ARE BILINGUALS LESS PRONE TO FALSE MEMORIES IN THEIR SECOND LANGUAGE?

MERVE SITKI

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ARE BILINGUALS LESS PRONE TO FALSE MEMORIES IN THEIR SECOND LANGUAGE?

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MERVE SITKI

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ABSTRACT

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Sıtkı, Merve

M.A., Cognitive Neuropsychology

Supervisor: Assoc. Prof. Simay İkier

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The present study examined whether bilinguals are more prone to memory errors in their first language (L1) or in their second language (L2). In the Deese-Roediger-McDermott (DRM) paradigm (Deese, 1959; Roediger & MCDermott, 1995), false memories for the critical non-studied words are observed due to studying a list of semantically related words that are all related to the critical non-studied word. According to the Revised Hierarchical Model (Kroll & Steward, 1994), in bilinguals, the link between L1 lexicon and the semantic system is stronger than the link between L2 lexicon and the semantic system. Since false memory formation in the DRM paradigm relies on the semantic relatedness of the words, we hypothesized

higher false memory in L1 than in L2. Turkish and English bilinguals studied Turkish and English word lists with prior norms of approximately similar rates of generating false recognition for the critical non-studied words. At the recognition phase, some of the studied items, the critical non-studied items and the new items were presented and the participants were asked to identify all studied items. Results showed higher false recognition for the critical non-studied items and higher false alarms for the new items in L1 than in L2. Correct recognition was higher in L2 than in L1. Response time measures showed that L2 processing was faster than L1 processing. The results were discussed related to the predictions of bilingualism theories.

Keywords: Bilingualism, false memory, DRM paradigm, recognition memory

ÖZ

İKİDİLLİ BİREYLER BELLEK HATALARINA İKİNCİ DİLDE DAHA AZ MI AÇIKTIR?

Sıtkı, Merve

Yüksek Lisans, Bilişsel Nöropsikoloji

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Bu çalışma, ikidilli bireylerin birinci dillerinde (D1) mi yoksa ikinci dillerinde (D2) mi bellek hatalarına daha yatkın olduğu incelenmiştir. Deese-Roediger-McDermott (DRM) paradigmasında (Deese, 1959; Roediger & MCDermott, 1995) katılımcılara birbiriyle anlamsal bağı olan sözcüklerden oluşan listeler sunulur ve listede olmayan, ancak listedeki tüm sözcükler ile anlamsal bağı olan kritik sözcüğün listedeymiş gibi hatırlandığı bellek hataları gözlemlenir. Revize Hiyerarşik Model'e (Revised Hierarchical Model; RHM) göre (Kroll & Steward, 1994), ikidillilerde, D1 sözlükçesi (lexicon) ile anlamsal sistem arasındaki bağlantı, D2 sözlükçesi ve anlamsal sistem arasındaki bağlantıdan daha güçlüdür. DRM

paradigmasında bellek hatalarının temeli, sözcükler arasındaki anlamsal ilişkiye dayandığından, D1'de D2'den daha fazla bellek hatası beklenmiştir. Türkçe ve İngilizce konuşan ikidilli katılımcılar, kritik sözcükler için yanlış tanıma oranlarının geçmiş norm çalışmalarında yaklaşık olarak aynı olduğu Türkçe ve İngilizce sözcük listelerini çalışmışlardır. Tanıma testi aşamasında bazı çalışılmış sözcükler, çalışılmamış olan kritik sözcükler ve çalışılmamış olan yeni sözcükler katılımcılara sunulmuş ve katılımcılardan çalışılmış olan tüm sözcükleri belirtmeleri istenmiştir. Sonuçlar, çalışılmamış olan kritik sözcükler için D1'de D2'ye göre daha fazla bellek hatası ve yeni sözcükler için D1'de D2'ye göre daha fazla yanlış alarm olduğunu göstermiştir. Doğru tanıma D2'de D1'den daha yüksektir. Yanıt verme süresi ölçümleri, D2'deki işlemenin D1'deki işlemeden daha hızlı olduğunu göstermiştir. Sonuçlar ikidillilik kuramlarının öngörüleri çerçevesinde tartışılmıştır.

Anahtar kelimeler: İkidillilik, bellek hataları, DRM paradigması, tanıma belleği

To my dear mum and dad

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CHAPTER 1

INTRODUCTION

1.1. Overview of the Current Study

In today's world, individuals extensively need more than one language in daily life, whether it is for the basis of work, education or travel purposes. Learning a second language is becoming a necessity and out of this need, more people are becoming fluent at speaking at least two languages (Keysar, Hayakawa, & An, 2012; Marian & Shook, 2012). With the increasing number of people becoming bilinguals, the effects of learning a second language on memory and decision making are becoming prevalent. Bilinguals receive and process information in their native language (L1) and their second language (L2) and the switch in between languages can have an impact in accurate recall of information (Marmolejo, Diliberto-Macaluso, & Altarriba, 2009).

