11	14.9 %	
2	19	25.7 %	
3	16	21.6 %	
4	15	20.3 %	
Total	74	100%	
0= Never, 1= Rarely, 2= Sometimes, 3= Often, 4= Always			

Table 6. 5. MMQ Strategy-use Descriptives: Q4- Q6

MMQ- Strategy-use subscale			Graphical representation
4. I create images in my mind to remember things better.			<p>Q4</p> <p>FREQUENCY OF ANSWERS</p> <p>0 1 2 3 4</p>
Answer	Number of responses	Percent of responses	
0	11	14.9 %	
1	6	8.1 %	
2	16	21.6 %	
3	21	28.4 %	
4	20	27 %	
Total	74	100%	
5. I write things on a calendar to help me remember.			<p>Q5</p> <p>FREQUENCY OF ANSWERS</p> <p>0 1 2 3 4</p>
Answer	Number of responses	Percent of responses	
0	32	43.2 %	
1	8	10.8 %	
2	16	21.6 %	
3	8	10.8 %	
4	10	13.5 %	
Total	74	100%	
6. I organize information into categories to help me remember.			<p>Q6</p> <p>FREQUENCY OF ANSWERS</p> <p>0 1 2 3 4</p>
Answer	Number of responses	Percent of responses	
0	13	17.6 %	
1	11	14.9 %	
2	15	20.3 %	
3	15	20.3 %	
4	20	27 %	
Total	74	100%	
0= Never, 1= Rarely, 2= Sometimes, 3= Often, 4= Always			

Statement number four (table 6.5) is “I create images in my mind to remember things better”. The graph of the frequency distribution is skewed to the left; hence, the majority of responses are either ‘often’ or ‘always’ (28 % for the former and 27 % for the latter). When compared to those who indicated that they rarely (6 participants, 8.1% of the sample) or never use the strategy (11 participants, 14.9% of the sample), there is a clear difference in response rates.

From these responses, one can conclude that the majority of students create mental images to help them recall information.

Table 6. 6. *MMQ Strategy-use Descriptives: Q7-Q9*

MMQ- Strategy-use subscale			Graphical representation																					
7. I say something out loud to help me remember it.			Q7 <table border="1"> <caption>Data for Q7 Bar Chart</caption> <thead> <tr> <th>Answer</th> <th>Number of responses</th> <th>Percent of responses</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>19</td> <td>25.7 %</td> </tr> <tr> <td>1</td> <td>13</td> <td>17.6 %</td> </tr> <tr> <td>2</td> <td>12</td> <td>16.2 %</td> </tr> <tr> <td>3</td> <td>8</td> <td>10.8 %</td> </tr> <tr> <td>4</td> <td>22</td> <td>29.7 %</td> </tr> <tr> <td>Total</td> <td>74</td> <td>100%</td> </tr> </tbody> </table>	Answer	Number of responses	Percent of responses	0	19	25.7 %	1	13	17.6 %	2	12	16.2 %	3	8	10.8 %	4	22	29.7 %	Total	74	100%
Answer	Number of responses	Percent of responses																						
0	19	25.7 %																						
1	13	17.6 %																						
2	12	16.2 %																						
3	8	10.8 %																						
4	22	29.7 %																						
Total	74	100%																						
Answer	Number of responses	Percent of responses																						
0	19	25.7 %																						
1	13	17.6 %																						
2	12	16.2 %																						
3	8	10.8 %																						
4	22	29.7 %																						
Total	74	100%																						
8. I check my wallet, pocket, or purse before leaving home to make sure I remember everything.			Q8 <table border="1"> <caption>Data for Q8 Bar Chart</caption> <thead> <tr> <th>Answer</th> <th>Number of responses</th> <th>Percent of responses</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>1</td> <td>1.4 %</td> </tr> <tr> <td>1</td> <td>8</td> <td>10.8 %</td> </tr> <tr> <td>2</td> <td>12</td> <td>16.2 %</td> </tr> <tr> <td>3</td> <td>11</td> <td>14.9 %</td> </tr> <tr> <td>4</td> <td>42</td> <td>56.8 %</td> </tr> <tr> <td>Total</td> <td>74</td> <td>100%</td> </tr> </tbody> </table>	Answer	Number of responses	Percent of responses	0	1	1.4 %	1	8	10.8 %	2	12	16.2 %	3	11	14.9 %	4	42	56.8 %	Total	74	100%
Answer	Number of responses	Percent of responses																						
0	1	1.4 %																						
1	8	10.8 %																						
2	12	16.2 %																						
3	11	14.9 %																						
4	42	56.8 %																						
Total	74	100%																						
Answer	Number of responses	Percent of responses																						
0	1	1.4 %																						
1	8	10.8 %																						
2	12	16.2 %																						
3	11	14.9 %																						
4	42	56.8 %																						
Total	74	100%																						
9. I make a list of things I must do in order to remember.			Q9 <table border="1"> <caption>Data for Q9 Bar Chart</caption> <thead> <tr> <th>Answer</th> <th>Number of responses</th> <th>Percent of responses</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>18</td> <td>24.3 %</td> </tr> <tr> <td>1</td> <td>14</td> <td>18.9 %</td> </tr> <tr> <td>2</td> <td>16</td> <td>21.6 %</td> </tr> <tr> <td>3</td> <td>13</td> <td>17.6 %</td> </tr> <tr> <td>4</td> <td>13</td> <td>17.6 %</td> </tr> <tr> <td>Total</td> <td>74</td> <td>100%</td> </tr> </tbody> </table>	Answer	Number of responses	Percent of responses	0	18	24.3 %	1	14	18.9 %	2	16	21.6 %	3	13	17.6 %	4	13	17.6 %	Total	74	100%
Answer	Number of responses	Percent of responses																						
0	18	24.3 %																						
1	14	18.9 %																						
2	16	21.6 %																						
3	13	17.6 %																						
4	13	17.6 %																						
Total	74	100%																						
Answer	Number of responses	Percent of responses																						
0	18	24.3 %																						
1	14	18.9 %																						
2	16	21.6 %																						
3	13	17.6 %																						
4	13	17.6 %																						
Total	74	100%																						
0= Never, 1= Rarely, 2= Sometimes, 3= Often, 4= Always																								

Another statement to which responses were significantly skewed to the left is statement number eight. As a response to the statement “I check my wallet, pocket, or purse before leaving home to make sure I remember everything”, the majority (42 students, 57% of the sample)

answered that they always used this strategy. Just like statement number eight, statements 10, 11, 12, and 15 (table 6.7 and table 6.7) are all significantly skewed to the left, indicating that most students use the following memory strategies: selective attention, placing things in specific locations, reinforcement, and backtracking in cases of failed recall.

Table 6. 7. MMQ Strategy-use Descriptives: Q10-Q12

MMQ- Strategy-use subscale			Graphical representation												
10. I intentionally focus on details of things that I want to remember.			<p>Q10</p> <table border="1"> <tr><th>Answer</th><th>Number of responses</th></tr> <tr><td>0</td><td>5</td></tr> <tr><td>1</td><td>11</td></tr> <tr><td>2</td><td>21</td></tr> <tr><td>3</td><td>16</td></tr> <tr><td>4</td><td>21</td></tr> </table>	Answer	Number of responses	0	5	1	11	2	21	3	16	4	21
Answer	Number of responses														
0	5														
1	11														
2	21														
3	16														
4	21														
Answer	Number of responses	Percent of responses													
0	5	6.8 %													
1	11	14.9 %													
2	21	28.4 %													
3	16	21.6 %													
4	21	28.4 %													
Total	74	100%													
11. I place things in certain places so I can remember them, like in front of my door.			<p>Q11</p> <table border="1"> <tr><th>Answer</th><th>Number of responses</th></tr> <tr><td>0</td><td>6</td></tr> <tr><td>1</td><td>8</td></tr> <tr><td>2</td><td>19</td></tr> <tr><td>3</td><td>17</td></tr> <tr><td>4</td><td>24</td></tr> </table>	Answer	Number of responses	0	6	1	8	2	19	3	17	4	24
Answer	Number of responses														
0	6														
1	8														
2	19														
3	17														
4	24														
Answer	Number of responses	Percent of responses													
0	6	8.1 %													
1	8	10.8 %													
2	19	25.7 %													
3	17	23 %													
4	24	32.4 %													
Total	74	100%													
12. I repeat things to myself several times so I can remember them.			<p>Q12</p> <table border="1"> <tr><th>Answer</th><th>Number of responses</th></tr> <tr><td>0</td><td>5</td></tr> <tr><td>1</td><td>6</td></tr> <tr><td>2</td><td>20</td></tr> <tr><td>3</td><td>20</td></tr> <tr><td>4</td><td>23</td></tr> </table>	Answer	Number of responses	0	5	1	6	2	20	3	20	4	23
Answer	Number of responses														
0	5														
1	6														
2	20														
3	20														
4	23														
Answer	Number of responses	Percent of responses													
0	5	6.8 %													
1	6	8.1 %													
2	20	27 %													
3	20	27 %													
4	23	31.3 %													
Total	74	100%													

0= Never, 1= Rarely, 2= Sometimes, 3= Often, 4= Always

Table 6. 8. MMQ Strategy-use Descriptives: Q13-Q15

MMQ- Strategy-use subscale			Graphical representation												
13. I create a story to link together information I want to remember.			<p>Q13</p> <table border="1"> <tr><th>Answer</th><th>Number of responses</th></tr> <tr><td>0</td><td>27</td></tr> <tr><td>1</td><td>20</td></tr> <tr><td>2</td><td>14</td></tr> <tr><td>3</td><td>6</td></tr> <tr><td>4</td><td>7</td></tr> </table>	Answer	Number of responses	0	27	1	20	2	14	3	6	4	7
Answer	Number of responses														
0	27														
1	20														
2	14														
3	6														
4	7														
Answer	Number of responses	Percent of responses													
0	27	36.5 %													
1	20	27 %													
2	14	18.9 %													
3	6	8.1 %													
4	7	9.5 %													
Total	74	100%													
14. I write down in a notebook things I want to remember.			<p>Q14</p> <table border="1"> <tr><th>Answer</th><th>Number of responses</th></tr> <tr><td>0</td><td>16</td></tr> <tr><td>1</td><td>10</td></tr> <tr><td>2</td><td>19</td></tr> <tr><td>3</td><td>12</td></tr> <tr><td>4</td><td>17</td></tr> </table>	Answer	Number of responses	0	16	1	10	2	19	3	12	4	17
Answer	Number of responses														
0	16														
1	10														
2	19														
3	12														
4	17														
Answer	Number of responses	Percent of responses													
0	16	21.6 %													
1	10	13.5 %													
2	19	25.7 %													
3	12	16.2 %													
4	17	23 %													
Total	74	100%													
15. I mentally repeat my steps in order to remember something like an item I have misplaced.			<p>Q15</p> <table border="1"> <tr><th>Answer</th><th>Number of responses</th></tr> <tr><td>0</td><td>9</td></tr> <tr><td>1</td><td>8</td></tr> <tr><td>2</td><td>21</td></tr> <tr><td>3</td><td>17</td></tr> <tr><td>4</td><td>19</td></tr> </table>	Answer	Number of responses	0	9	1	8	2	21	3	17	4	19
Answer	Number of responses														
0	9														
1	8														
2	21														
3	17														
4	19														
Answer	Number of responses	Percent of responses													
0	9	12.2 %													
1	8	10.8 %													
2	21	28.4 %													
3	17	23 %													
4	19	25.7 %													
Total	74	100%													
0= Never, 1= Rarely, 2= Sometimes, 3= Often, 4= Always															

While for some questions the frequency of responses is clearly skewed to the right (questions 1, 2, 5, and 13), for other questions, the number of respondents are about the same for each response option. For instance, in questions three, seven, nine, and 14, participants' positive responses and their negative responses are about the same. Furthermore, while responses that are skewed to the right indicate that those particular memory strategies (like using an alarm, asking others, using a calendar, and creating stories to aid memory are not used often) are not used often, a significant number of other strategies are, according to subjects' responses, used more often.

These strategies, like organizing information into categories, selective attention, and repeating information multiple times, are mentioned in statements four, six, eight, 10, 11, 12, and 15.

6.1.1.3. Ability

The final category of the MMQ is the ability sub-scale. Like contentment, this subscale also consists of 10 statements. Respondents select from zero (never) to four (always) the option that best describes their memory performance or ability based on statements that discuss common memory mistakes. Higher responses indicate that the mistake is committed more often while lower scores indicate that the mistake is committed less often. Hence, the higher the scores are the lower the respondents rate their memory ability and vice versa. Response frequencies for the ability subscale are presented from table 6.9 to table 6.11.

Examples of mistakes that are rarely committed by participants are presented in statements one, two, four, and six (presented in table 6.9 and table 6.10). In response to the first statement (table 6.9), “I forget to return things I have borrowed from people”, the majority of students (57 students; 77% of the sample) answered that they rarely or never make this mistake. Likewise, in the second statement, which concerns misplacing objects used regularly, the majority of participants answered that they rarely (22 respondents, 29.7%) or never (29.7%) commit this mistake.

Table 6. 9. MMQ Ability Descriptives: Q1-Q3

MMQ- Ability subscale			Graphical representation
1. I forget to return things I have borrowed from people.			Q1 <p>Frequency of answers</p> <p>■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	34	45.9 %	
1	23	31.3 %	
2	11	14.9 %	
3	5	6.8 %	
4	1	1.4 %	
Total	74	100%	
2. I misplace things I use daily, like keys or glasses.			Q2 <p>Frequency of answers</p> <p>■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	22	29.7 %	
1	22	29.7 %	
2	10	13.5 %	
3	9	12.2 %	
4	11	14.9 %	
Total	74	100%	
3. I have trouble remembering a phone number I just looked up.			Q3 <p>Frequency of answers</p> <p>■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	11	14.9 %	
1	12	16.2 %	
2	23	31.1 %	
3	14	18.9 %	
4	14	18.9 %	
Total	74	100%	
0= Never, 1= Rarely, 2= Sometimes, 3= Often, 4= Always			

Table 6. 10. MMQ Ability Descriptives: Q4-Q6

MMQ- Ability subscale			Graphical representation
4. I have trouble recalling names of people I just met.			Q4 <p>Frequency of answers</p> <p>■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	19	25.7 %	
1	24	32.4 %	
2	14	18.9 %	
3	11	14.9 %	
4	6	8.1 %	
Total	74	100%	
5. I forget things that I meant to take with me.			Q5 <p>Frequency of answers</p> <p>■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	11	14.9 %	
1	19	25.7 %	
2	33	44.6 %	
3	8	10.8 %	
4	3	4.1 %	
Total	74	100%	
6. I forget appointments or meetings I have with other people.			Q6 <p>Frequency of answers</p> <p>■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	45	60.8 %	
1	17	23.0 %	
2	5	6.8 %	
3	4	5.4 %	
4	3	4.1 %	
Total	74	100%	
0= Never, 1= Rarely, 2= Sometimes, 3= Often, 4= Always			

Responses for statement four and statement six (table 6.10) are also skewed. Statement four asks respondents to indicate how often they forget names of people shortly after meeting them. A plurality of students indicated that they rarely (24 students, 32.4%) or never (19 students, 25.7%) commit this memory mistake, and 17 students (23%) indicated that they committed this

mistake often. From the aforementioned response, one can assume that these memory mistakes are not committed often by participants in the sample.

In examining the other responses, one can see that only one mistake seems to be committed often by the participants. This can be found in statement number nine (table 6.11), “I have difficulty remembering the right words I want to use in a conversation”. Responses seem to be slightly skewed to the left, indicating that more participants chose either often or always compared to those who chose never or rarely. A plurality of the subjects answered that they committed the mistake often (21 participants, 28.4%) or always (15 participants, 20.3%), and only some responded that they rarely (15 participants, 20.3%) commit this mistake. From these answers, one can conclude that most students have experienced at least some instances in which they find it difficult to remember the right word

While the aforementioned responses are skewed either to the right or to the left, responses to the rest of the statements (statements 3, 5, 7, 8, and 10) do not appear to be skewed. For instance, the third statement, “I have trouble remembering a phone number I just looked up”, yielded a somewhat normal distribution of response rates. Eleven students (15%) responded that this was something they had never experienced and 12 students (16%) responded that this was something they had rarely experienced. On the other end of the response spectrum, 14 students (19%) responded that this was something they had experienced, and another 14 students (19%) responded that this was something they always experienced. The largest response rate was the more neutral response “sometimes” with 23 respondents (31%).

Table 6. 11. MMQ Ability Descriptives: Q7-Q10

MMQ- Ability subscale			Graphical representation
7. I forget what I was just about to do; for example, walking into a room and forgetting why.			Q7
Answer	Number of responses	Percent of responses	
0	8	10.8 %	
1	18	24.3 %	
2	25	33.8 %	
3	11	14.9 %	
4	12	16.2 %	
Total	74	100%	
8. I forget to accomplish tasks I had planned to accomplish.			Q8
Answer	Number of responses	Percent of responses	
0	9	12.2 %	
1	18	24.3 %	
2	35	47.3 %	
3	7	9.5 %	
4	5	6.8 %	
Total	74	100%	
9. I have difficulty remembering the right words I want to use in conversation.			Q9
Answer	Number of responses	Percent of responses	
0	1	1.4 %	
1	15	20.3 %	
2	22	29.7 %	
3	21	28.4 %	
4	15	20.3 %	
Total	74	100%	
10. I forget details of things I saw or heard.			Q10
Answer	Number of responses	Percent of responses	
0	10	13.5 %	
1	12	16.2 %	
2	31	41.9 %	
3	13	17.6 %	
4	8	10.8 %	
Total	74	100%	
0= Never, 1= Rarely, 2= Sometimes, 3= Often, 4= Always			

Similar to statement three, a number of other statements did not yield skewed responses; rather, they yielded somewhat normal distributions of response rates. They are statements five, seven, eight, and ten. Similar to statement three, statement five yielded response rates in which the highest rate of response is neutral (33 students, 45% of the sample) while only 11 (15%) responded that they never forget things they had intended on taking with them, 19 (16%) responded that they rarely experienced this, eight (11%) responded that they experienced this often, and three (4%) responded that they always experienced this. Likewise, in statement seven, “I forget what I was just about to do. For example, walking into a room and forgetting why”, the rate of positive and negative responses were about equal, with 26 students (35%) responding with either ‘never’ or ‘rarely’, 23 students (31%) responding with either ‘often’ or ‘always’, and 25 students (34%) responding with sometimes.

Similarly, statement eight yielded a non-skewed distribution of responses. To the statement “I forget to accomplish tasks I had planned to accomplish”, 27 students (36.5 %) responded with either ‘never’ or ‘rarely’, 12 students (16 %) responded with either ‘often’ or ‘always’, and 35 students (27%) responded with ‘sometimes’. To the final statement, “I forget details of things I saw or heard”, 22 students (30%) responded with either ‘never’ or ‘rarely’, 21 students (28%) responded with either ‘often’ or ‘always’, and 31 students (42 %) responded with ‘sometimes’. Again, overall, some responses are skewed to the right, indicating that respondents rarely or never commit those particular memory mistakes. Other responses are skewed to the left, indicating that those mistakes are committed often or always. Finally, other responses are not skewed, indicating that response rates are, overall, about the same for all response options.

According to the results of the MMQ, the majority of participants seem to be discontent with their memory, use a plurality of memory strategies, and do not commit memory mistakes

often. First, in terms of contentment, the majority of responses (responses to six out of 10 questions) were skewed to the left, indicating that more students were discontent than those who were content with their memory ability. Second, in terms of strategy-use, the majority of responses were skewed to the left (responses to seven out of 15 questions compared to only four that were skewed to the right; the rest of the questions were neither skewed to the left nor to the right), indicating that more students did not use the stated memory strategies compared to those who did. Finally, in terms of the ability subscale, the majority responses were skewed to the right, indicating that students do not commit the mentioned mistakes often (responses to seven questions compared to only one questions that was skewed to the left). The next sub-section presents frequency tables for the SLWAI.

6.1.2. The Second Language Writing Anxiety Inventory

The second questionnaire used in this study was the SLWAI, which was adopted as a measure of L2 writing anxiety (frequency distributions are presented in tables 6.12 through 6.15). The questionnaire is comprised of 15 statements based on a 5-point Likert scale. Each statement presents an anxiety-provoking situation within the L2 writing context. Respondents were expected to select the option that best reflects how often they experience what is mentioned in the statement. Ratings ranged from 0 (never) to 4 (always). The higher the ratings were, the more the respondent experiences the particular situation of L2 writing anxiety. In examining their responses to the statements, the rate of responses for each option seem to vary greatly from statement to statement. While for many statements responses deviated to the left of the frequency distribution graph (ratings of 0 and 1), for a few statements, responses deviated to the far right, and for others, responses were in-between. For instance, the first statement “While writing in English, I get nervous” and the fourth statement “I do my best to avoid writing English compositions” (table

6.12) are both skewed to the right. This indicates that the majority of respondents do not become nervous when writing in English and that they do not generally try to avoid writing in English.