In the present study, the main aim was to investigate the effects of retrieving information in L1 versus L2, on false memory formation. The framework is set by the language theories and the DRM paradigm is used in the examination of false memory. The study also aims to understand the strength of the semantic networks in L1 and L2 and to expand our knowledge in false memory in bilinguals. Besides these main aims, this study also potentially expands our knowledge on whether individuals will be less prone to making false memory errors in L2 and whether this can be reflective of the biases in decision making.

1.2. False Memory

False memory is defined as the distorted recollection of events (Reyna, Corbin, Weldon & Brainerd, 2016). The episodic memory allows the retention of the specific past events and experiences. False memories are often revealed in episodic recollections, in which the individual voluntarily retrieves memories and is aware of the act of retrieval. False memories can be revealed in various instances and even the retrieval of real-life events of the individuals can be false, meaning that the memories have never occurred or experienced by the individual (Loftus, 1997; Reyna et al., 2016). The difference of the false memory from the actual memories is that the recollection of the past event is false and fabricated and it is filled with the imaginary memory distortions (Loftus, 1997). Other instances include retrieving information which has not been presented, as if it has been. This type of error is referred to as an intrusion error (Loftus, 1997).

The mechanism underlying the retrieval of real versus false memories can be explained by the Fuzzy Trace Theory, which also sets the framework for the development of various false memory paradigms (Reyna et al., 2016). According to the Fuzzy Trace Theory the retention of information occurs in two ways: verbatim traces and gist. The accurate, factual representation of memory is referred to as the verbatim traces and the general idea of the information is referred to as the gist traces (Reyna, 2012). Individuals are capable of processing information in both verbatim and gist traces but, there is a tendency to encode the information as gist, instead of verbatim (Reyna et al., 2016).

The Fuzzy Trace Theory assumes that the verbatim and the gist memories function independently; encoding, maintenance, retrieval and the forgetting take place separately for gist and verbatim memories (Reyna, 2012). To elaborate further, verbatim memory is the representation of the true recall of the exact pictures and the words whereas, the gist memory relies on the meaning of the information, irrespective of the actual recall of the picture or the words (Reyna, 2012). When a task demands the processing of the information to match the exact representation, verbatim traces are used and the distracter information that shares similar meaning is rejected. Whereas, when the task requires the retrieval of the meaning of the information, there is reliance on both the verbatim representations and meaning-consistent gist representations (Reyna, 2012).

The Fuzzy Trace Theory claims that the false memories rely on gist representations of the past event, whereas the verbatim traces use vivid experiences to describe the past event. The reliance on the gist representations allows the

verbatim trace of the memory to be less accessible than the gist traces (Reyna et al., 2016). Additionally, the verbatim traces are more prone to forgetting and the interference effects (Reyna et al., 2016). The interference effects include source confusion of the verbatim memory and false memory formation by suggestibility. According to Loftus (1997), false memories can be planted by the means of external suggestion, as practiced by the police investigations, psychotherapists and family members. When a past memory is revisited, with the inclusion of a different approach from an external suggestion, a false recall can be implemented. In the cases of a therapist visit or legal investigations, it is very likely to implement false events, especially because, there is an openness to suggestibility (Loftus, 1997).

The construction of false memories is done by the combination of actual memories with external suggestions (Loftus, 1997). In this process the source of the event is forgotten, enabling the loss of the source of the information- this phenomenon is called source confusion (Loftus, 1997). Source monitoring errors cause false recollection of events. Additionally, the imagination of possible past event scenarios also increases the likelihood of creating a false memory. Loftus (1997) called this phenomenon the imagination inflation, which induces the false event as a familiar memory instead of the part of the imagination. Even though the memory is false, there is a belief of certainty and validity in the recollection of the event (Loftus, 1997). In false memory, the recollection is based on impulses and is highly affected by outside suggestions and it is influenced by emotionally generated fantasies (Mendez & Fras, 2011). False memories are not just missing recollections in the memory but, they are misleading (Reyna et al., 2016).

1.3. The Deese-Roediger-McDermott Paradigm

The emergence of the widely accepted false memory task of Deese-Roediger-McDermott (DRM) paradigm enabled the evaluation of the distortions of the memory (Deese, 1959; Roediger & McDermott, 1995). The DRM paradigm demonstrates the fabrications in the memory and permits the task items to contribute to the formation of false memory in a laboratory setting (Mendez & Fras, 2011; Pardilla-Delgado & Payne 2017).

The DRM paradigm tests how the word associations affect memory recall (Roediger, Balota & Watson, 2001). Deese's interest was towards understanding the veridical and false recall as a factor of the semantic associations (Roediger et al., 2001). In semantic relations, the processing depends on the relational strength of the words. To further explain, semantic knowledge is the general facts and information about the world (Tulving, 1972). The thought processes are formed by the associations made by the semantic concepts. In the case of the DRM paradigm, the false memory is based on the semantic relations, which puts the attention on the semantic associations (Storbeck & Clore, 2011). True recollection of the events, also called the verbatim processing, depends on the decreased activation of the semantic associations (Storbeck & Clore, 2011).

The DRM task has three phases which firstly enables the learning of a list of words, called the encoding phase. The encoding phase is composed of the words semantically related to each other. For example items such as bed, rest, awake, tired, dream, wake and snooze; which are all related to the word sleep, which is not part of the list. According to Pardilla-Delgado and Payne (2017), in the encoding phase, the

illusion of the DRM phenomenon occurs because of the semantic network activation in the brain. The semantic network is the associations of the word knowledge base, in which the introduction of a concept activates the related ideas (Roediger, Balota & Watson, 2001). Each and every learned concept is tied to a related network of semantic analogy. For example, the presentation of the word doctor would increase the recall of the word nurse because of its related associative-semantic network (Roediger, Balota & Watson, 2001). Activation of one concept can activate the related concepts associated to it and the incorrect activation of a concept can trigger false recall (Otgaar et al., 2018). In the DRM task, the false memory for the item that is related to all the other presented items is an implicit associative response (Otgaar et al., 2018; Roediger, Balota & Watson, 2001).

According to Roediger and McDermott (1995), there are two factors that strengthen the semantic associations: backwards associative strength (BAS) and forward associative strength (FAS) and both influence false memory construction. BAS is the association of the studied list items to the unstudied critical lure, whereas, FAS is the association of unstudied item (critical lure) with the studied list words. False memory occurs in conditions of high BAS, when the association of the studied words and the unstudied words are high (Beato & Arndt, 2017). In this case, the source of the critical lure information is missing and the source monitoring of the information fails. In the Roediger and McDermott (1995) study, the subjects claimed to have recollections of having heard the critical lure in the DRM list, which posits that the semantic activation of the words occurred either consciously-in the encoding

phase- or unconsciously by the spreading of the activation, thus, forming the associative link between the studied list words and the unstudied critical lure.

Evidently, The Fuzzy Trace Theory indicates that the semantic similarity between the list words and the critical lure (for example in the case of BAS and FAS), will explain the extent to which the gist or the verbatim retrieval will be utilized (Arndt, 2012; Roediger et al., 2001). The higher the association between the list words and the critical lure, the more enhanced the use of the gist traces and the more diminished the use of verbatim retrieval are (Roediger et al., 2001). Additionally, the memory error in remembering the lure item occurs because of its similar semantic associations with the studied list words (Arndt, 2012). Thus, during the encoding phase, the event individuals experience produces a memory trace and in the latter retrieval processes, the semantic activation determines the similarity of the items (Arndt, 2012).

In the DRM paradigm, after the encoding phase, either a recall or a recognition test is conducted to test the false memory effect (Pardilla-Delgado & Payne, 2017). In the recall test the participant is asked about what is remembered from the list of words, whereas in the recognition test, the participant is given a mixed list of target words, some new words and the critical lure, and is asked whether each item is a studied old word or a new one that has not been presented at the encoding phase (Pardilla-Delgado & Payne, 2017). In the false memory effect, the memory relies on the gist of the semantic information, leading the participant to generate or choose the critical lure as a target item (Pardilla-Delgado & Payne,

2017). The DRM paradigm demonstrates that memory can be reconstructive and adaptive.

In the Roediger and McDermott (1995) study, the adaptation of Deese's false memory task is implemented. In this study, the auditory presentation of the 15 words that share the strongest associations with the missing word or the critical lure is given to the participants. Immediately after the presentation of the study-list, the free recall task is implemented. After the recall task, the recognition test is given covering all the lists. According to Roediger and colleagues (2001), the recognition of the critical lure is comparably higher than the studied list recognition.

In a recent study, it was found that an increase in the semantically similar words in the lists can amplify false memory recall (Pardilla-Delgado & Payne, 2017). The two experiments conducted with the inclusion of the recall and recognition tasks produced the false memory effect, resulting in the retrieval of the critical lures. In Pardilla-Delgado and Payne's (2017) study, by manipulating the factors that can affect memory consolidation, such as stress and sleep, and adding the delay phases between the encoding the recall task, the persistence of the false memory over veridical memory is demonstrated. Presenting the recognition task immediately after the recall task increased recognition (Pardilla-Delgado & Payne, 2017). If a longer delay was presented, the results of recognition test may have varied and could have led to an increase in false recall.

Stadler, Roediger and McDermott (1999) conducted a study with no delay between the encoding, recall and the recognition tasks and the participants were warned about the critical lures. The participants recalled the words that were not on

the lists more often than the words that were on the list. Through the establishment of the DRM word norms, the critical words chosen imply the highest false recall and recognition effect. The modality effect should also be considered in the presentation of the DRM task because, the performance of the participant depends on the presentation of the studied and unstudied word lists. Both of the studies (Pardilla-Delgado & Payne, 2017; Stadler, Roediger & McDermott, 1999) used auditory presentation of the words. The auditory presentation was found to increase the false memory effect, whereas the visual presentation of information decreased it (Pierce, Gallo, Weiss & Schacter, 2005). The visual presentation promotes item-specific processing, so the participants can discriminate between the studied words and the related lure words. Additionally, the visual presentation of the words enhances source monitoring and leads to better recollection than the auditory presentation (Pierce et al., 2005).