Table 6. 12. *SLWAI Descriptives: Q1-Q4*

SLWAI			Graphical representation
1. While writing in English, I get nervous.			<p>Frequency of answers</p> <p>■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	30	40.1 %	
1	19	26 %	
2	12	16.4 %	
3	6	8.2 %	
4	6	8.2 %	
Total	73	100%	
2. I feel my heart beating when writing English composition (like paragraphs or essays) under a time limit.			<p>Frequency of answers</p> <p>■ 0 ■ 1 ■ 2</p>
Answer	Number of responses	Percent of responses	
0	13	17.8 %	
1	12	16.4 %	
2	11	15.1 %	
3	17	23.3 %	
4	20	27.4 %	
Total	73	100%	
3. Knowing that my writing will be evaluated makes me worried or uneasy while writing.			<p>Frequency of answers</p> <p>■ 0 ■ 1 ■ 2</p>
Answer	Number of responses	Percent of responses	
0	9	12.3 %	
1	11	15.1 %	
2	22	30.1 %	
3	19	26 %	
4	12	16.4 %	
Total	73	100%	
4. I do my best to avoid writing English compositions.			<p>Frequency of answers</p> <p>■ 0 ■ 1 ■ 2</p>
Answer	Number of responses	Percent of responses	
0	18	24.7 %	
1	25	34.2 %	
2	14	19.2 %	
3	10	13.7 %	
4	6	8.2 %	
Total	73	100%	
0= Never, 1= Rarely, 2= Sometimes, 3= Often, 4= Always			

Table 6. 13. SLWAI Descriptives: Q5-Q8

SLWAI			Graphical representation
5. When I start to write English compositions, my mind becomes empty.			<p>Q5</p> <p>FREQUENCY OF ANSWERS</p> <p>0 1 2 3 4</p>
Answer	Number of responses	Percent of responses	
0	6	8.2 %	
1	20	27.4 %	
2	17	23.3 %	
3	21	28.8 %	
4	9	12.3 %	
Total	73	100%	
6. I worry that my English compositions are worse than others.			<p>Q6</p> <p>FREQUENCY OF ANSWERS</p> <p>0 1 2 3 4</p>
Answer	Number of responses	Percent of responses	
0	12	16.4 %	
1	18	24.7 %	
2	18	24.7 %	
3	16	21.9 %	
4	9	12.3 %	
Total	73	100%	
7. I shake or sweat when I write English compositions under time pressure.			<p>Q7</p> <p>FREQUENCY OF ANSWERS</p> <p>0 1 2 3 4</p>
Answer	Number of responses	Percent of responses	
0	18	24.7 %	
1	16	21.9 %	
2	17	23.3 %	
3	17	23.3 %	
4	5	6.8 %	
Total	73	100%	
8. When my writing is to be evaluated, I worry about getting a bad mark.			<p>Q8</p> <p>FREQUENCY OF ANSWERS</p> <p>0 1 2 3 4</p>
Answer	Number of responses	Percent of responses	
0	2	2.7 %	
1	12	16.4 %	
2	12	16.4 %	
3	32	43.8 %	
4	15	20.5 %	
Total	73	100%	
0= Never, 1= Rarely, 2= Sometimes, 3= Often, 4= Always			

According to statement number ten, “I would rather write in a different language than in English”, most students would rather not write in a different language than English (27 students, 37% of the sample, said never; 16 students, 21.9% said rarely, and 14 students, 19.2% said sometimes). Likewise, according to statement number 11 (Table 6.14), “I am afraid of what other students would think of my English composition”, most respondents are not worried about what other students think of their English writing; 25 participants (34.2%) said never, and 19 (26%) said rarely. Similarly, according to statement 12 (Table 6.14), “I become afraid that I would get asked to read what I have written”, the majority participants are not afraid of getting asked to read what they have written in English; to this statement, 18 (24.7%) said never, 21 (28.8%) said rarely, and 18 (24.7%) sometimes. Finally, according to statement number 13 (Table 6.15), “I freeze up when I am unexpectedly asked to write an English composition”, a plurality of participants do not freeze up when they are unexpectedly asked to write in English; 15 participants (20.5%) responded with never, and 29 (39.7%) said rarely. From all the statements to which responses deviated to the right (statements 1, 4, 10, 11, 12, 13, 14, and 15) one can assume that most students do not experience high levels of writing anxiety related to the particular circumstances mentioned in each statement.

In contrast to the aforementioned statements, a few others yielded results in the opposite direction. For instance, according to statement number two, “I feel my heart beating when writing English composition (like paragraphs or essays) under a time limit”, most participants feel their heart beating when writing in English under a time limit; 17 (23.3%) replied with often; and 20 (27.4%) said always. Likewise, according to statement number three, “Knowing that my writing will be evaluated makes me worried or uneasy while writing”, a plurality of participants become anxious knowing that their writing will be evaluated; 19 participants (26%) replied with often; 12 (16.4%) said always while 22 (30.1%) said sometimes.

Table 6. 14. SLWAI Descriptives: Q9-Q12

SLWAI			Graphical representation
9. My thoughts get mixed up when I start writing under a time limit.			Q9 <p>Frequency of answers ■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	2	2.7 %	
1	11	15.1 %	
2	13	17.8 %	
3	32	43.8 %	
4	15	20.5 %	
Total	73	100%	
10. I would rather write in a different language than in English.			Q10 <p>Frequency of answers ■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	27	37 %	
1	16	21.9 %	
2	14	19.2 %	
3	11	15.1 %	
4	5	6.8 %	
Total	73	100%	
11. I am afraid of what other students would think of my English composition.			Q11 <p>Frequency of answers ■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	25	34.2 %	
1	19	26 %	
2	11	15.1 %	
3	8	11 %	
4	10	13.7 %	
Total	73	100%	
12. I become afraid that I would get asked to read what I have written.			Q12 <p>Frequency of answers ■ 0 ■ 1 ■ 2 ■ 3 ■ 4</p>
Answer	Number of responses	Percent of responses	
0	18	24.7 %	
1	21	28.8 %	
2	18	24.7 %	
3	8	11 %	
4	8	11 %	
Total	73	100%	
0= Never, 1= Rarely, 2= Sometimes, 3= Often, 4= Always			

Table 6. 15. SLWAI Descriptives: Q13-Q15

SLWAI			Graphical representation																					
13. I freeze up when I am unexpectedly asked to write an English composition.			<p>Q13</p> <table border="1"> <tr><th>Answer</th><th>Number of responses</th><th>Percent of responses</th></tr> <tr><td>0</td><td>15</td><td>20.5 %</td></tr> <tr><td>1</td><td>29</td><td>39.7 %</td></tr> <tr><td>2</td><td>8</td><td>11 %</td></tr> <tr><td>3</td><td>15</td><td>20.5 %</td></tr> <tr><td>4</td><td>6</td><td>8.2 %</td></tr> <tr><td>Total</td><td>73</td><td>100%</td></tr> </table>	Answer	Number of responses	Percent of responses	0	15	20.5 %	1	29	39.7 %	2	8	11 %	3	15	20.5 %	4	6	8.2 %	Total	73	100%
Answer	Number of responses	Percent of responses																						
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1	29	39.7 %																						
2	8	11 %																						
3	15	20.5 %																						
4	6	8.2 %																						
Total	73	100%																						
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0	15	20.5 %																						
1	29	39.7 %																						
2	8	11 %																						
3	15	20.5 %																						
4	6	8.2 %																						
Total	73	100%																						
14. I worry about what others think about my English writing.			<p>Q14</p> <table border="1"> <tr><th>Answer</th><th>Number of responses</th><th>Percent of responses</th></tr> <tr><td>0</td><td>19</td><td>26.0%</td></tr> <tr><td>1</td><td>20</td><td>27.4 %</td></tr> <tr><td>2</td><td>18</td><td>24.7 %</td></tr> <tr><td>3</td><td>10</td><td>13.7 %</td></tr> <tr><td>4</td><td>6</td><td>8.2 %</td></tr> <tr><td>Total</td><td>73</td><td>100%</td></tr> </table>	Answer	Number of responses	Percent of responses	0	19	26.0%	1	20	27.4 %	2	18	24.7 %	3	10	13.7 %	4	6	8.2 %	Total	73	100%
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1	20	27.4 %																						
2	18	24.7 %																						
3	10	13.7 %																						
4	6	8.2 %																						
Total	73	100%																						
15. I become worried that I would get selected to read my writing in class.			<p>Q15</p> <table border="1"> <tr><th>Answer</th><th>Number of responses</th><th>Percent of responses</th></tr> <tr><td>0</td><td>20</td><td>27.4 %</td></tr> <tr><td>1</td><td>13</td><td>17.8 %</td></tr> <tr><td>2</td><td>18</td><td>24.7 %</td></tr> <tr><td>3</td><td>14</td><td>19.2 %</td></tr> <tr><td>4</td><td>8</td><td>11 %</td></tr> <tr><td>Total</td><td>73</td><td>100%</td></tr> </table>	Answer	Number of responses	Percent of responses	0	20	27.4 %	1	13	17.8 %	2	18	24.7 %	3	14	19.2 %	4	8	11 %	Total	73	100%
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3	14	19.2 %																						
4	8	11 %																						
Total	73	100%																						
0= Never, 1= Rarely, 2= Sometimes, 3= Often, 4= Always																								

Again, while some statements yielded positively skewed response rates, and others yielded negatively skewed rates, responses for a number of statements yielded rather neutral response rates. For instance, in statement number five, “When I start to write English compositions, my mind becomes empty”, about an equal number of students selected each response; 26 students (36

%) selected either never or rarely, 30 students (41 %) selected either often or always, and 17 students (23 %) selected the neutral response. Although response rates varied from statement to statement, overall, the researcher can make a cautious assumption. In reviewing response rates of students to the 15 statements in the SLWAI, the researcher can assume that the majority of the students do not experience L2 writing anxiety. This assumption is based on the fact that more statements (eight statements) deviated to the far right in the frequency distribution when compared to those that deviated to the far left (only four statements). It should be noted that the total sample size for those who answered the SLWAI is 73 while the total for those who answered the MMQ is 74. While the sample is the same, and both sections of the survey were answered together, this difference in sample size is attributed to the fact that one student did not answer the SLWAI.

Overall, the majority of participants seem to be discontent with their memory, use a plurality of memory strategies, do not commit memory mistakes often, and do not experience high levels of writing anxiety. Although the subjects seem to be more discontent with their memory ability, their memory is not as bad as they consider it to be. Despite the fact that the majority of the statements in the contentment subscale were answered in the negative (i.e., students were not content), the majority of the statements in the strategy-use scale were answered in the positive (i.e., students use the strategies). Furthermore, although more students indicated that they were discontent with their memory, more students indicated that they did not commit such memory mistakes as those stated in the ability subscale. Here, there seems to be a bit of a contradiction since one may expect subjects to commit more memory mistakes considering that more are discontent with their overall ability.

However, it can be assumed that these students' memory ability is better than they consider it to be because of the memory strategies they employ, or it can be assumed that they employ more

memory strategies to try to compensate for what they believe to be a bad memory ability, which in turn may be the reason for the better performance indicated in their ability scores.

In an explanation of the method of interpretation of the questionnaire, Troyer and Rich (2002) state that “dissatisfaction with one’s memory is a manifestation of more generalized feelings of low self-worth or anxiety” (p.8). Accordingly, because more subjects seem to be discontent with their memory ability, the researcher expected higher anxiety levels, albeit the construct with which the current study is concerned is writing anxiety, not general anxiety. However, contrary to the researcher’s expectations, the majority of subjects did not report experiencing so much L2 writing anxiety. This lack of association between students’ contentment with their memory and their L2 writing anxiety can be attributed to the fact that general anxiety and FLA, notably writing anxiety, are known to be two separate constructs (Horwitz et al., & Scovel, 1978), and the anxiety to which Troyer and Rich’s (2002) referred is general anxiety.

This sub-section has presented frequency distributions for the rate of each response to the statements provided in the questionnaires employed in this study. These questionnaires measured two main variables: metamemory levels and anxiety levels. For the variable metamemory, three sub-scales were measured: contentment, strategy-use and ability. The upcoming sub-section presents another form of descriptive statistics— measures of central tendency and measures of dispersion.

6.2. Descriptive Statistics: Central Tendency and Dispersion

The two other forms of descriptive statistics are measures of central tendency and measures of dispersion (Descriptive and Inferential Statistics, 2019). This sub-section presents both forms of statistics simultaneously for the four variables studied. Though the sample for this study is comprised of a total of 80 participants, six of them did not respond to the questionnaires. For these

participants, their data was incorporated into any analysis not dependent on anxiety or metamemory scores, such as the analysis of main treatment effects of dual N-back training on writing scores (the third research question). However, for analyses dependent on data from the questionnaires, such as those examining interaction effects (the fourth and fifth research question), the sample size was 74 and not 80 because those who did not respond to the questionnaires were excluded from the analysis.

Table 6.16 presents statistics for total scores for each of the three sub-categories of metamemory and for the categories of L2 writing and anxiety. As the table shows, total score (out of 40) for the contentment sub-scale ranged from 8 to 38 with a mean (M) of 26.55 and a standard deviation (SD) of 7.18. Total scores for the ability sub-scale (out of 40) ranged from 6 to 31 (M= 16.47, SD= 6.32). Furthermore, total scores for the strategy-use subscale (out of 60) ranged from 6 to 53 (M=31.53, SD=9.36). Finally, total scores for L2 writing anxiety (out of 60) ranged from 0 to 58 (M=26.70, SD= 13.62).

Table 6. 16. *Descriptives for Contentment, Ability, Strategy-use, and Anxiety*

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Contentment	74	8.00	38.00	26.5541	7.18282
Ability	74	6.00	31.00	16.4730	6.31637
StrategyUse	74	6.00	53.00	31.5135	9.36218
Anxiety	73	.00	60.00	27.0811	14.54775

These results indicate that students' contentment scores are relatively high considering that the average score is 26.55 from a total of 40. Furthermore, the SD, which measures how dispersed data points are around the mean, seems to be rather high (7.18) indicating that data points—thus, scores—are not concentrated around the mean. This indicates that contentment scores varied greatly between the two extremes, with some students having very high contentment scores and

some having very low scores. This is supported by the minimum and maximum scores for contentment, which range from eight to 38. The results also indicate that the average ability score was rather low (an average of 16.47 from a total of 40), with scores that are dispersed about the mean ($SD= 6.31$), albeit less dispersed than those of contentment. Accordingly, students' ability scores are, overall, lower than their contentment scores, and they are relatively closer to the mean than those of contentment scores.

For the third category of metamemory, strategy-use, the mean score of 31.51 (of a total of 60) indicates that scores are neither too high nor too low. Furthermore, when compared to the SD of the ability subscale and the contentment subscale, both of which are out of 30 instead of 60, the SD of 9.36 in strategy-use score indicates that scores are only somewhat dispersed. Although this not supported by the minimum and maximum scores, which range from six to 53, the researcher assumes that these are only extreme values and that scores in-between are not too widely dispersed. Table 6.16 also includes measures of central tendency and dispersion for the variable writing anxiety. As the table shows, anxiety scores are highly dispersed ($SD=14.54$), which is reflected in the range of scores (0-60). This indicates that students' writing anxiety scores are highly are significantly different from one student to the next.

Table 6.17 presents measures of central tendency and measures of dispersion for the variable L2 writing performance, including statistics for both pre-intervention writing scores and post-intervention writing scores for both groups combined. For the pre-test, students' scores (out of 30) ranged from 3 to 21.5 ($M= 12.40$, $SD= 4.32$), and for the post-test, students' scores (also out of 30) ranged from 8 to 21.5 ($M=13.56$, $SD= 3.34$). These statistics indicate that, overall, subjects performed only somewhat better in the post-intervention writing test than in the pre-test,

These descriptives, however, are all-inclusive; they summarize the total sample's statistics. Table 6.18 presents the same statistics separately for the CG and EG.

Table 6. 17. *Descriptives for Pre-writing and Post-writing*

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
PreWriting	80	3.00	21.50	12.3969	4.32495
PostWriting	80	8.00	21.50	13.5563	3.34417

Table 6. 18. *Descriptives for Control and Treatment groups*

Descriptives				
	group		Statistic	Std. Error
Pre-writing	control	Mean	12.7574	.65496
		Std. Deviation	3.81905	
		Minimum	5.00	
		Maximum	21.50	
	exp	Mean	11.6316	.74904
		Std. Deviation	4.61736	
		Minimum	3.00	
		Maximum	21.50	
Post-writing	control	Mean	13.0147	.53174
		Std. Deviation	3.10055	
		Minimum	8.00	
		Maximum	18.50	
	exp	Mean	14.0395	.56554
		Std. Deviation	3.48623	
		Minimum	8.50	
		Maximum	21.50	

Table 6.18 shows that pre-test scores for the CG ranged from 5 to 21.5 (M=12.76, SD= 3.82), and pre-test writing scores for the EG ranged from 3 to 21.5 (M= 11.63, SD= 4.62). For the post-test, the CG's scores ranged from 8 to 18.5 (M= 13.01, SD= 3.10) while the EG's scores ranged from 8.5 to 21.5 (M=14.04, SD=3.49). These scores indicate that both groups' writing

performance improved from pre- to post-intervention; however, the EG's rate of improvement appears to be significant in comparison to the CG's improvement (a change from 11.63 to 14.04 for the EG compared to 12.75 to 13.01 for the CG). The SD for the two groups' scores appears to be relatively the same in the pre-test and in the post-test, indicating that the variation in scores remained almost constant.

Tables 6.16, 6.17, and 6.18 above provide an overview of the main measures of central tendency and measures of dispersion for writing performance both as a whole and as they are categorized into groups. Table 6.19 below presents descriptive statistics for the duration (in minutes) of which participants in the EG practiced dual N-back training. While dual N-back WMT has been reported to be effective after eight hours of training (480 minutes) (Jaeggi et al., 2008; Klingberg, 2010), many subjects did not practice it for that long despite being given enough time to do so. As the table shows, the time in which they practiced the training program ranged from 24.57 minutes to 521.03 minutes (M=208.46, SD= 136.96). An average of 208.46 minutes is much lower than the recommended duration for the program to be effective, so based on the average duration, significant changes are not expected to take place. Finally, an SD of 136.96 indicates that values were greatly dispersed from one participant to the next, with some practicing for as little as 25 minutes and others going beyond the recommended 480 minutes.

Table 6. 19. *Descriptives for Dual N-back*

Descriptives		Statistic	Std. Error
N-back	Mean	208.4635	22.51660
	Std. Deviation	136.96312	
	Minimum	24.57	
	Maximum	521.03	

To sum up, this section presents all descriptive statistics for each of the four variables dual N-back WMT, anxiety, metamemory, and L2 writing. This was done in order to gain an understanding of the nature of and kind of distribution of data been used to answer the research questions. Nevertheless, descriptive statistics alone are insufficient for answering the research questions or drawing conclusions at any level. Therefore, the researcher proceeded with the use of inferential statistics, which are presented in the coming section.

6.3. Inferential Statistics

While descriptive statistics are informative for helping a researcher gain an understanding of the nature of the data at hand, inferential statistics are used to answer research questions, test hypotheses, draw conclusions about the sample, and make inferences about the population based on the sample (Descriptive and Inferential Statistics, 2019). This section provides results for the multiple inferential test statistics employed in attempts to answer the research questions and draw conclusions. Each research question is recapitulated below, alongside the statistics employed to answer the question.

Question 1: To what extend is EFL learners' writing performance associated with their writing anxiety levels?

In order to establish a correlation, or lack thereof, between anxiety levels and writing performance, the researcher first tested for the assumptions of Pearson's product-moment correlation coefficient, a standard measure of correlation between two continuous-scale data (Hauke & Kossowski, 2011). The first assumption is that the level of measurement for the data is continuous. This assumptions was not violated since the questionnaires were coded into continuous-level measurements. The total possible score on the SLWAI is 60, so scores could have ranged from 0-60, which is a continuous scale. The second assumption is related-pairs assumption,

which means that each participant should have one pair of data, a measurement for the predictor variable, and a measurement for the outcome variable. Again, this assumption was not violated; the researcher removed from the sample any participant whose data was missing for one or both measurements. The third assumption is the absence of outliers (Hauke & Kossowski, 2011). Figure 6.1 presents boxplots for writing and anxiety measures. From the boxplots, it is clear that the assumption of absence of outliers has not been violated since neither of the plots contain outliers.