1.4. Memory Systems in Bilinguals

To understand the application of the false memory paradigm in bilinguals, the memory systems need further elaboration. A prominent model of the bilingual memory system is the Revised Hierarchical Model (RHM) developed by the Kroll and Steward (1994). The RHM explains the asymmetries between the lexical connections of L1 to L2 (Kroll, van Hell, Tokowicz, & Green, 2010). The RHM made a few assumptions about the L1 and the L2 processes of memory. Firstly, the conceptual representations are shared between L1 and L2. Secondly, lexical representations are specific to each language. Thus, there are two distinct lexicons,

for L1 and for L2, which are connected to a unitary semantic system. Lastly, the connection between L1 and L2 is asymmetric.

The asymmetry hypothesis in RHM states that the link between L1 lexicon and the semantic system is stronger than the L2 lexicon and the semantic system (Duyck & Brysbaert, 2004; Kroll & Steward, 1994). This is because, the word meanings are more strongly activated by L1 than by L2. In contrast, the lexical connection from L2 to L1 is much stronger than the one from L1 to L2. Since L2 words are learned through the association of the L1 translation, the lexical level is stronger in L2. Due to the asymmetries in L1 and L2 connections, forward translation enables conceptual activation, whereas backward translation relies on the lexical connections (Duyck & Brysbaert, 2004).

The asymmetries in the lexical connections result in higher latency in forward translation (from L1 to L2) and, it also increases the speed of the backward translation in bilinguals (Basnight-Brown, 2014). The L1 has the priority access to the meaning of the semantic concepts that an individual learns early in life, whereas, the L2 is mediated by interacting with the L1 translation (Kroll, van Hell, Tokowicz, & Green, 2010). The native language of the bilingual has greater vocabulary storage, so it is assumed that the L1 has a larger lexicon than the L2 lexicon (Basnight-Brown, 2014). The strongest connection between the encoding of the language develops in the L1 and the acquisition of the L2 occurs later on in life. As the L2 develops, the vocabulary is integrated into the memory of the first language's lexicon (Basnight-Brown, 2014). The concepts integrated into the memory have a weaker link with the L2 but, with the increase in language proficiency, the strength of the

connections between the semantic concepts becomes stronger. Therefore, proficiency in L2 reduces the asymmetries between languages.

Additionally, the modified version of the RHM emphasizes the importance of the strength of the connection between L1 and L2, instead of viewing them as one being faster than the other (Duyck & Brysbaert, 2004). The strength of connection in lexical nodes is stronger from L2 to L1, and in semantic nodes the strength of connection is stronger from L1 to L2 (Brysbaert & Duyck, 2010). The activation of the nodes depends on the strength of the connection between the languages. According to Duyck and Brysbaert (2004), language should not be viewed as an all-or-none activation of the semantic and lexical processes but, rather the build-up of activation from both the lexical and semantic pathways should be considered. In L2 activation, the mapping of the words and their meanings are more important than the interconnection between the mapping of the L2 words and the L1 equivalents (Duyck & Brysbaert, 2004).

The difference between L1 and L2 is due to the asymmetry in language proficiency. Accordingly, the level of proficiency in a language is the determining factor in information processing. For example, lower proficiency in L2 was associated with faster reaction time in L1 in text-level comprehension (Perez, Hansen & Bajo, 2018). Higher language proficiency in L1 is related to faster comprehension in L1 than in L2 (Perez, Hansen & Bajo, 2018). Therefore, the strength of the connection between L1 and the L2 is mediated by the language proficiency. The RHM theory postulates that as the bilingual becomes more fluent in L2, there will be less need to check the translations of the meanings from L1 and a direct connection

with the L2 to the concepts can be established (Basnight-Brown, 2014). Therefore, the strength of the connection in lexical nodes can be stronger from L2 to L1 and the strength of the semantic nodes connection can be stronger from L1 to L2 (Brysbaert & Duyck, 2010).

Another dominant theory of bilingualism is the Bilingual Interactive Activation (BIA) model, which proposes that the selection of the language is a top-down phenomenon, enabling the processes of inhibition and selection over the language processes (Dijkstra & Van Heuven, 2002; Grainger, Midgley, & Holcomb, 2010). The top-down system utilizes the executive functions, activating the inhibitory processes. The chosen language of either L1 or L2 processes can be enhanced or inhibited, therefore, while speaking in L1, there will not be interference from the L2.

Djikstra and Van Heuven (2002) upgraded the BIA model; by adding new components that better describe the bilingual's language processes and named it the Bilingual Interactive Activation Plus (BIA+) model. According to Brysbaert and Duyck (2010), the BIA model lacks the capacity to fully explain the processes of the bilingual word processing. The BIA+ model is developed to include the word recognition and the task-decision system by making distinctions between the two processes (Brysbaert & Duyck, 2010). The addition of the task-decision system provides the model for the bilingual's outcome oriented language system. The ability to practice control in the language processes enables the language articulation to stay on the specific language by inhibiting the alternative (Brysbaert & Duyck, 2010).

The main argument of the BIA+ model is that the word recognition is not a controlled phenomenon- upon word recognition the associated words are activated regardless of the language (Roelofs, 2002). The processing of the language takes place in a top-down (language specific) and bottom-up (non-selective) manner (Basnight-Brown, 2014). The non-selective language activation allows both the contextually appropriate and the inappropriate written and spoken words to be active upon word recognition (Basnight-Brown, 2014). This enables the activation of both the L1 and the L2 in the bilingual's language processes (Djikstra & Van Heuven, 2002). The task-decision parameter is added to provide a controlled path for utilizing the language in selecting a specific language according to the recognized word. Additionally, the task-decision subsystem is based on the operations of the executive functions; incorporating the mechanisms of cognitive control, attention and inhibitory mechanisms. The decision system provides the threshold according to the task situation. Therefore, the control of the language can be based on the goal-reference of the individual (Roelofs, 2002).

Both theories of bilingualism indicate that there are two memory storage systems: for the L1 and the L2 (Basnight-Brown, 2014; Djikstra & Van Heuven, 2002; Dornic, 1979; Javier, 1996). This finding is indicative of the independence of the L1 and L2 language systems. The language asymmetries proposed by the RHM allows for the consideration of the bilingual proficiencies (Basnight-Brown, 2014). The fluent bilinguals can access the conceptual and the lexical connections more effectively, whereas less proficiency in L2 results in the reliance of the L2 on L1 in

information processing (Kroll & Steward, 1994). The proficiency in L2 can allow for higher cognitive control in the language processing as well.

The bilingual mind addresses the cognitive and emotional experiences distinctively in accordance to the language of encoding (Javier, 1996). To address the information processing in bilinguals, firstly the issues in perception, attention and the memory recall should be considered- as L1 and L2 have distinctive differences. The speed of the encoding and the recall is highly dependent on the language dominance (Dornic, 1979). In bilinguals, there is only one thoroughly developed language system; as respectively there is the dominant L1 and the weak L2 (Dornic, 1979). The first learned language has better automaticity with regards to the speed of information processing (Dornic, 1979). In addition, the second language relies on the inhibition-suppression mechanisms to manage the lexical activation, as proposed by the BIA+ model. As a result, to facilitate language production, the other language processes are inhibited (Green, 1986). The high cognitive load allows the slower information processing in L2 in contrast to L1, in order to increase the accuracy of the retrieval mechanisms. The assumption is that higher attention is required for L2 processing. Based on this assumption, L2 can result in increased attention to information and as a result, increased retrieval.

The literature on bilingualism and cognitive control postulates that L2 is less prone to errors than L1. A study by Moreno et al. (2010) indicates that the use of L2 enables greater executive control in linguistic processing through the facilitation of the event-related potentials. The linguistic processing was assessed by two different judgment tasks: the acceptability task and the grammaticality task. In the first task

the participants were asked whether the sentence had grammatical error or improper meaning. In the second task, the sentence grammar errors were assessed. Bilinguals made more mistakes in the acceptability task compared to the monolinguals but, in the grammaticality task, containing higher complexity and requiring more executive control abilities, both groups made less error. More prominently, in the more complex task, bilinguals required more executive control than the monolinguals (Moreno et al., 2010). Overall, the findings support that bilinguals use enhanced amount of conflict resolution and selective attention when utilizing L2 to inhibit the L1 processes, also these cognitive processes require less effort in bilinguals (Moreno et al., 2010).

Similar findings were found by Blumenfeld and Marian (2013) which showed that bilinguals resolve linguistic conflicts to move onto the task-relevant new information. The inhibitory mechanism in the linguistic processes was assessed by comparing monolinguals, lower proficiency bilinguals and higher proficiency bilinguals. In the first phase, the participants listened to words in L1 (English) and tried to identify them on the four pictures consisting of the English target word, the Spanish competitor word, and two filler items, while having their eye-movements recorded. In the four set of pictures, the target pictures were given with the words that share the similar phonological structure, along with two neutral-sounding pictures. For example, with the presentation of the auditory stimuli of the word “comb”, a picture of a rabbit (in Spanish “conejo”) was also presented with the filler words of sword and rail (Blumenfeld & Marian, 2013). The pictures contained between-language competitors. Activation of the target words in English and the

inhibition of the competing words in Spanish were tracked by the eye-movements. The bilinguals with higher proficiency in Spanish were less influenced by the interference caused by the phonological competitors in the subsequent priming probe trials. The results of the eye-tracking evaluation of competitor pictures and the filler pictures showed 4.8% competitor effect in higher proficiency bilinguals, 1.2% in lower proficiency bilinguals and 1.4% in monolinguals. This finding suggests that L2 engagement prioritizes the timing of the cognitive control to inhibit the irrelevant information (Blumenfeld & Marian, 2013).