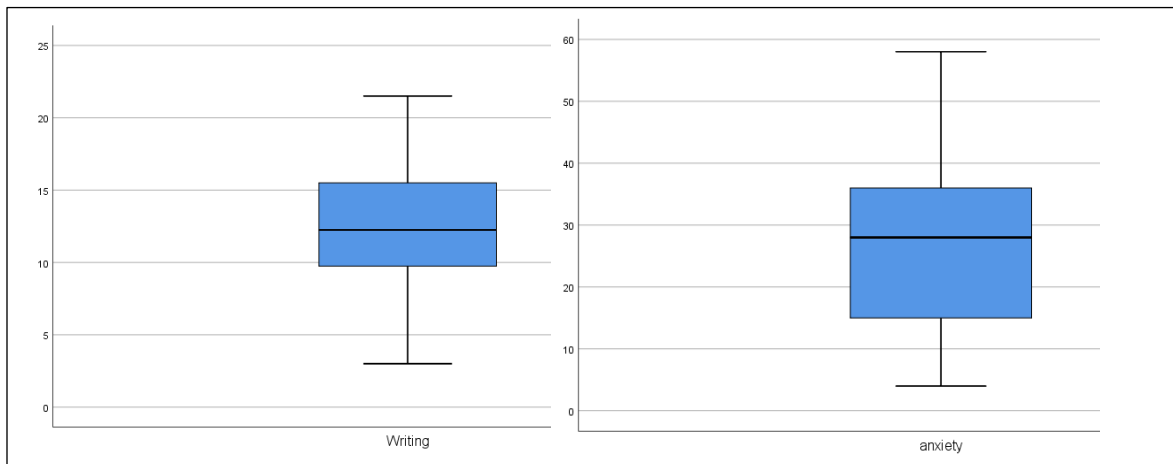


Figure 6. 1. Boxplots for Writing and Anxiety

Another assumption of Pearson’s product moment correlation coefficient is normality (Hauke & Kossowski, 2011). A common test of normality is Kolmogorov-Smirnov’s statistic. Table 6.20 presents results from Kolmogorov-Smirnov’s test of normality for the distribution of writing and anxiety scores. Normality (or a lack thereof) is indicated by the significance value, otherwise known as the *p*-value; normally distributed data should yield a *p*-value greater than .05 while data that is not normally distributed should yield a *p*-value of or less than .05. As the table shows, the Kolmogorov-Smirnov test of normality indicates that data is normally distributed for writing scores ($D(74) = .07, p = .200$) as well as anxiety scores ($D(73) = .09, p = .200$). This means that the data for both anxiety and writing do not violate the normality assumption of Pearson’s correlation analysis.

Since all assumptions of Pearson’s analysis have not been violated, the researcher proceeded by running Pearson’s test statistic instead of running an alternative test statistic. Table 6.21 presents results from Pearson’s analysis. In the results, a *p*-value of .05 or less indicates statistical significance; i.e., it indicates that there is significant correlation. Results from the analysis indicate that a significant negative correlation exists between anxiety and L2 writing performance ($r(73) = -.45, p = .000$). The negative nature of the correlation yielded indicates that the correlation between the two variables is negative; in other words, as one variable increases, another decreases, so as anxiety scores increase, writing scores decrease and vice versa.

Table 6. 20. *Kolmogorov-Smirnov Test for Writing and Anxiety*

Kolmogorov-Smirnov^a			
	Statistic	df	Sig.
Writing	.071	74	.200*
Anxiety	.089	73	.200*

Table 6. 21. *Pearson’s Correlation Analysis Writing* Anxiety*

Anxiety	Pearson Correlation	-.446**
	Sig. (2-tailed)	.000
	N	73

** . Correlation is significant at the 0.01 level (2-tailed).

Figure 6.2 presents the scatterplot and the line of best fit for the dataset. As the scatterplot shows, the dots are dispersed in a manner that forms a slight slope. The line of best fit, generated by SPSS’s correlate function, confirms this. The line, generated amongst a dataset within a scatterplot, represents the type of relationship two datasets have (Schober, Boer & Schwarte, 2018). In this case, the set of points by themselves can only be slightly indicative of the type of relationship that exists, but the line reveals that there is a negative association. As anxiety

increases, writing scores decrease. For instance, those with anxiety scores of 0–10 mostly have writing scores of 14–20 while those of anxiety scores from 40–50 have writing scores of 3–6.

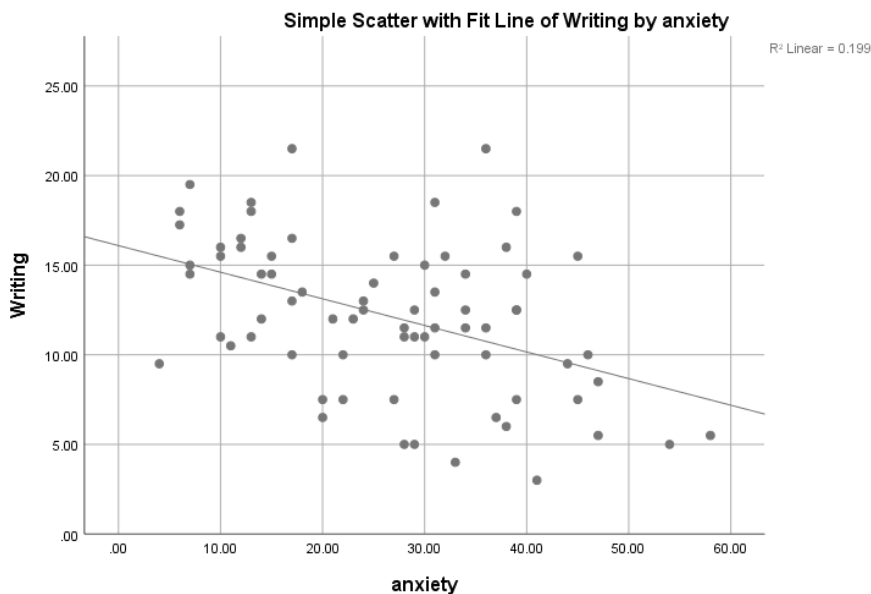


Figure 6. 2. Scatterplot of Writing * Anxiety

Accordingly, when analyzing responses to the SLWAI against performance in writing assessment, Pearson’s correlation analysis indicates that the two variables L2 writing anxiety and L2 writing performance are significantly correlated with each other. Moreover, the two variables are negatively correlated; in other words, as L2 writing anxiety increases, L2 writing performance seems to decrease, and as L2 writing anxiety decreases, L2 writing performance seems to improve. These results are a strong indication that L2 writing anxiety is debilitating in the L2 writing context, a claim made by numerous researchers. Attaining the aforementioned results has enabled the researcher to answer the first research question, which is “To what extend is EFL learners’ writing performance associated with their writing anxiety levels?” In doing so, the first hypothesis, “A

significant negative correlation exists between EFL learners' anxiety levels and their writing performance" has been tested and accepted (refer to section 6.4 for a full discussion of the results).

Question 2: To what extent is EFL learners' writing performance associated with their metamemory levels?

The researcher answered this research question in a manner similar to that of the first research question because they both called for the use of a statistic for correlation. The researcher first checked whether the data violated the assumptions of Pearson's correlation analysis. This was already done for the outcome variable L2 writing performance in the previous question, so the researcher only repeated this step for each of the subscales of metamemory. In doing so, the Kolmogorov-Smirnov test was first used to check for normality (table 6.22). As table 6.22 shows, the data did not follow a normal distribution for the contentment subscale ($D(74) = .110, p = .026$) since the significance value is greater than 0.5, violating the normality assumption. The data, however, did follow a normal distribution for the ability subscale ($D(74) = .08, p = .200$) as well as the strategy-use subscale ($D(74) = .097, p = .082$).

Table 6. 22. *Kolmogorov-Smirnov Test for Contentment, Ability, and Strategy-use*

	Kolmogorov-Smirnov ^a		
	Statistic	df	Sig.
Contentment	.110	74	.026
Ability	.080	74	.200*
Strategy Use	.097	74	.082*

The researcher proceeded to check for outliers. Boxplots for the three scales are presented in figure 6.3. As the boxplots show, no outliers exist for data from the subscales of contentment and ability, but there is one outlier in the data from strategy use. Results from the boxplots and Kolmogorov-Smirnov's test of normality indicate that Pearson's correlation coefficient is not the

most suitable test statistic for this data. Hence, a non-parametric alternative to Pearson's analysis was used.

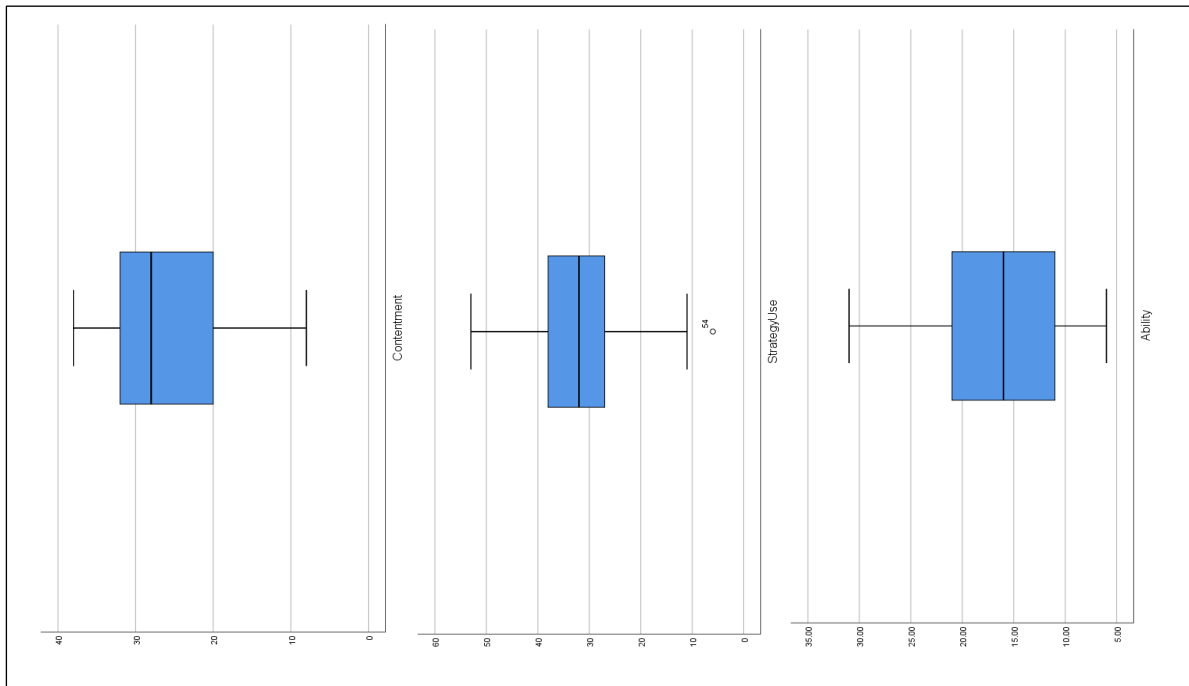


Figure 6. 3. Boxplots for Contentment, Strategy-use, and Ability

The researcher ran Spearman's correlation analysis, a non-parametric alternative to Pearson's analysis (Hauke & Kossowski, 2011), in order to test for any correlation between scores on the three sub-scales of metamemory and writing scores. Results from the analysis are presented in table 6.23. As the table shows, L2 writing performance is not significantly associated with the contentment subscale of metamemory ($r(74) = .008, p = .943$). Furthermore, L2 writing performance is not significantly associated with the ability subscale ($r(74) = -.207, p = .076$), nor is it associated with the strategy-use subscale ($r(74) = -.037, p = .755$).

The researcher also constructed scatterplots for each set of variables (Figure 6.4 and figure 6.5). Figure 6.4 (left) shows the scatterplot for the set of data for contentment and writing scores. Figure 6.4 (right) shows the set of data for ability and writing scores, and figure 6.5 shows the data

for strategy use and writing scores. From the scatterplots and each of their respective line of best fit, the absence of a correlation between the variables is clear. The two variables that come only slightly close to being associated are ability and writing scores— a near-association that is insignificant, both statistically and visually.

Table 6. 23. Spearman's Correlation Analysis Writing * Metamemory

		Contentment	Ability	Strategy Use	
Spearman's rho	Writing	Correlation Coefficient	.008	-.207	-.037
		Sig. (2-tailed)	.943	.076	.755
		N	74	74	74

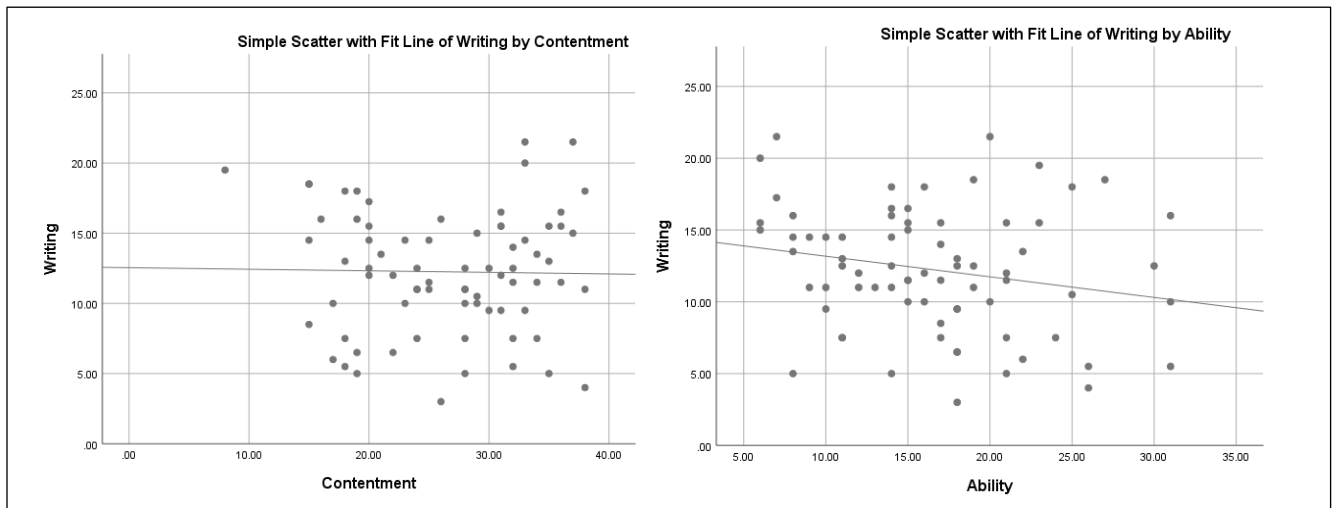


Figure 6. 4. Scatterplots Writing * Contentment, Writing * Ability

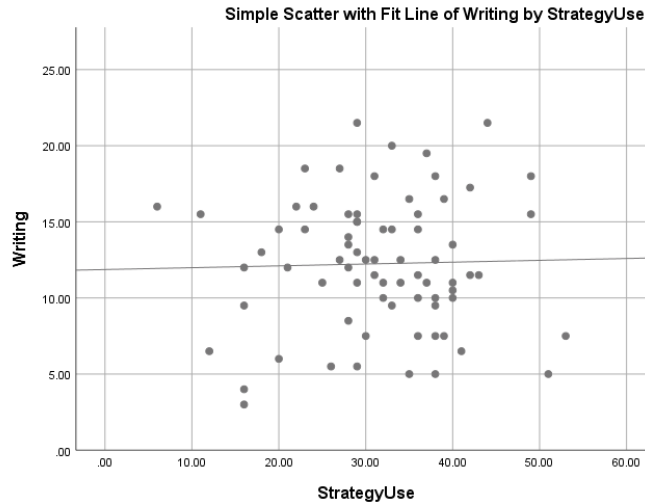


Figure 6. 5. Scatterplot Writing * Strategy-use

In sum, students’ responses to the three sub-scales of the MMQ and their writing performance were analyzed for any potential correlation between any two of the variables. Results from the analysis have revealed that none of the three subscales of metamemory are correlated with L2 writing performance. These results are in parallel with neither the researcher’s expectations nor the reviewed literature. In yielding these findings, the researcher answered the second research question “To what extent is EFL learners’ writing performance associated with their metamemory levels?” Furthermore, in answering the second research question, the researcher rejects the second hypothesis “Learners’ metamemory levels are positively correlated with their writing performance.” (Refer to section 6.4 for a full discussion of the results).

Question 3: How does dual N-back WMT affect EFL learners’ writing performance?

Instead of the t-test, ANCOVA was chosen as the test statistics for answering this research question. This is because the t-test would only allow for the comparison of pre-to-post means or control-to-treatment group means. In using the t-test, reliability of the results would, therefore, be compromised. If the researcher were to compare post-test scores without considering pre-test scores, changes in results could be attributed to many things other than the treatment; maturation

and their initial level (pre-test scores) are two examples. If the researcher were to compare each group's progress from pre-to-post-test, then compare the two groups' level of progress for a significant difference, this also would compromise reliability. An example of what may happen is having both groups significantly improving when comparing their pre-to-post-test overall means and their levels of improvement being not too different from each other. Such results would be difficult to interpret. To avoid these issues, ANCOVA was employed because it allows for the comparison of group means while taking into account a covariate. More specifically, the researcher compared their post-test means while assigning their pre-test scores as a covariate, therefore controlling for pre-test scores and avoiding all the aforementioned issues.

The researcher proceeded in answering this research question in a slightly similar manner to the first two, by testing for assumptions of parametric statistics. The main assumptions of ANCOVA are continuous-level dependent and covariate variables, categorical-level independent variable with at least two categories or groups, independence of observation, absence of outliers, normality and homogeneity of variances (One-way ANCOVA in SPSS Statistics, 2019). The dependent variable in this study, which is final writing scores, as well as the covariate, which is initial writing scores, are measured on a continuous-level scale, so the first main assumption is met. The independent variable is based on a categorical scale (i.e., treatment vs. no treatment) with two groups (CG and EG), so the second assumption is met. Independence of observation mainly refers to the lack of overlapping of observations in the two groups; for instance, a student in the control group should not have another observation in the experimental group, meaning the student only belongs to one group. The fourth assumption, absence of outliers, was tested visually via boxplots. The boxplots for pre-test and post-test scores are presented in figure 6.6. As the boxplots show, there are no outliers in the pre-test and post-test data.

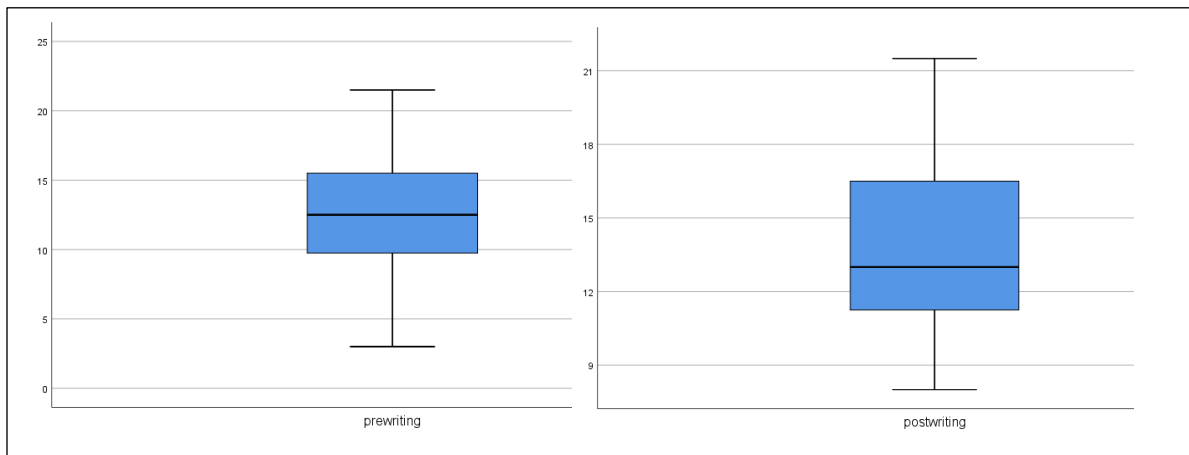


Figure 6. 6. Boxplots for Pre-test and Post-test Writing Scores

The normality assumption was checked using Kolmogorov-Smirnov’s test of normality. Results from the test statistic are presented in table 6.24, which shows that the distribution of data is normal for pre-test scores for both the CG ($D(42) = .08, p = .200$), and the EG ($D(38) = .08, p = .200$), and for post-test writing scores (CG: $D(42) = .10, p = .200$; EG: $D(38) = .11, p = .200$), so this assumption is not violated. The third assumption, homogeneity of variances, was tested using Levene’s test statistic for equality of variances. As Levene’s test (table 6.25) indicates, there is homogeneity of variances across groups for pre-writing scores ($F(1, 78) = 1.11, p = .295$) as well as post-writing scores ($F(1, 78) = 1.102, p = .610$). Since ANCOVA’s main assumptions were not violated, the researcher proceeded by running the test statistic.