1.5. Semantic Networks

Language conceptualizes the reality of the individual by structuring the thought processes (Lupyan & Lewis, 2019). Language acts as a filter to conceptualize reality. According to the linguistic relativity or the Sapir-Whorf hypothesis, the semantic composition of the language influences cognition and the way reality is perceived (Sapir, 1929; Wolff & Holmes, 2010). The linguistic relativity hypothesis holds three main ideas: the first assumption is that languages hold different meanings. Second, the semantic composition of the language influences the perception and the way individuals conceptualize the world. Lastly, individuals that speak different languages think and behave differently as a result of the differences in semantic relations (Sapir, 1929; Wolff & Holmes, 2010). Based on the linguistic relativity hypothesis, the concept of culture, information about the world and how the world is perceived by the individual is influenced by the semantic relations (Wolff & Holmes, 2010). As Sapir indicated, language conceptualizes the social reality for each

individual and the reality experienced is built upon the language habits of the society (Sapir, 1929). Different language communities have different worlds and represent their own social reality (Sapir, 1929). The way individuals construct the world is dependent on the semantic relations in the language. Therefore, the interactions with the world depend on the functions of the language. It can also be stated that the individual's cognition is influenced by the structure but, language does not determine the individual's view of the world (Sapir, 1929).

Individuals speaking two languages can recognize the differences in semantic relations. For example, in English, the verb is marked to indicate the occurrence of the time of an event, the sentence "it snowed this morning" has a different way of saying it in Turkish (Slobin & Aksu, 1982). There are two past tenses in the Turkish language that indicates if the person witnessed the event or realized that it snowed upon waking up (Slobin & Aksu, 1982). Sapir (1929) indicates that no language is similar to represent the same social reality. There are differences within the semantic relations across languages influencing bilinguals.

In bilinguals, when one language is used, the second language is also active at the same time; this is referred to as the co-activation of the languages and this process is done automatically (Marian & Spivey, 2003; Shook & Marian, 2019). For instance, when an individual hears a word, before the completion of the word at once, the sound of the word arrives in sequential order (Marian and Spivey, 2003). Before hearing the entire word, the language system in the brain tries to guess the word by activating the matching words, forming the mapping of the corresponding words. In

bilinguals, this activation occurs in both languages, regardless of the language the word is in (Marian & Spivey, 2003).

The research (Marian & Shook, 2012) shows that bilingual brain functions differently than monolinguals. For instance, knowing two languages leads to the slower reaction time in naming pictures, experience more tip-of-the-tongue states and switches between the languages when talking in just one language, also confusing the person in conversation if the listener does not know the speaker's language (Marian & Shook, 2012). The persistent competition between the L1 and the L2 allows the bilingual to become better at conflict resolution, enabling the bilingual mind to make quick judgments on the language processing, such as the selection of sentence acceptability and the appropriate syntactic processing (Marian & Shook, 2012; Moreno, Bialystok, Woodniecka, & Alain, 2010). To sustain a balance between the languages, bilinguals use persistent control of the processes of attention and inhibition. The bilingual mind relies on the executive functions, which is a regulatory mechanism of the cognitive abilities, allowing the processes of organization, planning, attention and inhibition to be applied when needed (Abutalebi et al., 2008; Abutalebi et al., 2012; Bialystok, Craik, & Luk, 2012; Marian & Shook, 2012). The executive function becomes stronger as there is a constant practice over bringing balance to the competing of the two languages, which enables better conflict management; for example, the cognitive system of the bilingual uses extra resources to disregard the irrelevant word choice, also keeps the focus on the topic of the conversation and picks the appropriate word for the context (Marian & Shook, 2012).

Additionally, the inhibitory control mechanism is used to disregard the competing information (Marian & Shook, 2012).

1.6. Decision Making

Knowing two languages provides greater cognitive control by influencing the decision making processes (Keysar, Hayakawa, & An, 2012). Decision making involves two types of cognitive processes, which Kahneman (2003) labeled as the intuition (system 1) and reasoning (system2). In the dual-processing theory, the cognitive processes operate under the two distinct divisions of system 1 and system 2, which explains the thinking and the behavioral attributes of the individuals while reasoning and decision-making (Evans, 2008). According to the dual process theory, individuals have two minds. The cognitive operation of system 1 functions outside of the conscious awareness, thus, it is unintentional, heuristic (selects the most available information for decision making), requires little cognitive resources, involuntary, automatic, intuitive, and relies on pattern recognition. The system 2 is intentional, requires more cognitive resources, functions voluntarily and operates within conscious awareness. The second system in the decision making processes is analytic, systematic and rule-governed. These two systems operate under different decision making circumstances. System 1 functions under routine events and when there is a time constraint, therefore, a quick decision can be made. System 2 is engaged when there is an absence of a skill, uncertainty and in situations where there can be little room for error, therefore, the thinking is slow and attentive (Kahneman, 2003). Both systems complement each other in making the correct judgment

(Kahneman, 2003). When a new skill is being attained, the reasoning and decision making relies on the system 2 processes whereas, the learned skills, such as the native language, reside in system 1 (Kahneman, 2011). In the case of speaking a foreign language, in unbalanced bilinguals, the system 2 is utilized more, relying on the systematic cognitive processes, whereby making decisions more attentively and deliberately (Keysar, Hayakawa, & An, 2012).

The dual-processing model of decision making demonstrates that system 2 is linked to language and fluid intelligence: the ability to solve abstract problems, and new skill acquisition. Therefore, thinking in L2 has less error margin in decision making. On the other hand, thinking in L1 is linked to the system 1, as the native tongue is the default language of the individual, requires low effort, and the thoughts are automatically formed into the syntax of the language. The research in decision making provides the differences between L1 and L2 speakers. Evidently, language has an influence over the reasoning and the decision-making processes (Keysar, Hayakawa, & An, 2012). The recall and recognition of information can vary between the L1 and the L2 languages (Marmolejo, Diliberto-Macaluso, & Altarriba, 2009). Recognition performance in L2 is more accurate compared to L1 (Francis & Strobach, 2013).

Bilingual language processing consists of weaker L2 word associations than L1 words (Francis & Strobach, 2013). The bilingual memory is prone to the word frequency effects influencing the factors of recall and recognition. While the low frequency words are better recognized, high frequency words are better recalled. According to the Source-of-Activation-Confusion Theory, lower frequency words

are associated with a lower strength in memory (Diana & Reder, 2006). Thus, fewer episodic connections and less contextual competition are facilitated, enhancing recollection while decreasing false recognition (Diana & Reder, 2006; Francis & Strobach, 2013). In bilinguals, words in L2 have fewer episodic memory connections, thus, L2 is less prone to contextual interference (Francis & Strobach, 2013). In addition, in L2 there is also fewer semantic memory connections. In a recall task, the recollection of veridical information becomes more accurate as a result of less contextual interference. Additionally, L2 words have less baseline familiarity level which decreases the reliance of L2 words on familiarity, which prevents memory errors (Francis & Strobach, 2013). The L2 words have an advantage over the L1 words because of their distinctiveness in episodic memory, which reduces contextual interference, enabling higher recognition performance in L2 speakers (Francis & Strobach, 2013).

The degree of fluency can influence the decision making processes in bilinguals. There are three types of bilingualism based on the time of second language acquisition and the level of language dominance (D'Acierno, 1990). Compound bilingualism is the acquisition of two languages simultaneously at the same time, in the same environment and both languages are regarded as the L1 (D'Acierno, 1990). Coordinate bilingualism is the acquisition of two languages in different settings, for example in the context of home and school. Lastly, in the sub-coordinate bilingualism one language is more dominant. In the case of coordinate and sub-coordinate bilingualism, system 2 is utilized more often than compound bilingualism.

The study done by Keysar, Hayakawa and An (2012), demonstrated that thinking in the second language enables the reduction in decision making biases. The study implicated the modified version of the Kahneman and Tversky's (1979) Asian disease problem to check the framing effect on risk taking by presenting gain and loss frames. Framing effect is defined as a cognitive bias and occurs in cases where when a scenario with a positive frame is presented in which gains are emphasized, there is risk aversion, whereas in the presentation of the negative frame in which losses are emphasized, there is more risk taking (Keysar, Hayakawa, & An, 2012). In fact, if decision making was logical, the decisions should have been similar in the two frames, since the emphasizing number of losses or gains describes the exact same scenario. Participants that used the foreign language when making a decision had a lower incidence of framing effect compared to the native language condition. The authors explained their results based on cognitive and emotional factors. According to Keysar, Hayakawa and An's (2012) study, decision making is less biased in L2 because of two reasons: first, there is a lack of emotional facilities in L2. Secondly, L2 poses greater cognitive load than L1. Thinking in a foreign language requires more cognitive control which in turn facilitates attentional resources and the results can be due to the increase in cognitive load when speaking in a foreign language (Keysar, Hayakawa, & An, 2012). Additionally, the decision making processes are influenced by emotion and affect. The literature on the foreign language effect indicates that there is a reduction in emotional facilities when speaking in the second language (Costa et al., 2014; Keysar, Hayakawa, & An, 2012; Vives, Aparici, & Costa, 2018). Thus, this can result in less bias. The reduction in the

emotional resonance associated with the foreign language also influences the L2 speaker's preference for risk aversion. Therefore, thinking in L2 can enable bilinguals to be less prone to making cognitive errors.