Table 6. 24. Kolmogorov-Smirnov Test for Control and Experimental Groups

	group	Kolmogorov-Smirnov ^a		
		Statistic	df	Sig.
Pre-writing	control	.083	42	.200*
	exp	.078	38	.200*
Post-writing	control	.102	42	.200*
	exp	.114	38	.200*

Table 6. 25. *Levene's Test of Homogeneity of Variances for Writing*

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Pre-writing	1.110	1	78	.295
Post-writing	.262	1	78	.610

Results from the ANCOVA test are presented in table 6.26. The row ‘group’ emphasized in bold is of primary interest in this study. It presents the data for the difference between the two groups after controlling for pre-test writing scores. According to the information presented in this row, there is a significant difference between the two groups’ post-test writing scores after controlling for their pre-test scores ($F(1, 77) = 9.016, p = .004$), indicating that the intervention does have some sort of effect on writing performance.

Table 6. 26. *ANCOVA Results Controlling for Pre-test Scores*

Tests of Between-Subjects Effects

Dependent Variable: **POST-WRITING**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	412.972 ^a	2	206.486	33.791	.000	.467
Intercept	422.065	1	422.065	69.070	.000	.473
Pre-writing	396.070	1	396.070	64.816	.000	.457
Group	55.094	1	55.094	9.016	.004	.105
Error	470.525	77	6.111			
Total	15585.250	80				
Corrected Total	883.497	79				

a. R Squared = .467 (Adjusted R Squared = .454)

Although an effect has been established, the strength of the effect is unknown, so the column “Partial Eta Squared” (otherwise known as partial η^2) presents the effect size. Therefore, the effect size partial $\eta^2 = .105$ indicates a small to moderate effect size. Lakens (2013) summarizes the different uses and interpretations of effect sizes and states that in one-way ANOVA, a small

effect size is when the η^2 value is between .01 and .06, a medium effect size is between .06 and .14, and a large effect size is .14 or greater. Lankens (2013) also states that when a covariate is involved, the estimates are not consistent. When there is more than one independent variable, such as in ANCOVA and Multiple Regression analysis, these estimates should not be referred to; rather, a small effect size is denoted by a partial η^2 of .02, a medium effect size being .13, and a large effect size being .26 (Watson, 2019).

Another significant row is “pre-writing”, right above the row “group”. This row presents the effect of the covariate, pre-test writing scores, on the dependent variable, post-test writing scores. As indicated, pre-test writing scores significantly predict post-test writing scores ($F(1, 77) = 64.816, p = .000$), with a much greater effect size (partial $\eta^2 = .457$) than that of the treatment on post-test scores. In other words, the role of pre-test scores in predicting post-test scores is major, to the point where if it were excluded from the analysis, there would probably be major confounding since a significant portion of the effect of the treatment is actually attributed to students’ initial scores.

Overall, the treatment seems to have a significant effect on L2 writing performance, even after accounting for initial scores. Hence, in yielding the above results, the researcher effectively answered the third research question: “How does dual N-back WMT affect EFL learners’ writing performance?” The researcher thus rejected the third hypothesis “There is no main treatment effect of dual N-back WMT on EFL learners’ writing performance”. Contrary to the researcher’s expectations, there does seem to be a main treatment effect of dual N-back WMT on EFL learners’ writing performance. (Refer to section 6.4 for a full discussion of the results).

Question 4: To what extent is there a two-way interaction effect of each of the two moderating variables (metamemory and anxiety) on dual N-back WMT in its effect on L2 writing performance?

To test for two-way interaction, the researcher used two-way ANOVA. Another means of testing for interaction is multiple regression, but multiple regression is used when measuring for any interaction between observed variables only, all measured on a continuous scale (McDonald, 2009). For instance, regression analysis would be suitable for testing whether there is any interaction between metamemory and anxiety on writing scores of learners. All of the variables would be observed only, and they would be measured on a continuous-level scale; there would be no manipulation of any sort. However, when measuring treatment-interaction effects, two-way ANOVA is more suitable since there is manipulation of the independent variable (McDonald, 2009).

Like other parametric tests, two-way ANOVA carries with it certain assumptions that should not be violated in order to yield the most reliable results (Two-way ANOVA in SPSS Statistics, 2019). One of the main assumptions of two-way ANOVA is that the dependent variable is measured on a continuous scale. The dependent variable in this study, L2 writing performance, is measured on a 30-point continuous scale, so the first assumption is not violated. The second main assumption is that the independent variables should be measured on a categorical scale, and they should consist of two or more groups, or categories. The independent variables L2 writing anxiety scores and metamemory scores were originally measured on a continuous scale, so the researcher classified the scores into categories and transformed them into categorical scales. Students' writing anxiety scores were classified into four categories: low anxiety (0-14), low-mid anxiety (15-29), mid-high anxiety (30-44), and high anxiety (45-60).

In terms of metamemory, each of the sub-scales were analyzed individually, and each of them was also assigned four categories. The four categories for the contentment sub-scale were low contentment (0-9), low-mid contentment (10-19), mid-high contentment (20-29), and high contentment (30-40). The same was done for the ability sub-scale, but different values were assigned to the categories: low ability (30-40), low-mid ability (20-29), mid-high ability (19-20), and high ability (0-9). This is because the wording of the statements was reversed so that the higher responses meant lower ability scores. For instance, in one of the statements, “I forget to return things I have borrowed from people”, the response options were 0 for strongly disagree, 1 for disagree, 2 for uncertain, 3 for agree, and 4 for strongly agree. A response of strongly agree (4) would mean that they commit this memory mistake more often, so they have lower ability. The final sub-scale, strategy-use, was also divided into four categories as well: low strategy-use (1-14), low-mid strategy-use (15-29), mid-high strategy-use (30-44), and high strategy-use (45-60).

Another assumption of two-way ANOVA is absence of extreme outliers. The researcher already ran boxplots for the independent variables when answering the first and second research questions. Although there appeared to be one outlier for the metamemory subscale “contentment”, it is nowhere close to being an extreme outlier since it was only slightly deviant from the rest of the data points. Another assumption of two-way ANOVA is approximately normal data for the independent variables (Two-way ANOVA in SPSS Statistics, 2019). Table 6.27 presents results from Kolmogorov-Smirnov’s test of normality for anxiety scores, pre-test writing scores, post-test writing scores, and for the metamemory sub-scales of contentment, strategy-use, and ability. Results reveal that normality is achieved for strategy use ($D(74) = .097, p = .082$), ability ($D(74) = .080, p = .200$), anxiety ($D(73) = .81, p = .200$), pre-test writing ($D(74) = .067, p = .200$) scores, and post-test writing scores ($D(74) = .080, p = .200$). Normality, however, is not achieved for the

subscale of contentment ($D(74) = .110, p = .026$). Although the normality assumption was violated for one of the six variables, according to Two-way ANOVA in SPSS Statistics (2019), the test statistic is robust to violations in normality; in other words, as long as it is not a major violation, results of the test statistic would still be valid and reliable, so two-way ANOVA can still be used.

Table 6. 27. *Kolmogorov- Smirnov Test for All Variables*

	Kolmogorov-Smirnov ^a		
	Statistic	df	Sig.
Contentment	.110	74	.026
StrategyUse	.097	74	.082*
Ability	.080	74	.200*
Anxiety	.089	73	.200*
PreWriting	.067	74	.200*
PostWriting	.080	74	.200*

After having established that most of two-way ANOVA's assumptions have not been violated, the researcher ran the test statistic. The test statistic was run four times: once to test whether there is a treatment-anxiety interaction effect, and three times to test whether there is a treatment-metamemory interaction effect, once for each of the three sub-scales of metamemory. The researcher tested each of the sub-scales individually because of the way in which they were measured. As already mentioned in the preceding sections, coding values for each sub-scale are different. For instance, the higher the strategy-use subscale is for each participant, the higher their metamemory is for that particular sub-scale. However, for the ability sub-scale, the higher the score is, the lower the ability of that participant. This is because the questions in the ability sub-scale target respondents' memory ability by asking them how often they commit a certain type of memory mistake. Hence, the higher the score is for a question, the more the respondent commits that mistake, so the lower his metamemory level is for the ability sub-scale. Because of the different measuring scales of each metamemory sub-scale, the researcher decided to run different

two-way ANOVA tests to measure treatment-metamemory interaction effects, one for each metamemory sub-scale.

The first test of two-way ANOVA was run in attempt to examine whether there was any treatment-anxiety interaction effect on students' writing performance. In other words, once the treatment was implemented, did students' anxiety levels affect the effect of the treatment on their final writing performance? Table 6.28 presents results of the test statistic.

Table 6. 28. *Two-way ANOVA Results for Treatment-anxiety Interaction effect*

Tests of Between-Subjects Effects

Dependent Variable: Post-writing

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	237.902 ^a	7	33.986	3.970	.001	.303
Intercept	9711.801	1	9711.801	1134.481	.000	.947
Group	12.312	1	12.312	1.438	.235	.022
Anxiety	118.402	3	39.467	4.610	.006	.178
Group * anxiety	77.762	3	25.921	3.028	.036	.124
Error	547.876	66	8.561			
Total	14016.000	74				
Corrected Total	785.778	73				

a. R Squared = .303 (Adjusted R Squared = .226)

The table shows results of the two-way ANOVA test statistic. The row “group” shows the results of the main effect, which is the effect of the treatment on the dependent variable (writing) before taking into consideration the moderator variable (anxiety). Results have revealed that the treatment itself (represented by the row “group”) did not yield a significant effect ($F(1, 73) = 1.438, p = .235$). However, the researcher has already tested the main treatment effect (research question 3) and found that, after controlling for pre-test scores, there was a significant difference between the two groups. Accordingly, the main focus is to examine whether anxiety interacted with the treatment in its effect on writing performance. The row “anxiety*group” presents the

statistics for treatment-anxiety interaction, indicating that there was a significant treatment-anxiety interaction effect on writing performance ($F(3, 73) = 3.028, p = .036$). A partial η^2 of 0.124 indicates that the effect size is moderate; therefore, anxiety moderately affects the effect of the treatment on L2 writing performance.

Figure 6.7 below is a graphical representation of the relationship between the three variables.

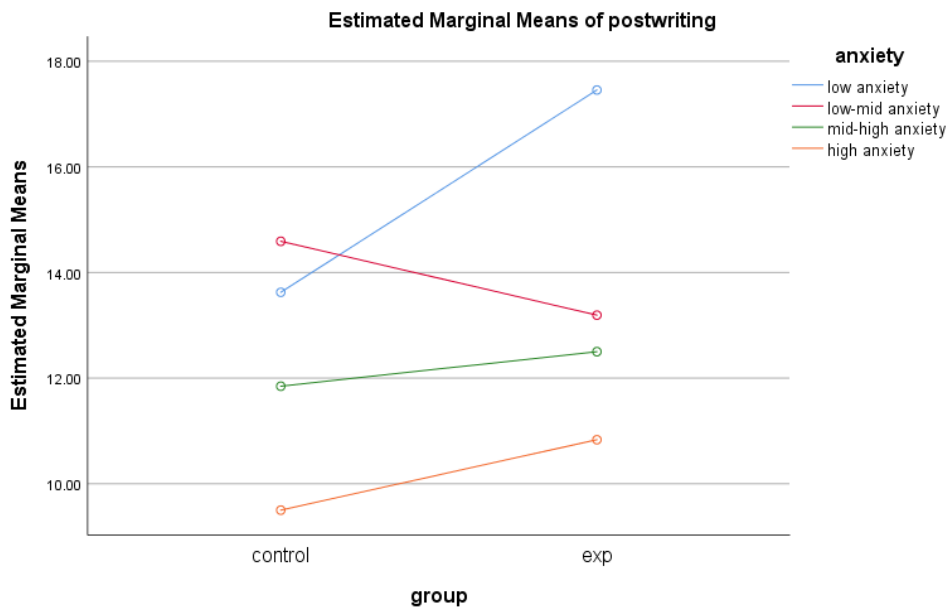


Figure 6. 7. Two-way Interaction, Treatment * Anxiety

The graphical representation allows for a more practical and comprehensible interpretation of the results presented in table 6.28. The different lines represent the different anxiety levels of respondents, ranging from “low anxiety” to “high anxiety”. The horizontal axis represents the group, whether it is the CG or EG, and the vertical axis represents subjects’ writing scores. As the graph reveals, subjects in three of the four categories of anxiety in the EG outperformed those in the same categories in the CG. The most significant information, however, lies in the different scores of subjects with different anxiety levels. Subjects with the highest writing scores are those with the lowest levels of anxiety and vice versa. Accordingly, while students subject to the

treatment outperformed those in the CG, those with lower levels of anxiety performed even better than those with higher levels of anxiety, even within the EG. In other words, although the EG outperformed the CG overall, their performance varied considerably depending on their anxiety levels. Therefore, anxiety was a significant moderator in the relationship between the two treatment and writing performance.

The researcher ran the second two-way ANOVA to test for any potential interaction between the treatment and the metamemory subscale of strategy-use. The same procedures for testing for treatment-anxiety interaction were repeated. Table 6.29 below presents results from the test statistic. Again, the middle row (group * strategy-use) represents the effect of the treatment as it is moderated by the metamemory sub-scale strategy-use. The data indicates that the treatment-strategy-use interaction effect on writing is not statistically significant ($F(3, 72) = 1.625, p = .192$). Results indicate that the effect of dual N-back WMT on writing performance is not moderated by strategy use. A value of partial $\eta^2 = .070$ confirms the lack of interaction effect because of its small and insignificant effect size.

Table 6. 29. *Two-way ANOVA Results for Interaction with Strategy-use*

Tests of Between-Subjects Effects						
Dependent Variable: Writing						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	131.768 ^a	7	18.824	1.818	.099	.164
Intercept	4531.447	1	4531.447	437.579	.000	.871
Group	6.177	1	6.177	.597	.443	.009
Strategy-use	69.746	3	23.249	2.245	.091	.094
Group * Strategy-use	50.484	3	16.828	1.625	.192	.070
Error	673.122	65	10.356			
Total	14353.250	73				
Corrected Total	804.890	72				

a. R Squared = .164 (Adjusted R Squared = .074)

The relationship between the variables is again presented graphically in figure 6.8. As the figure shows, there is a clear pattern when comparing the CG's writing scores with the EG's writing scores. The pattern, however, is slightly less obvious when considering level of strategy-use. A careful analysis reveals that participants with the highest level of strategy use (orange line) performed significantly better in the EG than in the CG. By contrast, those with the lowest level of strategy-use (blue line) performed significantly better in the CG than in the EG. Those with an average level of strategy-use (red and green lines) seemed to be about neutral. Disregarding the middle categories, the fact that participants with the highest strategy-use scores performed so much better in the EG, and vice versa, indicates that the sub-category of metamemory, strategy-use, moderates the effect of the treatment on writing performance. Those with higher levels of strategy-use seem to have been affected more by the treatment while those with low strategy-use performed even worse than students from the CG. This indicates that, despite not having statistically significant interaction (Table 6.29), there is a slight treatment-metamemory interaction effect on writing performance, particularly for the metamemory subscale of strategy-use. This interaction effect, however, is not statistically significant.

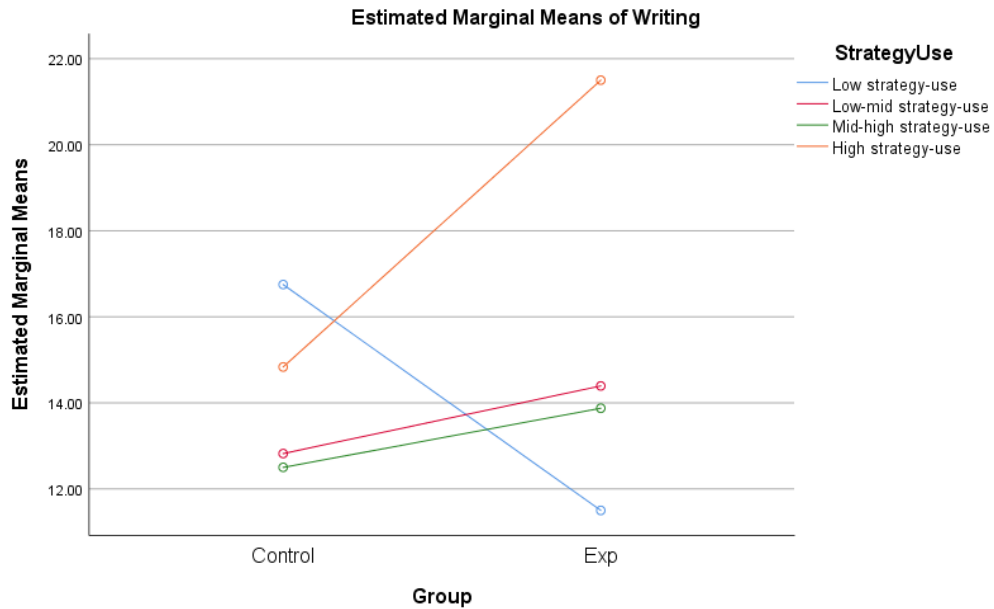


Figure 6. 8. Two-way Interaction, Treatment * Strategy-use

The researcher ran the third two-way ANOVA in order to test for any interaction between ability and the treatment in its effect on students' writing scores. Table 6.30 presents results of the two-way ANOVA test statistic.

Table 6. 30. Two-way ANOVA Results for Interaction with Ability

Tests of Between-Subjects Effects

Dependent Variable: Writing

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	145.234 ^a	7	20.748	2.068	.059	.180
Intercept	6188.447	1	6188.447	616.737	.000	.903
Group	.039	1	.039	.004	.951	.000
Ability	64.003	3	21.334	2.126	.105	.088
Group * Ability	52.850	3	17.617	1.756	.164	.074
Error	662.256	66	10.034			
Total	14497.250	74				
Corrected Total	807.490	73				

a. R Squared = .180 (Adjusted R Squared = .093)

The row “group * ability” presents the level of interaction, or lack thereof, between ability and the treatment. The results indicate that the interaction is not statistically significant ($F(3, 73) = 1.756, p = .164$). In other words, the metamemory category of ability does not significantly moderate the effect of Dual N-back WM training on writing performance. A partial η^2 value of .074 confirms the small and insignificant effect size. The relationship between the variables is presented graphically in figure 6.9.

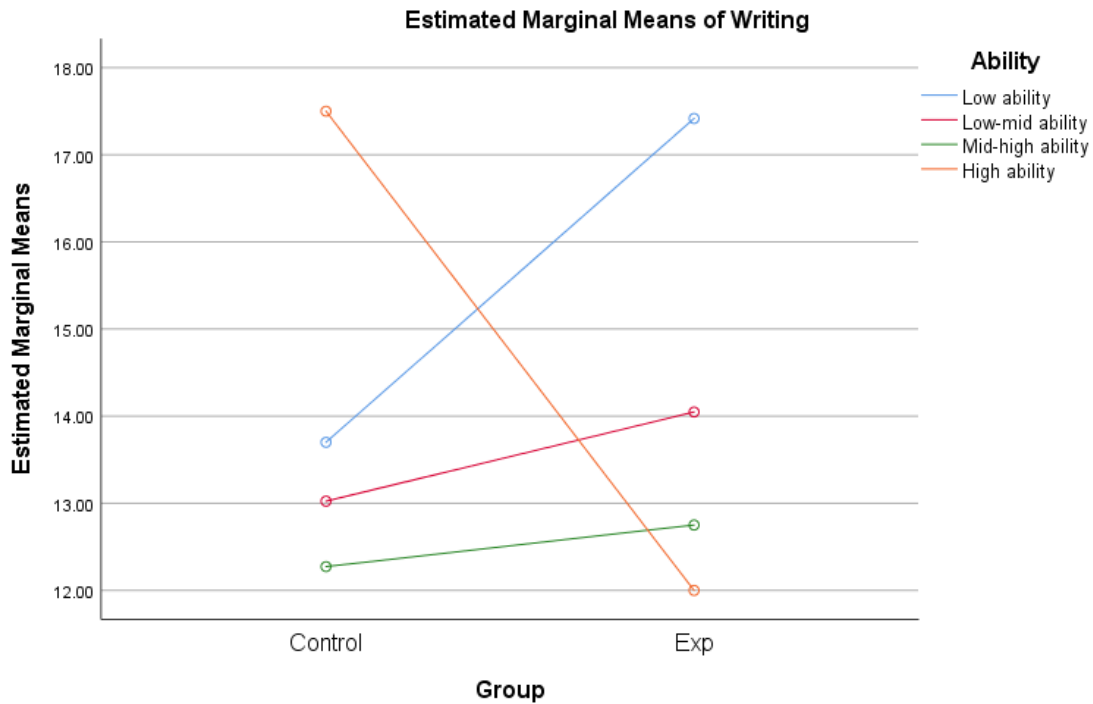


Figure 6. 9. Two-way Interaction, Treatment * Ability

Figure 6.9 shows how the three variables interact. The EG, for the most part, seems to have outperformed the CG in writing. Because this has already been established, the aim is to examine whether the effect of the intervention was moderated by the ability subscale. As a reminder, ability scores are reversed in terms of how they are interpreted, so participants in the “high ability” category have the lowest level of ability and those in the “low ability” category have the highest

level of ability. Similar to the graph for strategy-use, this graph seems to reveal a slight interaction effect of ability and the treatment on writing scores. Participants in the CG with the highest ability scores (thus, the lowest level of ability) (orange line) performed significantly better in writing than those in the EG. By contrast, those in the CG with the lowest ability score (and the highest ability) performed significantly higher in the EG than in the CG. This stark difference indicates that metamemory (notably the category of ability) may be a considerable moderator in the effect of the treatment on writing performance. However, like in the preceding two-way ANOVA analysis, the slight interaction is not statistically significant.

The researcher ran a final two-way ANOVA to test for treatment-contentment interaction effect on writing performance. Table 6.31 presents results of the test statistic, which indicate that there is little to no metamemory-treatment interaction effect on writing performance ($F(2, 74) = 1.169, p = .317$; partial $\eta^2 = .034$). Figure 6.10 shows a graphical representation of the results.

Table 6. 31. *Two-way ANOVA Results for Interaction with Contentment*

Tests of Between-Subjects Effects

Dependent Variable: Writing

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	77.819 ^a	6	12.970	1.191	.322	.096
Intercept	4408.665	1	4408.665	404.814	.000	.858
Group	34.451	1	34.451	3.163	.080	.045
Contentment	19.678	3	6.559	.602	.616	.026
Group * Contentment	25.461	2	12.730	1.169	.317	.034
Error	729.670	67	10.891			
Total	14497.250	74				
Corrected Total	807.490	73				

a. R Squared = .096 (Adjusted R Squared = .015)

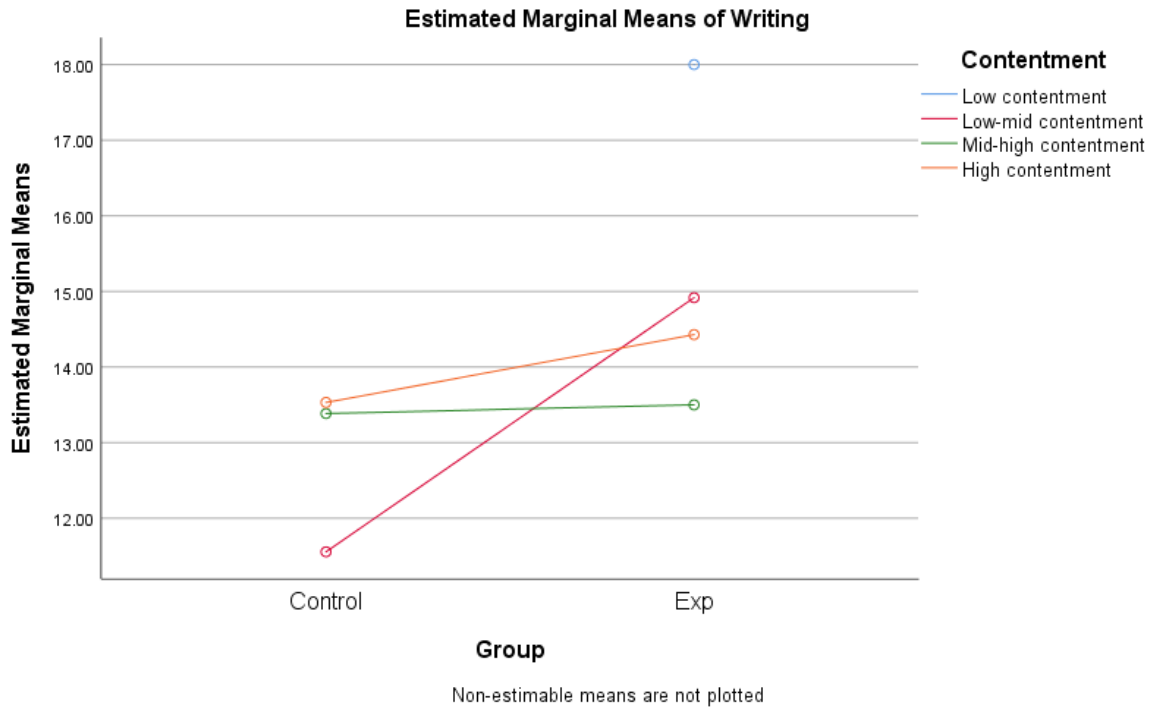


Figure 6. 10. Two-way Interaction, Treatment * Contentment

Figure 6.10 shows that, overall, writing scores appeared to be higher in the EG than in the CG. This is the case for all categories of contentment. However, when considering how contentment levels fluctuate within the context of the treatment and writing scores, there does not seem to be much of a treatment-contentment interaction effect on writing scores. No subjects in the CG were categorized in the “low contentment” subscale. Writing performance of individuals in the other contentment categories fluctuated slightly, but not so much that it can be considered as an interaction of variables. Participants in the CG with the second lowest contentment level (red line) performed the worst in writing out of the three categories available for the CG; meanwhile, in the EG, those in the same category performed the best. No noticeable pattern appeared otherwise, especially in the EG. The second lowest writing scores were from participants with the highest contentment scores, and the lowest writing scores were from those with the second highest

contentment scores. The lack of any noticeable pattern in the figure and the lack of statistical significance in the table indicate that there is little, if any, treatment-contentment interaction effect on writing performance. In other words, the metamemory subscale of contentment does not moderate the effect of the intervention on writing performance.

Overall, the current research question aimed to test for several sets of hypothesized two-way interaction effects. First, the research question sought to test for a potential two-way writing anxiety-treatment interaction effect on L2 writing scores. Second, the research question sought to test for a potential two-way metamemory-treatment interaction effect on L2 writing scores. Because metamemory, as measured in this study, is divided into three sub-scales (contentment, ability, and strategy-use) based on three different coding values, their hypothesized interaction effects were tested independently. Therefore, the researcher ran four independent two-way ANOVA tests. In doing so, the researcher answered the initial research question “To what extent is there a two-way interaction effect of each of the two moderating variables (metamemory and anxiety) on dual N-back WMT in its effect on L2 writing performance?”

As the four tests of two-way ANOVA have revealed, in terms of statistical significance, there is a significant, moderate, writing anxiety-treatment interaction effect on writing performance; however, there is no significant metamemory-treatment interaction effect. Notably, students with higher anxiety levels were affected differently by the treatment and performed worse in writing compared to those with lower anxiety levels. However, when viewing the results visually, a slight interaction effect also appeared between the treatment and the two metamemory sub-scales of strategy-use and ability, but not contentment. In answering the above research question, the researcher partly rejected the fourth hypothesis “There is a significant positive metamemory-treatment and negative anxiety-treatment two-way interaction effect on L2 writing

performance”. Although the anxiety-treatment interaction was statistically significant, the metamemory-treatment interaction was not statistically significant. (Refer to section 6.4 for a full discussion of the results.)

Question 5: To what extent is there a three-way interaction effect of the two moderating variables on the intervention in its effect on L2 writing performance?

Three-way ANOVA is a test statistic used to test for a three-way interaction effect between variables. That is, it measures how three independent variables interact in their effect on the dependent variable. In the case of this study, the three independent variables are the treatment of dual N-back WMT, metamemory levels, and anxiety levels. The dependent variable is writing performance.

Three-way ANOVA was used to test for a three-way interaction effect on writing performance (Three-way ANOVA, 2019). In other words, the test statistic was used to see the combined effect of the two moderating variables (metamemory and anxiety), which are considered independent variables, on the third independent variable, which is the treatment, in its effect on writing performance. One main question is answered when testing for three-way interaction: upon implementation of dual N-back WMT, are subjects with different anxiety levels and different metamemory levels affected differently by the dual N-back intervention?

Three-way ANOVA, just like the other parametric statistics used in this study, comes with certain assumptions that must be met. One of the main assumptions is that the dependent variable should be measured on a continuous scale (Three-way ANOVA, 2019). The dependent variable in this study is writing, which is originally measured on a 30-point continuous scale. The second assumption is that each of the three independent variables consists of at least two categorical groups (Three-way ANOVA, 2019). The first independent variable is the treatment, and it is based

on a two-level categorical scale; the two levels are treatment and the no-treatment, reflected in the two groups CG and EG. The second independent variable is anxiety, which is measured on a categorical scale with four levels: low anxiety, low-mid anxiety, mid-high anxiety, and high anxiety. Likewise, the third independent variable, metamemory, is measured on a four-level categorical scale: low metamemory, low-mid metamemory, mid-high metamemory, and high metamemory.

The third assumption is independence of observations (Three-way ANOVA, 2019), which basically means that the different groups do not overlap in terms of the subject in each group. For instance, someone in the CG should not be in the treatment group as well. This assumption was not violated. Another main assumption is approximately normal distribution of data. When answering the first four research questions, the researcher already established that relatively normal data was attained. Similarly, the assumption of absence of major outliers was established in answering the first four questions. With all assumptions having been met, the researcher ran three-way ANOVA to test for a three-way interaction effect of WMT, anxiety, and metamemory on writing scores.

Since metamemory was divided into three subscales, the researcher ran three different three-way ANOVAS. Instead of running one test statistic to examine a three-way interaction between the first two independent variables and metamemory, the researcher ran an independent test for each of the three sub-scales of metamemory. The first tested for any three-way interaction effect of the treatment, anxiety, and contentment on writing performance; the second was to test for any three-way interaction effect of the treatment, anxiety, and strategy-use, and the third was to test for a three-way interaction of the treatment, anxiety, and ability.

Table 6.32 presents results from the first three-way ANOVA test. The row “group*anxiety*contentment” is the main concern since this is where statistics for the three-way interaction are. Results from the test statistic reveal that there is no statistically significant three-way interaction effect of dual N-back WMT, anxiety levels, and contentment levels on writing performance, $F(4, 74) = .686, p = .605$. The small effect size (partial $\eta^2 = 0.051$) confirms the lack of even a slight three-way interaction. This lack of three-way interaction is reflected in the visual data. Figure 11 presents different graphical representations of the three-way interaction between group, anxiety, and contentment.

Table 6. 32. *Three-way ANOVA Results for Interaction with Contentment*

Tests of Between-Subjects Effects

Dependent Variable: Writing

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Squared	Eta
Corrected Model	325.395 ^a	22	14.791	1.565	.095	.403	
Intercept	5296.337	1	5296.337	560.291	.000	.917	
Group	16.949	1	16.949	1.793	.187	.034	
Anxiety	84.296	3	28.099	2.973	.040	.149	
Contentment	.269	3	.090	.009	.999	.001	
Group * Anxiety	48.023	3	16.008	1.693	.180	.091	
Group * Contentment	22.812	2	11.406	1.207	.308	.045	
Anxiety * Contentment	52.988	6	8.831	.934	.479	.099	
Group * Anxiety * Contentment	25.954	4	6.488	.686	.605	.051	
Error	482.095	51	9.453				
Total	14497.250	74					
Corrected Total	807.490	73					

a. R Squared = .403 (Adjusted R Squared = .145)

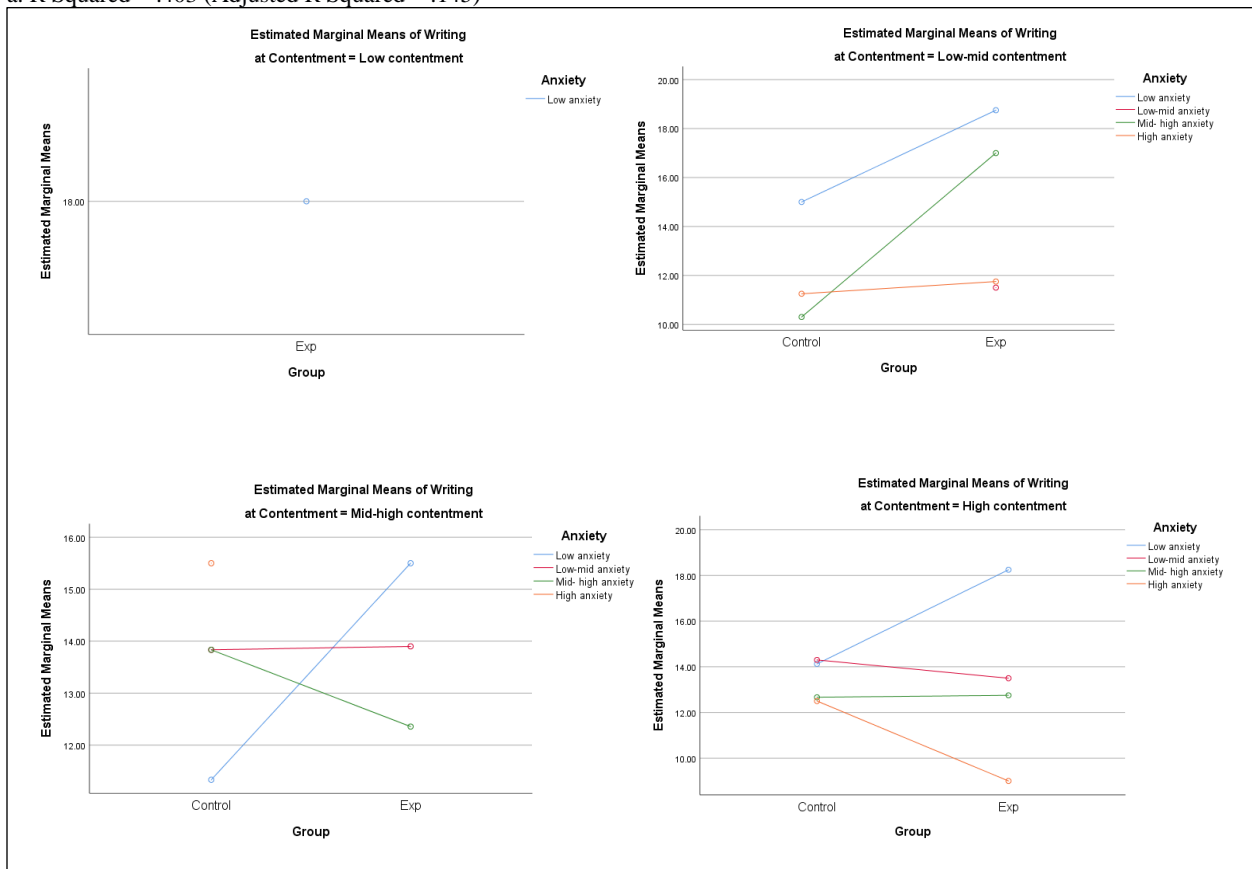


Figure 6.11. Three-Way Interaction, Treatment * Anxiety * Contentment

Figure 6.11 is a graphical representation of the relationship between the four variables. The lines within each graph represent the different anxiety levels, the horizontal axis in each graph represents the different groups, control and treatment, and the vertical axis represent writing scores. Finally, the four different graphs represent the different levels of contentment. The top left graph shows participants with low contentment, for which only one data point is available since there was only one individual in the category of low contentment; this individual is in the EG, and he/she happens to have low anxiety. Consequently, in the first graph, there are no means of comparing different data points for a possible interaction effect. The other three graphs show

results for the other three levels of contentment and how the interaction between anxiety and the treatment varies from one level to another.

There is no sort of pattern in writing performance by anxiety and group from one contentment level to the other. For instance, students with the lowest anxiety levels in the EG outperformed those in the CG within all three levels of contentment. When comparing those with higher anxiety levels, students in the EG outperformed those in the CG within all contentment levels. If there was a slight interaction between contentment and the other variables, this pattern would change from one contentment level to the next instead of being fixed as it is. Contentment, therefore, does not moderate the relationship between anxiety, dual N-back WM training, and writing performance.

The second three-way ANOVA aimed to test for a three-way interaction between the treatment, anxiety, and the metamemory subscale strategy-use in their effect on writing performance. Results for the test of three-way interaction are presented in table 6.33, in the row “group*anxiety*strategyUse”. These results reveal that there is no significant three-way interaction effect between the treatment, anxiety levels, and levels of strategy-use ($F(1, 72) = .165$, $p = .686$, partial $\eta^2 = .003$). Hence, based on the almost-inexistent effect size, the effect of anxiety on the treatment is not the least bit moderated, or affected, by the metamemory subscale strategy-use. The relationship between the four variables is presented in figure 6.12.

Figures 6.12 is a visual representation of the relationship between the four variables. The different graphs show how writing scores fluctuate among those with different levels of strategy-use within the context of anxiety levels and the two groups. The graphs are in line with the results yielded in the table. Just as the table indicates, there does not seem to be any significant pattern in

how writing scores fluctuate. Hence, there one may conclude that there is no three-way interaction effect of dual N-back WMT, strategy-use, and anxiety on writing performance.

Table 6. 33. *Three-way ANOVA Results for Interaction with Strategy-use*

Tests of Between-Subjects Effects

Dependent Variable: Writing

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	101.175 ^a	7	14.454	1.444	.204	.136
Intercept	12007.609	1	12007.609	1199.242	.000	.949
Group	7.821	1	7.821	.781	.380	.012
Anxiety	70.068	1	70.068	6.998	.010	.099
StrategyUse	3.822	1	3.822	.382	.539	.006
Group * Anxiety	4.146	1	4.146	.414	.522	.006
Group * StrategyUse	.218	1	.218	.022	.883	.000
Anxiety * StrategyUse	.494	1	.494	.049	.825	.001
Group * Anxiety * StrategyUse	1.652	1	1.652	.165	.686	.003
Error	640.811	64	10.013			
Total	13891.000	72				
Corrected Total	741.986	71				

a. R Squared = .136 (Adjusted R Squared = .042)

However, the top left graph, the one containing data for the low-strategy-use group, is nearly empty; only two data points are available, the first for whom the subject is in the CG and the low anxiety group, and the second is for a subject who is in the EG and low-mid anxiety group. The bottom right graph is also almost empty, with only three data points on the graph, and like the top left graph, contains no form of comparison between participants in the different anxiety levels and groups. Accordingly, having omitting these two graphs from the analysis, only those in the low-mid strategy-use and those in the mid-high strategy-use can be compared for potential interaction effects. Being short of so much data, the researcher finds it rather difficult to draw any sound conclusions.

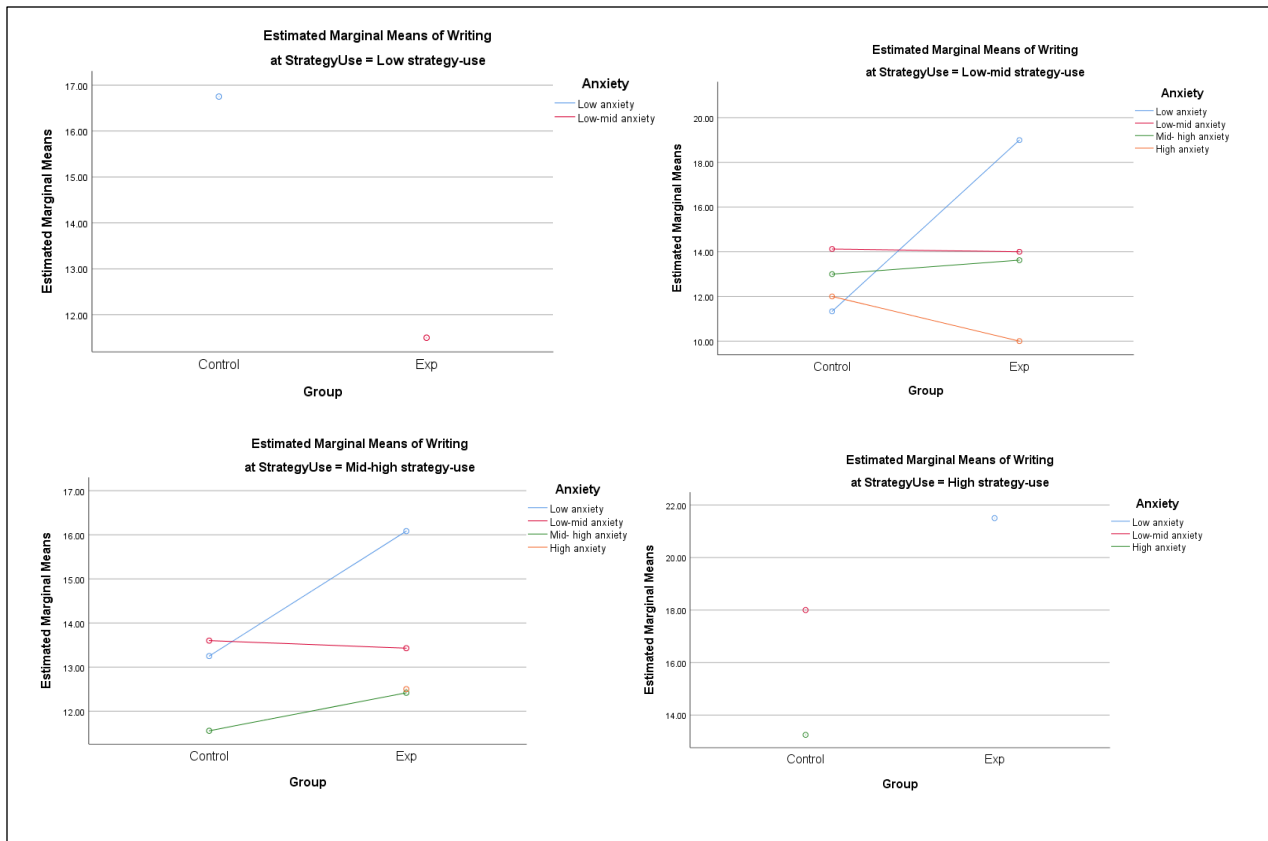


Figure 6.12. Three-way Interaction, Treatment * Anxiety * Strategy-use

The researcher ran the final three-way ANOVA to test for a three-way interaction effect of the treatment, anxiety, and the metamemory subscale of ability on students' writing performance. The row "group*anxiety*ability" in table 6.34 shows results for the three-way interaction effect. The results reveal that there is no statistically significant interaction effect of the three variables on writing performance ($F(2, 74) = .072, p = .931, \text{partial } \eta^2 = .003$). Again, the nearly-inexistent effect size indicates a complete lack of three-way interaction. Figure 6.13 presents the data visually.

Table 6. 34. Three-way ANOVA Results for Interaction with Ability

Tests of Between-Subjects Effects

Dependent Variable: Writing

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	301.230 ^a	20	15.061	1.577	.095	.373
Intercept	6195.036	1	6195.036	648.554	.000	.924
Group	9.885	1	9.885	1.035	.314	.019
Anxiety	50.503	3	16.834	1.762	.166	.091
Ability	46.812	3	15.604	1.634	.193	.085
Group * Anxiety	66.909	3	22.303	2.335	.084	.117
Group * Ability	6.612	2	3.306	.346	.709	.013
Anxiety * Ability	22.346	5	4.469	.468	.798	.042
Group * Anxiety * Ability	1.376	2	.688	.072	.931	.003
Error	506.260	53	9.552			
Total	14497.250	74				
Corrected Total	807.490	73				

a. R Squared = .373 (Adjusted R Squared = .136)

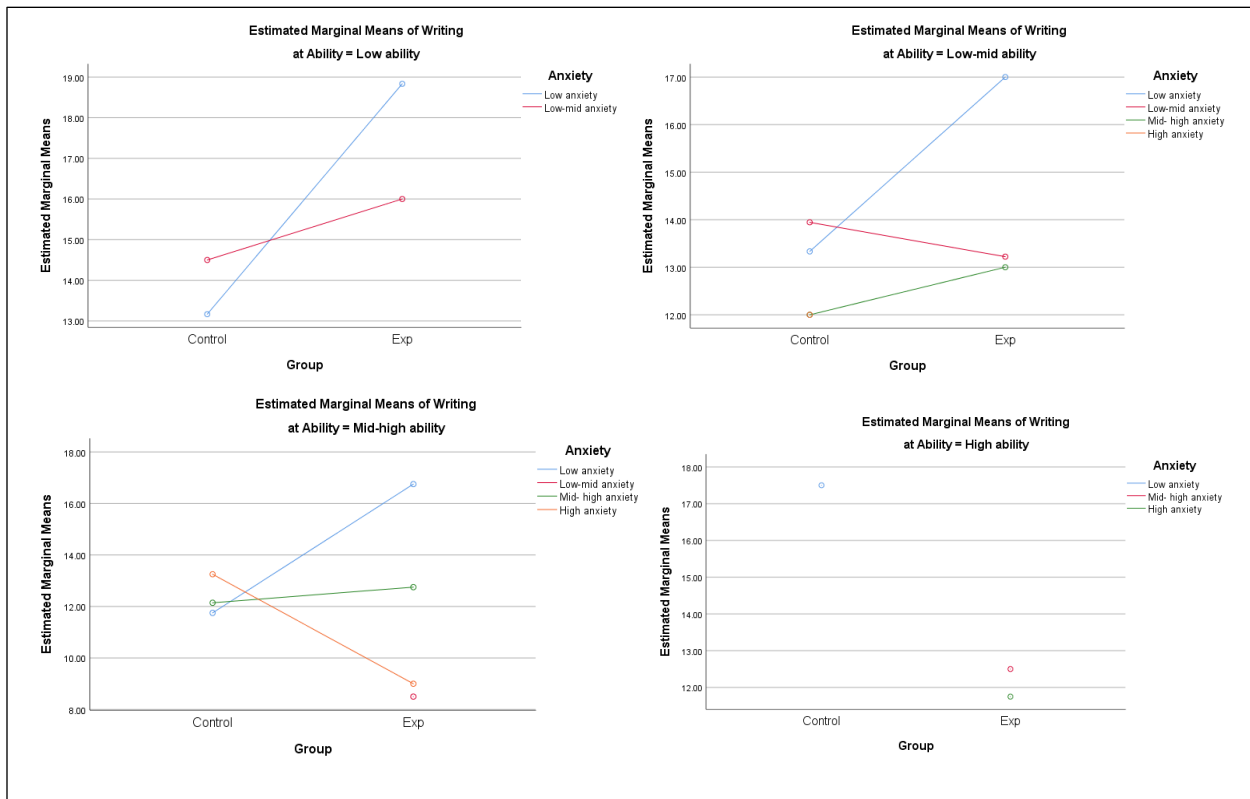


Figure 6. 13. Three-way Interaction, Treatment *Anxiety * Ability

Figure 6.3 visually represent the relationship between the four variables treatment, anxiety, ability, and writing performance. Writing scores do not follow any noticeable pattern from one ability level to the next. In contrast, scores seem to fluctuate randomly. Hence, there is no discrepancy between the table and the graphs. According to both the table and the graph, the data is far from achieving three-way interaction effect of the three independent variables on the dependent variable. Although there does not seem to be any pattern, like in the previous three-way ANOVA graphs, a considerable amount of data is lacking to be able to really make any sound conclusions.

Accordingly, in running the three three-way ANOVA analyses and generating their corresponding graphs, the researcher answered the final research question “To what extent is there a three-way interaction effect of the two moderating variables on the intervention in its effect on L2 writing performance?” In sum, results yielded from the analyses indicate that none of the three sub-scales of metamemory moderate the relationship between dual N-back WM training, L2 writing anxiety, and L2 writing performance. Therefore, there is no significant three-way interaction effect of the two moderating variables metamemory and anxiety on the intervention in its effect on L2 writing performance. In answering the above research question, the researcher rejected the final hypothesis “There is a significant three-way interaction effect of dual N-back WMT and the moderating variables on writing performance”. (Refer to section 6.4 for a full discussion of the results.)

6.4. Discussion

The primary aim of this study was to examine whether a treatment of Dual N-back WMT implemented on EFL learners would have any effect on their L2 writing performance. To accomplish this, the researcher tried to avoid measuring only the main treatment effect on L2

writing performance since any treatment or variable is most likely subject to being affected by other variables. Therefore, the researcher adopted two other variables and tested their moderating effect on how the treatment affected writing performance. The first variable adopted as a moderator is anxiety. The second variable is metamemory, which was divided into three sub-scales: contentment, strategy-use, and ability.

Five research questions were adopted for this study:

1. To what extent is EFL learners' writing performance associated with their writing anxiety levels?
2. To what extent is EFL learners' writing performance associated with their metamemory levels?
3. How does dual N-back WMT affect EFL learners' writing performance?
4. To what extent is there a two-way interaction effect of each of the two moderating variables (metamemory and anxiety) on dual N-back WMT in its effect on L2 writing performance?
5. To what extent is there a three-way interaction effect of the two moderating variables on the intervention in its effect on L2 writing performance?

Accordingly, the researcher adopted five corresponding hypotheses:

H₁: A significant negative correlation exists between EFL learners' anxiety levels and their performance.

H₂: Learners' metamemory levels are positively correlated with their writing performance.

H₃: There is no main treatment effect of dual N-back WMT on EFL learners' writing performance.

H₄: There is a significant positive metamemory-treatment and negative anxiety-treatment two-way interaction effect on L2 writing performance.

H₅: There is a significant three-way interaction effect of dual N-back WMT and the moderating variables on writing performance.

In testing for the relationship between EFL learners' anxiety levels and their writing performance (the first question), as per the researcher's expectations, results yielded a significant negative association between the two constructs. In other words, higher anxiety levels are associated with lower writing scores and vice versa. As anxiety levels rise, L2 writing scores drop. Although these findings support Tobias's (1986) assertion that FLA plays a significant role in language learning, they are in contrast with Park and French's (2013) findings, which support the facilitative role of the construct by revealing that learners with higher levels of anxiety outperformed those with lower levels of anxiety. The current findings also contrast those of Bell and McCallum (2012), who found a slightly positive correlation between anxiety and grades.

While some studies support the facilitative role of anxiety in achievement, this study revealed that anxiety plays a debilitating role. This supports findings by Hewitt and Stephenson (2012), Young (1986), and Salem and Al Diyar (2014), who all report a significant negative association between anxiety and general L2 achievement. In terms of L2 writing, the findings in this study are in line with several other studies, both theoretical (Krashen, 1981; Leki, 1999) and empirical (Al Asmari, 2013; Daly, 1977; Faigley, Daly, & Witte, 1981; Lee & Krashen, 2002; Lui & Ni, 2015; Khelalfa, 2018; Onwuegbuzie, Bailey, & Daley, 2000; Rezaei, Jafari, & Younas, 2014), who all yielded results in support of the debilitating role of anxiety on language learning, particularly writing.

Accordingly, in yielding a statistically significant negative association between anxiety scores and L2 writing scores, the researcher answered the first research question and tested the first hypothesis. The first hypothesis, that the two variables would be negatively associated, was accepted.

In answering the second research question, contrary to the researcher's expectations, results yielded a non-significant association between metamemory levels and L2 writing. The same results were found for all three sub-scales of metamemory. These findings are in contrast to those of Sinkavich (1991), who revealed that metamemory is a significant predictor of test performance. Findings from this study are also in disagreement with those of Carr and Borkowski (1987), who revealed that metamemory is significantly related to achievement. In terms of language learning, findings from the current study also contradict those of Reza and Nezhad (2001), who revealed that students subject to metamemory-based instruction outperformed those taught under a different approach. These result also contradict those of Ehrman, Green, and Oxford (1995), who established a link between metamemory and general language learning proficiency as well those of Ismaiel (2017), who established a link between metamemory and language learning achievement.

To the knowledge of the researcher, no previous studies yielded findings that are in line with results from the current study. One possible explanation is the fact that prior studies that have been reviewed are all within different domains, from general test performance to overall achievement, and language learning or proficiency. The researcher did not find prior research on metamemory in writing performance. Hence, the difference in the nature of the different constructs being studied may be the reason for the difference in the results being yielded.

Another possible explanation may lie in the tool used to measure metamemory. Flavell and Wellman (1977) distinguish between two types of metamemory: declarative and procedural metamemory. While the former construct is typically measured using questionnaires, the latter construct is tested empirically, with subjects being asked questions accompanied by a memory performance task in order to examine any discrepancies between subjects' beliefs about their

memory ability or performance and their actual performance (Cavanaugh & Perlmutter, 1982) (refer to section 2.6 for a more detailed explanation of measuring metamemory). This level of discrepancy is what defines their metamemory scores. Those who accurately predict their ability or performance have higher metamemory levels while those who fail at accurately predicting their ability or performance have lower metamemory levels. Accordingly, in the current study, the researcher found it highly convenient to measure procedural metamemory due to a number of constraints. Therefore, she had to settle for measuring only declarative metamemory using a questionnaire, which is insufficient for accurately gauging their metamemory levels. Hence, this lack of proper measurement of the construct may have contributed to the results yielded. In yielding the aforementioned results, the researcher rejected the second hypothesis, that learners' metamemory levels are positively correlated with their writing performance.

In answering the third research question, results revealed that there is a main treatment effect of the intervention on L2 writing scores. In other words, the treatment of dual N-back WMT significantly affected writing scores when, in the analysis, the variables anxiety and metamemory were not controlled for. The only variable that was accounted for was pre-test writing scores since they would most likely influence the difference between the two groups' post-test scores. These findings are on par with the researcher's expectations as well as many other studies. For instance, these findings support those of Daneman and Merikle (1996), who reported a significant association between WM and language processing. These findings also support Archibald (2017), who outlines the significance of WM in language learning, and Skehan (2002) and Yalçın, Çeçen, and Erçetin (2016), who suggest that WM is critical in L2 aptitude.

More importantly, these findings contribute to a better understanding of the effect of the debated WMT program, dual N-back. Findings in this study support claims made by Jaeggi et al.

(2008; 2010) and Klingberg (2010) that dual N-back contributes to improved performance in untrained tasks. On the other hand, these findings contradict those who believe the training program is ineffective (Bürki, Ludwig, Chicherio, & De Ribaupierre, 2014; Colom et al., 2013). Likewise, these findings support claims that WM is a significant contributor to writing performance, both theoretical (Hayes, 1996; Hayes & Flower, 1980; Kellogg, 1996) and empirical claims (Bergsleithner, 2010; McCutchen et al., 1994; Swanson & Berninger, 1996; Vanderberg & Swanson, 2007; Yi & Luo, 2013). These findings, however, do not support those of various other researchers who believe that no association exists between WM and L2 learning (Juffs, 2004; Taguchi, 2008). Hence, in answering the third research question and attaining the aforementioned findings, the researcher rejected the third hypothesis, that there would be no main treatment effect of dual N-back WMT on EFL learners' writing performance, was rejected.

In answering the fourth research question, results from the analysis have revealed that anxiety moderates the effect of the intervention on L2 writing performance, which is in line with the researcher's expectations. However, contrary to the researcher's expectations, metamemory is not a moderator in the effect of the intervention on L2 writing performance. The researcher believes that the significant treatment-anxiety interaction effect is attributed to negative effect that anxiety has on WM performance. If this is the case, then these findings support assertions that anxiety hinders WM (Corbetta & Shulman, 2002; Darke, 1988; Eysenck & Calvo, 1992; Hadwin, Brogan & Stevenson, 2005; Mitt, 2008; Owens, Norgate, & Hadwin, 2008). To the knowledge of the researcher, no studies examined two-way interaction effects of WM and anxiety or WM and metamemory; therefore, this study's findings cannot be compared with previous findings in this respect.

Furthermore, in terms of the lack of significance yielded in testing for the effects of metamemory on the other variables, as already mentioned in the beginning of the discussion, the researcher believes one possible reason may be improper measurements of the construct of metamemory. Another possible explanation, in the case of measuring for interaction, is the being short of so much data (refer to section 6.3, research question 4 and 5, for a detailed explanation). After yielding the aforementioned results and answering the fourth research question, the researcher partly rejected the fourth hypothesis, that there would be a significant positive metamemory-treatment and negative anxiety-treatment two-way interaction effect on L2 writing performance. Although metamemory was found to be an insignificant moderator, anxiety was, as per the researcher's expectations, found to be a significant moderator.

In answering the fifth question, results have revealed that there is no three-way interaction effect of anxiety, metamemory, and the treatment on L2 writing performance. Results, therefore, indicate that the effect of the intervention on students' writing scores is not affected by the combined effect of anxiety and metamemory. Since no previous studies examining such interaction effects were found by the researcher, she had no means of comparison for the findings attained. However, the researcher believes that the complete lack of interaction could possibly be attributed to being short of so much data (again, refer to section 6.3, research question 4 and 5, for a detailed explanation). Contrary to the researcher's expectations, the fifth hypothesis was rejected.

Overall, the findings indicate that anxiety is a determiner of writing outcomes. Moreover, dual N-back WMT does have an effect on L2 writing performance. The level of this effect, however, fluctuates depending on the level of anxiety. More specifically, learners with higher levels of anxiety benefit less from the training program than those with lower levels of anxiety.

Aside from this, the researcher cannot draw any further conclusions based on the non-significant finding.

Conclusion

The current chapter aimed to present the results attained from the various methods of data analysis employed for answering the five research questions and testing their corresponding hypotheses. The chapter was divided into several main sections based on the type of results being presented. First, two forms of descriptive statistics were presented, measures of frequency and measures of central tendency and dispersion. Second, inferential statistics were presented, with each test statistic used for answering each research question being presented separately. Finally, the results yielded were discussed in light of the existing literature and in light of the researcher's expectations. Overall, the researcher accepted one hypothesis and rejected three, and only partly rejected one.

7. Chapter Seven: Implications, Limitations, and Suggestions for Further Research

Introduction

The current chapter provides an overview of the various pedagogical implications of the findings attained from this study. Furthermore, a number of limitations encountered throughout the study are outlined below, along with the researcher's recommendations for further research into the topic.

7.1. Pedagogical Implications

Although a few of the researcher's hypotheses were rejected, the findings attained have served as a basis upon which the researcher has gained a better understanding of the relationship between the four constructs in this study. In establishing a causal relationship between WMT and L2 writing performance, this study contributes to the broader literature of WM as well that of L2 writing. First, it provides a practical example of how WM can be applied in the EFL classroom. Secondly, in establishing an association between anxiety and L2 writing, the findings can serve as another resource for language learning researchers and practitioners alike. In having such knowledge of the effect of anxiety on writing, they can take the appropriate measures to try and reduce or at least prevent language learning anxiety within the classroom. In doing so, learners may perform significantly better, and they will likely become more confident. Thirdly, these findings contribute to a better understanding of the highly-debated dual N-back WMT, particularly whether it is actually effective in improving untrained tasks, the most controversial point in the field of dual N-back WMT. This study can be considered as one more in the list of those who consider the training program to be effective.

With the established positive effect of the intervention on L2 writing (and WM in general on language achievement), what would be ideal is the implementation of dual N-back WMT in the EFL classroom. This, however, is highly impractical. What language teachers can do that would be more practical is adjust their teaching methods, taking into consideration the fact that WM storage and processing capacities are limited, and that these limitations will most likely affect language learning performance if not taken into consideration. The researcher recommends Cognitive-Load-Theory-based instructional methods, in which activities, and everything else about the method, are devised in an attempt to reduce the cognitive load placed on the limited WMC of learners, a cognitive load that is believed to be attributed to multiple drawbacks within multiple learning contexts.

7.2. Limitations

Despite establishing some significant associations, the study still has some limitations. The first limitation concerns the study design. Although experimental studies are helpful in establishing causal relationships, the downside to this study is that no form of qualitative data was collected. The data, the results, and thus the study would have been much more informative and reliable if the researcher had employed a combination of quantitative and qualitative methods of data collection and analysis. Qualitative data would have provided insight into learners' attitudes, thoughts, beliefs, and anything else that may not have been collected by quantitative means. Another limitation is lack of randomization. The sample is a convenience sample; the researcher could not apply random selection and random assignment of participants, mainly due to administrative constraints. With random selection and assignment, results would become more reliable because of the reduced chance of having extraneous variables.

Sample size is another limitation. Because of attrition, the sample was reduced to nearly half. This seemed to have an effect on the data collected and, consequently, on the results. For instance, data for the variables anxiety and contentment were each divided into four categories: “low”, “low-mid”, “mid-high”, and “high”. When testing for three-way interaction, the graphs (refer to section 6.3) revealed that several categories are missing participants who fit into that category. For example, for the category of “low contentment”, only one line was present for the other variable with which an interaction effect was being tested; this one line represents individuals with low anxiety. This means that only one individual with low anxiety was in the low contentment group; the sample did not contain individuals in the low-contentment group who also have low-mid anxiety, mid-high anxiety, or high anxiety. Likewise, no individuals in the CG within the low-mid contentment group had low-mid anxiety.

The same issue occurred in nearly all other sub-categories. In the low strategy-use group, only one data point was available for the CG (low anxiety), and only one data point was available for the treatment group (low-mid anxiety); data-points for all other level of anxiety were not available. Similarly, only three data-points were available within the level of high strategy-use. Moreover, the same amount of data as missing in the three-way analysis of ability. Hence, with so much data lacking, it became difficult to draw any sound conclusions, especially when testing for three-way interaction effects. In order for all sub-categories of contentment to overlap with all sub-categories of anxiety and to a chance of having enough participants in all subcategories, a much larger sample size is required.

Another limitation is insufficient practice of the dual N-back program. Although some participants surpassed the recommended eight hours of training, not all participants were so

cooperative. Without the recommended amount of training for all participants, interpreting the data and findings became more difficult.

7.3. Suggestions for Further Research

Considering the limitations experienced in this study, it may be beneficial to carry out a similar study while ensuring that the same flaws are not repeated. For instance, sample size appears to be the biggest limitation, one that should not be repeated since it would most likely lead to similar results. Another recommendation for further research is replication of the study within a broader scope; for example, conducting two experiments in two different settings would provide some insight into social and/or geographical differences in response to the various variables. Another recommendation is considering other variables that reflect inter-individual differences and their effect on the treatment. For example, further research may be needed to examine how motivation and other variables play a role in the effect of the treatment on the other three variables and vice versa. Another potential path for further research into the field is investigating exactly which aspects of writing, if any, are affected by WMT. For instance, does training improve most grammatical accuracy, vocabulary, coherence, or overall style? Or does it simply improve the overall final product? Regardless of the path taken by future researchers, the main recommendation is giving attention to the various limitations experienced in this study and to prevent them from being repeated.

Conclusion

This chapter first provided an overview of the various potential pedagogical implications of the findings attained in this study. This chapter then highlighted some of the major limitations encountered by the researcher throughout the study as well as limitation in the study design. Finally, in this chapter, the researcher provided some suggestions for further research.

General Conclusion

This current study aimed to investigate the potential effects of the dual N-back WMT program on EFL learners' writing performance. The researcher implemented the intervention on second year EFL students at the University of Larbi Ben M'hidi during the academic year 2017-2018. In examining the effects of the intervention, the researcher examined not only the main treatment effect, but she also examined the potential moderating (also known as interaction) effects of two other variables she believed to effect the independent and/or dependent variable. The first variable adopted as a potential moderator is L2 writing anxiety, and the second variable is metamemory. The researcher first tested for the moderating effect of each of moderating variable on the intervention in its effect on writing performance. After each moderating variable was tested individually for interaction effects, the researcher tested for their combined effect on the treatment's effect on writing performance.

This dissertation is divided into seven main chapters. The first four chapters constitute the literature review, the first chapter for the literature on WM, the second chapter for the literature on metamemory, the third chapter for the literature on anxiety, and the final chapter for the literature on EFL writing. The fifth chapter is devoted to explaining the methodology followed for the study, including the study design, population, sample, and method of data analysis, among other things. The sixth chapter is devoted to the results attained and their interpretation. Finally, the seventh chapter is outlines possible pedagogical implications of the results attained, limitations of the study, and suggestions for further research into the field.

Accordingly, this research constituted four main phases: the review of the literature, exploratory analysis, implementation of the intervention, and confirmatory analysis. Reviewing the literature helped the researcher establish a sound theoretical framework and basis upon which she could build her assumptions, research questions, and hypotheses. The phase of exploratory analysis comprised the initial pre-tests and questionnaire

administration. The implementation phase, constituting implementation of both the pilot study and the main study, was implemented for a duration of one semester. Finally, in the confirmatory analysis, the researcher administered the post-tests and questionnaires, and she analyzed their data in order to effectively answer the research questions.

The researcher posed the following research questions:

1. To what extent is EFL learners' writing performance associated with their writing anxiety levels?
2. To what extent is EFL learners' writing performance associated with their metamemory levels?
3. How does dual N-back WMT affect EFL learners' writing performance?
4. To what extent is there a two-way interaction effect of each of the two moderating variables (metamemory and anxiety) on dual N-back WMT in its effect on L2 writing performance?
5. To what extent is there a three-way interaction effect of the two moderating variables on the intervention in its effect on L2 writing performance?

Accordingly, the researcher adopted five corresponding hypotheses:

H₁: A significant negative correlation exists between EFL learners' anxiety levels and their performance.

H₂: Learners' metamemory levels are positively correlated with their writing performance.

H₃: There is no main treatment effect of dual N-back WMT on EFL learners' writing performance.

H₄: There is a significant positive metamemory-treatment and negative anxiety-treatment two-way interaction effect on L2 writing performance.

H₅: There is a significant three-way interaction effect of dual N-back WMT and the moderating variables on writing performance.

After answering the aforementioned questions and testing for their corresponding hypotheses, the following conclusions were drawn:

- EFL learners' writing performance is negatively associated with their L2 writing anxiety levels.
- EFL learners' writing performance is not significantly associated with their metamemory levels.

- There is no main treatment effect of dual N-back WMT on EFL learners' writing performance after controlling for pre-test scores.
- There is no significant metamemory-treatment interaction effect on L2 writing performance, but there is a significant negative anxiety-treatment two-way interaction effect on L2 writing performance.
- There is no significant treatment- anxiety- metamemory interaction effect of dual N-back WMT on L2 writing performance.

Overall, although statistically significant results were attained for a number of tests, the various limitations and hindrances, such as sample size, have made it quite difficult for the researcher to draw sound conclusions. Although the EG did appear to outperform the CG in writing after implementation of the treatment, the researcher still believes much more tedious research should be conducted to really be able to conclude with confidence that dual N-back WM really does improve L2 writing performance. A simple example of how such research can be conducted is looking further into how various variables are at play in the relationship between the training program and final writing performance.

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Appendices

Appendix A

Original SLWAI

Statement	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1. While writing in English, I'm not nervous at all.					
2. I feel my heart pounding when I write English compositions under time constraint.					
3. While writing English compositions, I feel worried and uneasy if I know they will be evaluated.					
4. I often choose to write down my thoughts in English.					
5. I usually do my best to avoid writing English compositions.					
6. My mind often goes blank when I start to work on an English composition.					
7. I don't worry that my English compositions are a lot worse than others'.					
8. I tremble or perspire when I write English compositions under time pressure.					
9. If my English composition is to be evaluated, I would worry about getting a very poor grade.					
10. I do my best to avoid situations in which I have to write in English.					
11. My thoughts become jumbled when I write English compositions under time constraint.					
12. Unless I have no choice, I would not use English to write composition.					
13. I often feel panic when I write English compositions under time constraint.					
14. I'm afraid that other students would deride my English composition if they read it.					
15. I freeze up when unexpectedly asked to write English compositions.					
16. I would do my best to excuse myself if asked to write English compositions.					
17. I don't worry at all about what other people would think of my English compositions.					
18. I usually seek every possible chance to write English compositions outside of class.					
19. I usually feel my whole body rigid and tense when I write English compositions.					
20. I'm afraid of my English composition being chosen as a sample to be discussed in class.					
21. I'm not afraid at all that my English compositions would be rated as very poor.					
22. Whenever possible, I would use English to write compositions.					

Appendix B

Adapted SLWAI

Statement	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1. While writing in English, I get nervous.	0	1	2	3	4
2. I feel my heart beating when writing English composition (like paragraphs or essays) under a time limit.	0	1	2	3	4
3. Knowing that my writing will be evaluated makes me worried or uneasy while writing.	0	1	2	3	4
4. I do my best to void writing English compositions.	0	1	2	3	4
5. When I start to write English compositions, my mind becomes empty.	0	1	2	3	4
6. I worry that my English compositions are worse than others	0	1	2	3	4
7. I shake(when your whole body moves uncontrollably usually because of fear) or sweat when I write English compositions under time pressure	0	1	2	3	4
8. When my writing is to be evaluated, I worry about getting a bad mark	0	1	2	3	4
9. My thoughts get mixed up when I start writing under a time limit.	0	1	2	3	4
10. I would rather write in a different language than in English.	0	1	2	3	4
11. I am afraid of what other students would think of my English composition.	0	1	2	3	4
12. I become afraid that I would get asked to read what I have written.	0	1	2	3	4
13. I freeze up when I am unexpectedly asked to write an English composition.	0	1	2	3	4
14. I worry about what others think about my English writing.	0	1	2	3	4
15. I become worried that I would get selected to read my writing in class	0	1	2	3	4

Appendix C

Original MMQ

**Multifactorial
Memory
Questionnaire**

How I Feel About My Memory

Name: _____ Date: _____

Below are statements about feelings that people may have about their memory. Read each statement and think about your feelings over the past two weeks. Then, check the box next to the response that best describes how much you agree or disagree.

-
1. I am generally pleased with my memory ability.
- 4** Strongly Agree **3** Agree **2** Undecided **1** Disagree **0** Strongly Disagree
-
2. There is something seriously wrong with my memory.
- 0** Strongly Agree **1** Agree **2** Undecided **3** Disagree **4** Strongly Disagree
-
3. If something is important, I will probably remember it.
- 4** Strongly Agree **3** Agree **2** Undecided **1** Disagree **0** Strongly Disagree
-
4. When I forget something, I fear that I may have a serious memory problem, like Alzheimer's disease.
- 0** Strongly Agree **1** Agree **2** Undecided **3** Disagree **4** Strongly Disagree
-
5. My memory is worse than most other people my age.
- 0** Strongly Agree **1** Agree **2** Undecided **3** Disagree **4** Strongly Disagree
-
6. I have confidence in my ability to remember things.
- 4** Strongly Agree **3** Agree **2** Undecided **1** Disagree **0** Strongly Disagree
-
7. I feel unhappy when I think about my memory ability.
- 0** Strongly Agree **1** Agree **2** Undecided **3** Disagree **4** Strongly Disagree
-
8. I worry that others will notice that my memory is not very good.
- 0** Strongly Agree **1** Agree **2** Undecided **3** Disagree **4** Strongly Disagree
-
9. When I have trouble remembering something, I'm not too hard on myself.
- 4** Strongly Agree **3** Agree **2** Undecided **1** Disagree **0** Strongly Disagree
-
10. I am concerned about my memory.
- 0** Strongly Agree **1** Agree **2** Undecided **3** Disagree **4** Strongly Disagree
-
11. My memory is really going downhill lately.
- 0** Strongly Agree **1** Agree **2** Undecided **3** Disagree **4** Strongly Disagree
-
12. I am generally satisfied with my memory ability.
- 4** Strongly Agree **3** Agree **2** Undecided **1** Disagree **0** Strongly Disagree
-
13. I don't get upset when I have trouble remembering something.
- 4** Strongly Agree **3** Agree **2** Undecided **1** Disagree **0** Strongly Disagree
-
14. I worry that I will forget something important.
- 0** Strongly Agree **1** Agree **2** Undecided **3** Disagree **4** Strongly Disagree
-
15. I am embarrassed about my memory ability.
- 0** Strongly Agree **1** Agree **2** Undecided **3** Disagree **4** Strongly Disagree
-
16. I get annoyed or irritated with myself when I am forgetful.
- 0** Strongly Agree **1** Agree **2** Undecided **3** Disagree **4** Strongly Disagree
-
17. My memory is good for my age.
- 4** Strongly Agree **3** Agree **2** Undecided **1** Disagree **0** Strongly Disagree
-
18. I worry about my memory ability.
- 0** Strongly Agree **1** Agree **2** Undecided **3** Disagree **4** Strongly Disagree

Appendix C (Continued)

Original MMQ

Memory Mistakes

Name: _____ Date: _____

Below is a list of common memory mistakes that people make. Decide how often you have done each one in the *last two weeks*. Then, check the box next to the appropriate response.

1. Forget to pay a bill on time.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

2. Misplace something you use daily, like your keys or glasses.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

3. Have trouble remembering a telephone number you just looked up.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

4. Not recall the name of someone you just met.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

5. Leave something behind when you meant to bring it with you.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

6. Forget an appointment.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

7. Forget what you were just about to do; for example, walk into a room and forget what you went there to do.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

8. Forget to run an errand.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

9. In conversation, have difficulty coming up with a specific word that you want.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

10. Have trouble remembering details from a newspaper or magazine article you read earlier that day.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

11. Forget to take medication.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

12. Not recall the name of someone you have known for some time.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

13. Forget to pass on a message.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

14. Forget what you were going to say in conversation.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

15. Forget a birthday or anniversary that you used to know well.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

16. Forget a telephone number you use frequently.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

17. Retell a story or joke to the same person because you forgot you already told him or her.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

18. Misplace something that you put away a few days ago.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

19. Forget to buy something you intended to buy.
 0 All the Time 1 Often 2 Sometimes 3 Rarely 4 Never

20. Forget details about a recent conversation.

Appendix C (Continued)

Original MMQ

**Multifactorial
Memory
Questionnaire**

Use of Memory Strategies

Name: _____ Date: _____

People often use different tricks or strategies to help them remember things. Several strategies are listed below. Decide how often you used each one in the *last two weeks*. Then, check the box next to the appropriate response.

-
1. Use a timer or alarm to remind you when to do something.
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
2. Ask someone to help you remember something or to remind you to do something.
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
3. Create a rhyme out of what you want to remember.
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
4. In your mind, create an image of something you want to remember, like a name and face.
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
5. Write things on a calendar, such as appointments or things you need to do.
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
6. Go through the alphabet one letter at a time to see if it sparks a memory for a name or word.
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
7. Organize information you want to remember, for example, organize your grocery list according to food groups.
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
8. Say something out loud in order to remember it, such as a phone number you just looked up.
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
9. Use a routine to remember important things, like checking that you have your wallet and keys when you leave home.
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
10. Make a list, such as a grocery list or a list of things to do.
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
11. Mentally elaborate on something you want to remember, for example, focus on a lot of the details.
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
12. Put something in a prominent place to remind you to do something, like putting your umbrella by the front door so you will remember to take it with you.
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
13. Repeat something to yourself at increasingly longer and longer intervals so you will remember it.
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
14. Create a story to link together information you want to remember.
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
15. Write down in a notebook things that you want to remember.
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
16. Create an acronym out of the first letters in a list of things to remember, such as carrots, apples, and bread (cab).
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
17. Intentionally concentrate hard on something so that you will remember it.
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
18. Write a note or reminder for yourself (other than on a calendar or in a notebook).
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never
-
19. Mentally retrace your steps in order to remember something, such as the location of a misplaced item.
- 4** All the Time **3** Often **2** Sometimes **1** Rarely **0** Never

Appendix D

Adapted MMQ

Statement	Never	Rarely	Sometimes	Often	Always
16. I use a timer or alarm to remind me to do things	0	1	2	3	4
17. I ask someone to help me remember to do something.	0	1	2	3	4
18. I use strategies to help me remember things	0	1	2	3	4
19. I create images in my mind to remember things better.	0	1	2	3	4
20. I write things on a calendar to help me remember.	0	1	2	3	4
21. I organize information into categories to help me remember.	0	1	2	3	4
22. I say something out loud to help me remember it.	0	1	2	3	4
23. I check my wallet, pocket, or purse before leaving home to make sure I remember everything.	0	1	2	3	4
24. I make a list of things I must do in order to remember.	0	1	2	3	4
25. I intentionally focus on details of things that I want to remember	0	1	2	3	4
26. I place things in certain places so I can remember them, like in front of my door.	0	1	2	3	4
27. I repeat things to myself several times so I can remember them	0	1	2	3	4
28. I create a story to link together information I want to remember	0	1	2	3	4
29. I write down in a notebook things I want to remember	0	1	2	3	4
30. I mentally repeat my steps in order to remember something like an item I have misplaced	0	1	2	3	4

Appendix D (Continued)

Adapted MMQ

Statement	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1) I forget to return things I have borrowed from people	0	1	2	3	4
2) I misplace things I use daily, like keys or glasses	0	1	2	3	4
3) I have trouble remembering a phone number I just looked up	0	1	2	3	4
4) I have trouble recalling names I of people I just met	0	1	2	3	4
5) I forget things that I meant to take with me	0	1	2	3	4
6) I forget appointments or meetings I have with other people	0	1	2	3	4
7) I forget what I was just about to do; for example, walking into a room and forgetting why	0	1	2	3	4
8) I forget to accomplish tasks I had planned to accomplish	0	1	2	3	4
9) I have difficulty remembering the right words I want to use in conversation	0	1	2	3	4
10) I forget details of things I saw or heard	0	1	2	3	4
1. I am generally pleased with my memory ability.	0	1	2	3	4
2. There is something seriously wrong with my memory	0	1	2	3	4
3. If something is important, I will remember it.	0	1	2	3	4
4. When I forget things, I worry that I may have a serious memory problem, like Alzheimer's disease.	0	1	2	3	4
5. My memory is worse than most other people my age	0	1	2	3	4
6. I have confidence in my ability to remember things	0	1	2	3	4
7. I feel unhappy when I think about my memory ability	0	1	2	3	4
8. I worry that others will notice that my memory is not very good	0	1	2	3	4
9. When I have trouble remembering something, I'm not too hard on myself	0	1	2	3	4
10. I am concerned about my memory being bad.	0	1	2	3	4

Appendix E

Writing Evaluation Rubric

	ORGANIZATION	DEVELOPMENT	SENTENCE STRUCTURE
6	<p>Exemplary Organization</p> <ul style="list-style-type: none"> Clearly stated topic Clear and logical order Strong introductory paragraph, supporting paragraphs and concluding paragraph Sophisticated transition within and between sentences, ideas and paragraphs 	<p>Exemplary Development</p> <ul style="list-style-type: none"> Sophisticated development of the topic for narrative and descriptive writing Sophisticated thesis statement and development of informative and persuasive writing Well executed progression of ideas Excellent response to prompt Strong use of examples, evidence or relevant details Strong use of analogies, illustrations or anecdotes 	<p>Exemplary Sentence Structure</p> <ul style="list-style-type: none"> Sophisticated and well controlled sentences Sentence variation (simple, compound, complex, compound-complex) Variation of phrases and clauses (gerund, participial, infinitive; subordinate clauses)
5	<p>Effective Organization</p> <ul style="list-style-type: none"> Clearly stated topic Clear and logical order Introductory paragraph, supporting paragraphs and concluding paragraph Purposeful transition within and between sentences, ideas and paragraphs 	<p>Effective Development</p> <ul style="list-style-type: none"> Appropriate development of the topic for narrative and descriptive writing Appropriate thesis statement and development of informative and persuasive writing Clear progression of ideas Effective response to prompt Clear use of examples, evidence or relevant details Clear use of analogies, illustrations or anecdotes 	<p>Effective Sentence Structure</p> <ul style="list-style-type: none"> Complete and correct sentences Sentence variation (simple, compound, complex, compound-complex) Variation of phrases and clauses (gerund, participial, infinitive; subordinate clauses)
4	<p>Adequate Organization</p> <ul style="list-style-type: none"> Clearly stated topic Some evidence of a logical order Introductory paragraph, supporting paragraphs and concluding paragraph Appropriate transition within and between sentences, ideas and paragraphs 	<p>Adequate Development</p> <ul style="list-style-type: none"> Sufficient development of the topic for narrative and descriptive writing Sufficient thesis statement and development of informative and persuasive writing Progression of ideas Adequate response to prompt Sufficient use of examples, evidence or relevant details Use of analogies, illustrations or anecdotes 	<p>Adequate Sentence Structure</p> <ul style="list-style-type: none"> Complete and correct sentences Some sentence variation (simple, compound, complex, compound-complex) (errors in more complex sentences do not detract) Variation of phrases and clauses (gerund, participial, infinitive; subordinate clauses)
3	<p>Limited Organization</p> <ul style="list-style-type: none"> Poorly stated topic Limited evidence of a logical order Introductory paragraph and concluding paragraph with limited supporting paragraphs Repetitive use of transition 	<p>Limited Development</p> <ul style="list-style-type: none"> Limited development of the topic for narrative and descriptive writing Limited thesis statement development of informative and persuasive writing Limited progression of ideas Limited use of examples, evidence or relevant details Limited response to prompt Limited use of analogies, illustrations or anecdotes 	<p>Limited Sentence Structure</p> <ul style="list-style-type: none"> Minor errors in sentence structure Limited sentence variation (simple, compound, complex, compound-complex) (errors in more complex sentence structure begin to detract) Limited use of phrases and clauses (gerund, participial, infinitive; subordinate clauses)

Appendix E (continued)

Writing Evaluation Rubric

2	<p>Minimal Organization/Minimal Response</p> <ul style="list-style-type: none"> • Lack of acceptable topic • Lacks evidence of a logical order • Lacks introductory paragraph, supporting paragraphs and/or concluding paragraph • Ineffective or overused transition 	<p>Minimal Development/Minimal Response</p> <ul style="list-style-type: none"> • Minimal development of the topic for narrative and descriptive writing • Minimal thesis statement and development of informative and persuasive writing • Lacks a logical progression of ideas • Minimal use of examples, evidence or relevant details • Minimal response to prompt • Minimal use of analogies, illustrations or anecdotes 	<p>Minimal Sentence Structure/Minimal Response</p> <ul style="list-style-type: none"> • Contains fragments and/or run-ons • Minimal sentence variation (simple, compound, complex, compound-complex) (errors in sentence structure detract) • Minimal use of phrases and clauses (gerund, participial, infinitive; subordinate clauses)
1	<p>Inadequate Organization</p> <ul style="list-style-type: none"> • Lacks stated topic • No logical pattern; difficult to follow • Inadequate paragraphing • Little or no transition 	<p>Inadequate Development</p> <ul style="list-style-type: none"> • Little or no development of the topic for narrative and descriptive writing • Unclear thesis statement and development for informative and persuasive writing • Unclear or no focus • Few or no examples, evidence or relevant details • Inadequate or no response to prompt • Little use of analogies, illustrations or anecdotes 	<p>Inadequate Sentence Structure</p> <ul style="list-style-type: none"> • Contains numerous fragments and/or run-ons • Little or no sentence variation (simple, compound, complex, compound-complex) (errors in sentence structure detract) • Little or no use of phrases and clauses (gerund, participial, infinitive; subordinate clauses)

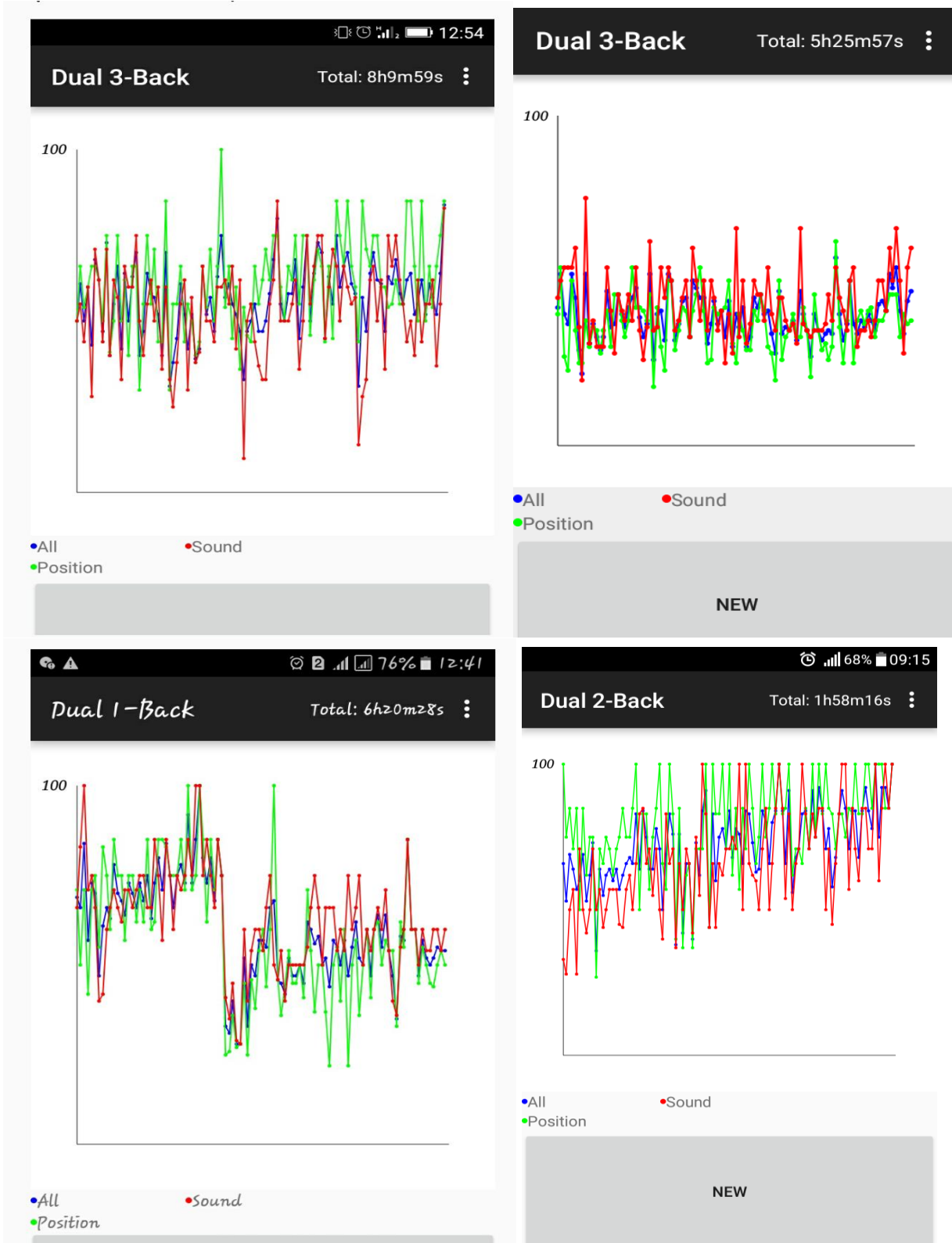
Appendix E (continued)

Writing Evaluation Rubric

	WORD CHOICE/GRAMMAR USAGE	MECHANICS
6	<p align="center">Exemplary Word Choice/Grammar Usage</p> <ul style="list-style-type: none"> • Vivid, precise/concise/ strong vocabulary • Consistent grammar usage <ul style="list-style-type: none"> ➤ Subject/verb agreement, Singular/plural nouns ➤ Verb (tense and usage), Pronoun usage ➤ Adjective/Adverb 	<p align="center">Exemplary Mechanics</p> <ul style="list-style-type: none"> • May have minor errors <ul style="list-style-type: none"> ➤ Punctuation ➤ Capitalization, Spelling ➤ Indentation • Needs little or no editing
5	<p align="center">Effective Word Choice/Grammar Usage</p> <ul style="list-style-type: none"> • Appropriate, precise/concise, clear meaning/ vocabulary • Mostly consistent grammar usage <ul style="list-style-type: none"> ➤ Subject/verb agreement ➤ Singular/plural nouns ➤ Verb (tense and usage) ➤ Pronoun usage ➤ Adjective/Adverb 	<p align="center">Effective Mechanics</p> <ul style="list-style-type: none"> • Few errors <ul style="list-style-type: none"> ➤ Punctuation ➤ Capitalization ➤ Spelling ➤ Indentation • Needs some editing
4	<p align="center">Adequate Word Choice/Grammar Usage</p> <ul style="list-style-type: none"> • Appropriate, specific meaning/ vocabulary • Somewhat consistent grammar usage <ul style="list-style-type: none"> ➤ Subject/verb agreement ➤ Singular/plural nouns ➤ Verb (tense and usage) ➤ Pronoun usage ➤ Adjective/Adverb 	<p align="center">Adequate Mechanics</p> <ul style="list-style-type: none"> • Some errors <ul style="list-style-type: none"> ➤ Punctuation ➤ Capitalization ➤ Spelling ➤ Indentation • Needs editing but doesn't impede readability
3	<p align="center">Limited Word Choice/Grammar Usage</p> <ul style="list-style-type: none"> • Vague, redundant, simplistic meaning/vocabular • Several inconsistencies in grammar usage <ul style="list-style-type: none"> ➤ Subject/verb agreement ➤ Singular/plural nouns ➤ Verb (tense and usage), Pronoun usage ➤ Adjective/Adverb 	<p align="center">Limited Mechanics</p> <ul style="list-style-type: none"> • Frequent errors <ul style="list-style-type: none"> ➤ Punctuation ➤ Capitalization ➤ Spelling ➤ Indentation • Begins to impede readability
2	<p align="center">Minimal Word Choice/Grammar Usage/Minimal Response</p> <ul style="list-style-type: none"> • Inadequate, imprecise, repetitive • Frequent inconsistencies grammar usage <ul style="list-style-type: none"> ➤ Subject/verb agreement ➤ Singular/plural nouns ➤ Verb (tense and usage) ➤ Pronoun usage ➤ Adjective/Adverb 	<p align="center">Minimal Mechanics/</p> <p align="center">Minimal Response</p> <ul style="list-style-type: none"> • Consistent errors <ul style="list-style-type: none"> ➤ Punctuation ➤ Capitalization, Spelling ➤ Indentation • Impedes readability
1	<p align="center">Inadequate Word Choice/ Grammar Usage</p> <ul style="list-style-type: none"> • Rambling, inappropriate, incorrect, unclear meaning/vocabulary • Distracting inconsistencies grammar usage <ul style="list-style-type: none"> ➤ Subject/verb agreement ➤ Singular/plural nouns ➤ Verb (tense and usage) ➤ Pronoun usage ➤ Adjective/Adverb 	<p align="center">Inadequate Mechanics</p> <ul style="list-style-type: none"> • Serious and consistent errors <ul style="list-style-type: none"> ➤ Punctuation ➤ Capitalization, Spelling ➤ Indentation • Impedes understanding/communication

Appendix F

Sample Dual N-back Scores from Participants



Appendix G

Sample Dual N-back score grids filled in by students

Day 6	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Level	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total	57	64	66	57	53	60	50	60	85	66	56	67	55	60	78	60	42	100	28	76	61	60	71	53
Position	57	67	67	57	52	62	57	50	66	71	52	60	60	75	71	50	52	100	33	100	51	42	57	53
Sound	57	71	35	57	55	75	44	85	100	62	55	71	44	85	85	71	71	100	75	57	85	75	85	80

Day 7	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	
Level	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Total	60	64	76	84	66	84	64	84	64	67	87	52	60	84	57	64	71	64	66	50	76	80	50	62	2
Position	50	57	71	87	66	87	66	71	42	50	83	57	75	33	62	57	57	42	71	37	66	85	71	85	62
Sound	44	71	85	85	66	85	62	100	85	35	85	50	42	85	50	83	85	85	85	66	85	75	62	50	80

Day 8	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Level	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total	78	94	56	50	58	78	64	60	62	66	76	62	64	71	71	64	57	24	50	78	25	83	62	100
Position	85	71	62	31	57	25	57	57	57	66	71	75	57	52	71	66	57	100	57	85	85	83	71	100
Sound	71	100	50	42	60	71	71	62	66	66	75	47	71	95	85	55	57	71	55	71	85	28	66	100

Day 9	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Level	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total	69	71	75	73	58	62	80	84	84	62	66	40	30	50	64	50	57	60	85	71	68	55	82	60
Position	50	85	85	71	52	57	85	71	71	75	85	85	35	62	57	50	71	60	100	57	85	85	82	60
Sound	85	57	66	75	60	64	75	100	100	62	75	75	75	35	71	50	37	71	25	85	62	45	100	57

Day 10	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Level	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total	84	78	80	71	70	50	60	71	83	71	62	60	68	68	58	70	71	47	91	2	58	82	80	83
Position	100	71	66	71	83	44	42	71	60	62	62	45	85	60	75	60	62	50	83	50	50	85	83	83
Sound	71	85	100	71	71	55	75	100	100	83	62	50	55	71	44	85	33	71	25	71	85	75	83	83

Day 6	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Level	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total	13	83	40	34	38	50	35	41	53	62	58	50	42	58	61	66	28	26	20	18	69	18	10	26
Position	13	100	36	37	33	16	14	16	14	33	16	16	16	28	33	33	11	14	85	66	0	22	33	
Sound	09	66	44	50	42	83	57	66	100	85	100	83	62	100	100	100	25	42	25	40	71	25	38	20

Day 7	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	
Level	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Total	27	33	60	41	26	57	73	81	44	33	14	14	23	28	42	43	13	40	21	0	33	50	24	16	
Position	16	29	57	30	44	57	62	100	44	14	14	12	28	29	57	50	57	57	33	14	14	85	66	0	22
Sound	33	37	62	36	10	57	85	71	36	50	16	16	16	28	28	37	50	25	12	0	50	47	17	25	

Day 8	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Level	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total	17	65	28	19	50	40	57	66	21	67	25	21	26	26	26	31	13	34	73	41	29	09	61	
Position	17	36	32	5	21	15	15	06	15	06	16	20	25	06	21	22	33	14	37	02	30	33	06	08
Sound	98	100	20	12	03	61	93	42	83	33	80	29	25	33	33	03	12	100	50	85	36	25	71	100

Day 9	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Level	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total	80	78	43	13	7	23	46	41	50	7	21	10	39	36	40	13	69	12	30	43	73	00	68	19
Position	66	93	37	12	16	14	33	66	50	16	10	16	32	13	15	16	69	13	11	43	02	13	55	5
Sound	100	75	55	14	0	39	15	16	50	0	33	83	41	58	06	15	20	10	13	30	75	100	83	11

Day 10	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Level	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total	33	20	80	14	12	31	12	13	60	13	25	18	23	60	18	71	18	73	28	23	41	58	40	
Position	23	40	57	30	12	10	25	14	30	25	37	28	33	47	75	0	100	19	66	44	25	85	06	57
Sound	5	14	50	49	11	12	40	42	99	0	22	25	0	42	33	50	25	83	14	25	42	50	15	

Appendix H

Pre-test and Post-test Writing Prompts

For both the pre-test and post-test, students were provided 90 minutes.

- **Pre-test writing prompt :**

Instead of a written prompt, students were provided with an audio track that served as the context for their writing prompt. The audio track was about a young man named Oscar who was handicapped, but despite being handicapped he defied all odds and became a professional athlete. They were asked to listen to the audio track as often as they wanted in the allotted time and answer the following prompt:

Prompt : Listen to the audio track as and respond to the following question : How do you think Oscar Pistarrios become such a successful athlete despite his disability ?

- **Post-test writing prompt :**

Because it was a formal exam, students were provided two different prompts to choose from. They were expected to elaborate, explain, support, and/or justify the statement they selected. Below are the two statements :

Prompt 1 : The best things in life are certainly not free.

Prompt 2 : The job of a primary school teacher is hard.

Appendix I

Sample of Students' Pre-test Essays

* Life is full of challenges and we all have to go through it but some of us believe that they are not good enough. We ^{since} choose to fight. People don't realize what they have and what they are missing until they lose it, take for example Oscar, a world champion that broke the world record in running without even having real legs. What's his secret?

God created humans in a perfect form, he gave us arms, legs, eyes but the most important thing is he gave us a mind. Oscar is without legs since he was one but that didn't make him less perfect. He used his mind ability and challenged himself to be the best version of himself despite it all. So believing in your self is the first step.

Second, one of the things that prevent us from acting is the fear of failure for that we don't dream. It does not matter how many times you fall it is about getting up and working hard even if you're competing with metal legs against real powerful legs you have to work for it even if it seemed impossible.

Third, Do not look back and keep working. Because some people care so much about people's opinion that they start doubting themselves and that is stupid. You have to be your own motivation even if the world disagreed with you saying that you can't do it do not lose hope. Be like

Sample of Students' Pre-test Essays (continued)

oscar when he asked for success he worked his way to it with his heart. Because there is nothing like the feeling you get when you succeed and like this champion did he dreamed big and did not care what people may think of him or gave them the chance to underestimate him.

Finally, being successful takes hard work and believing in yourself and never looking back and oscar is a ~~big~~ real life example that should look up to him because he believed that he is not going to fail because of ~~his~~ disability and like he said "you are not disabled by your disability you are able by the abilities that you have."

Sample of Students' Pre-test Essays (continued)

* Oscar Pistorious, the fastest man with no legs, is a well known athlete in the Olympic field. He gave the impossible to get such success. Oscar the blunder run and won despite his handicap because of three major words in his career.

First of all, the dream has not always the sense of not realise it, but the blunder, Oscar, had it as a basic important word to begin with his sport's journey, when he was at the age of 11 years old.

Second, Oscar continued running on the field after his dream with his artificial legs that had never hold him keeping on the path. He was such a courageous, fearless man and fought every difficulty that faced him; like, the refusal of the International Federal of Olympic sports to his participation demand. They said because of the artificial legs, he would make an unfair competition with normal athletes, he would never be tired.

Third, the man who thought to be unable broke the "No" with several attempts after few years, and had been accepted at the Olympic qualifications, also won the 1000, 2000, 4000 metre events.

In conclusion, even the unable people have the ability and power to rise among normal ones and challenge the impossible by following Oscar's words "dream, will, courage".

Sample of Students' Pre-test Essays (continued)

"the will makes wonders". Having a disability doesn't mean giving up your dreams, in contrast, you should challenge ourselves and overcome them with our abilities. Oscar Pistorius, (fastest man with no legs) is a perfect example and can be a role model for many others.

Oscar had no legs, but with his passion and desire he was able to run and win competitions. He wrote his name on the history of athletics, all this with his disability, then imagine what we can do with our disabilities!

"Ability" is also a great example of trying and determination although his request for participating in the Olympics was refused he kept trying until he got the acceptance and he won also, so if you failed, never give up and keep trying and dreaming until you reach your goal.

Strong personality is the key of success, Oscar would not achieve all this if he had a weak personality. If you want something work hard until you get it and fight for it.

As a conclusion, never let your disability stand in the way of your dreams, you are able with your abilities.

Appendix J

Sample of Students' Post-test Essays

Looking for a job is a difficult challenge for any jobless person, and when it comes to teaching domain people start wondering if they are ready to jump into a great responsibility, especially to the job of primary school teachers. This job which is found as the most hardest and most challenging for many reasons.

Teachers of primary school have a hard time in delivering the lessons or informations because students minds are still in the process of growing and developing for example: a high school student is more likely to comprehend the explanation of the teacher from the first time unlike the student of primary school who is has less chances in expecting the information. That's why teachers must be patient and more careful in their way of delivering the lesson which make it hard for first teacherly because it must be more than one way of explanation.

Students of primary school doesn't have the sense of independent so they depend on their whole informations on the teacher who is have to be positive and completely sure about the ideas that he delivers, for instance: if a primary school teacher accidentally tell his student a false information, the student will not trust even his parents when they tell him the opposite, that's why the teacher have to be careful about this kind of mistakes so the student does not lose his trust in the educational level of the teacher.

The treatment of a primary school student is very important because it is why the teacher have to be super careful in both action and speech so that are help to students being an example of a teacher who treat some student in a special way then others. This action of him will make a huge spot dark point on other the other student, it will make them less confident and insecure about them selves which will effect on them their whole life. Therefore must be fair and equal between all students.

In concluding The job of primary school teachers is hard and difficult because of three main reasons: must be capable of delivering informations and repeat it until the students understand. Second must be sure of every information have been delivered and finally the ability of treat being an equalizer when it comes to good treatment.

Sample of Students' Post-test Essays (continued)

out side world. For example, when one of them is exposed to enjoying all time, also have issues in his house, when ever he/she go to school the teacher will suffer for their extrovert behaviours so, Per they will try the best to let him or her contact with others and participate in room fun activities.

Other important, primol thing that teachers have to do some out-teaching work, especially, for the youngest primary school student they will be like their parents and help them to go to the bath room, for example, also make them go to sleep, solve fightings bet we them. Moreover, prepare presents and gifts to encourage them study.

In conclusion, the job of primary school teacher is indeed hard to face every day a complete out wear thinking and trying to solve problems and get enter to children's psychology. In fact, they are not only teachers but acting multi roles, clearly, as parents will their own.

What is supposed among people's imaginations, that the job of a primary school teacher is easy because of the contact with younger children that can be controlled, but in fact, it is the opposite, primary school teaching is more difficult to deal with due to medical, social reasons plus the way of how school teacher behave.

According to psychologists, children of the primary school have a more-mature thinking and mind with wisest thoughts which requires a soft hand known how to convince them doing that thing, and not doing that one. The teacher here is building the foundation with his/her good words also strategies.

Going to social reasons which involve the student's atmosphere of home, i.e., children, as known, are messers of

Samples of Students' Post-test Essays (continued)

The world's economy is in a hard situation. People all over the world are suffering from a lot of problems, this is why living a normal and average life is getting harder by the time. Life has been changing and keeps changing, everything differs through the time. So saying that happiness has no price now is totally wrong and illogic. Actually the best things in life which make you happy are for sure not free. The best things in life are difficult to own because they need a huge amount of money from luxuries, necessities and even taking a rest and enjoying themselves. enja

Luxuries are the favourite things, especially for women, they believe that having a lot of precious accessories is so important for instance a 2010 study shows that the most of the women who said that they are not

Happy have less luxuries than the ones who admitted their happiness, who are rich, also the prices of the gold and silver is so high comparing to other thing, besides, the diamond is the most expensive luxury in the world.

Necessities now are so expensive comparing to the past for exemple having a house and a car needs to providing more than 300 million in Algeria. However raising a family and having children is more difficult because the schools found are high. Moreover, the food is also expensive a normal meal in a restaurant in France is costs 20€ and the groceries cost more than 7€ for a things such as a banana, rice, etc.

Enjoying yourself to reduce the level of stress needs a fortune for instance having a vacation in some exotic country is so hard and not everyone has it. Next the hotels are expensive as well for exemple, a 3 stars hotel in Turkey costs 80€ for the night, besides entertainment tools such as x-box or even a TV need more than 3 million in Algeria and Disney land is not a place made for poor people.

Good life style in these days is way more different than before all the good things need cash and not everyone has it. It is difficult to have a well payed job so it is difficult to have the best things in life.

and a full account in the bank