1.7. Rationale for the Study

Bilingualism has profound implications in memory. The literature indicates that bilinguals are able to use cognitive control effectively to engage conflict control, facilitate alertness and exert inhibition to reduce the interference from the L1. Learning a second language influences the cognitive functions, affecting the modalities of decision making, memory recall and recognition. Keysar et al.'s (2012) study postulates that the utilization of L2 reduces decision making biases. L2 reduces the emotional valence of the linguistic context and enables better judgment (Keysar et al., 2012). These studies demonstrate that L2 is less prone to error compared to L1 and it is reasonable to expect that the utilization of L2 can also decrease memory errors. The aim of the present study is to expand the facilitation of L2 in the DRM paradigm. Since false memory in the DRM paradigm relies on the semantic connections between the words and since these connections vary in strength in L1 and L2 in bilinguals (Anastasi, Rhodes, Marquez & Velino, 2005; Kroll & Stewart, 1994), the hypothesis that there would be lower memory error in L2 becomes stronger.

In in the present study the DRM paradigm in bilinguals will be investigated to understand whether L2 utilization can reduce false memory recognition. It is hypothesized that the recognition of false critical lures will be higher for L1 than L2.

Secondly, recognition accuracy will be higher in L2 than L1. Lastly, false alarms will be lower in the recognition test for L2 than for L1, once more supporting the idea that memory is less prone to errors in L2. Response time measures of the correct recognition will be higher in L2 than L1 since dual-processing theory states that system 2 requires more cognitive resources and attentional facilities, therefore, L2 will require slow and deliberate processing (Kahneman, 2003).

CHAPTER 2

METHOD

2.1. Participants

Subjects were 53 (24 males, 29 females) Turkish-English bilinguals between the ages of 18 and 35, selected by convenience sampling. All participants speak Turkish as their first language and English as their second language. The average age of the subjects was 26.72 (*SD*= 5.05). The average onset of English learning was 9.11 (*SD*= 2.79) ranging from age 4 to 17 as determined by the Language History Questionnaire (LHQ 3.0) questionnaire with the inclusion criteria of listening, speaking, reading, and writing (Li, Zhang, Yu & Zhao, 2020). The eligibility was determined by three measures: the LHQ3.0 self-report rating, the English test score and the word test presented at the end of the study. All participants took part in an English proficiency test such as IELTS (minimum 6.0), TOEFL (minimum 60%) or passed the English preparatory program in the first year of high school. Additionally,

according to the LHQ 3.0, all participants were regarded as fluent based on the Multilingual Language Diversity Score in the LHQ. Participants had a mean score of 1.0 (*SD* = 0.05) on LHQ, with scores ranging from 0.93 to 1.33, and LHQ 3.0 classifies participants with the scores 1 to 2 as fluent. The score of 1 and above means that the participant is a bilingual, showing balanced usage of L1 and L2. According to the LHQ 3.0, 2 subjects are unbalanced bilinguals and 51 are balanced bilinguals.

The English proficiency level of the participants was further assessed with the word test presented on the last phase of the study, in which participants translated the English words to Turkish. The order of the English word test was randomized. The word test consisted of the English words in the study, including the studied and the unstudied critical lure words.

One subject was eliminated as a result of scoring less than 75% on the word test. Out of the 53 participants, 22 of them were undergraduate students, 22 participants were in graduate school and 5 participants were PhD students. Additionally, 5 participants were living outside of Turkey (Saudi Arabia=1, United States= 4, Italy=1, Germany=1).

2.2. Materials

2.2.1. The Language History Questionnaire (LHQ 3.0)

Developed by Li et al. (2019), the LHQ 3.0 is a web-based tool enabling the assessment of the linguistic background of the multilinguals or the second language learners. The LHQ has a total of 24 questions consisting of 7 Likert scale and 9 fill in

the blank questions. The questions were a self assessment of the participants' language usage. The questionnaire addressed the onset of language use, how the language learning was attained, language used in schools, and the amount of time spent using the language watching TV, listening to Radio/ podcasts, reading for hobby, work and for social media. A wide range of daily language use was covered to assess the L1 and L2 usage. The language proficiency in the areas of speaking, writing, reading and listening are tested. The self-reported linguistic proficiency and the language dominance is reported by the aggregate score function, giving a rough estimate of the proficiency level of the individual. The Multilingual Language Diversity (MLD) Score is the determining outcome in subject's eligibility in the study. A score of 1 indicates balanced bilingualism and fluency of using two languages. Scores above 1 in MLD indicates stronger L2 and scores below one indicates stronger L1. Both the Turkish and the English proficiency level of the participants were assessed by the LHQ 3.0 program. The program gave identification for each participant and the entry to the questionnaire was only allowed with the given roster ID. The results of the questionnaire were displayed on the LHQ 3.0 website.

2.2.2. The Deese-Roediger McDermott (DRM) task in English

The seven lists with the highest false memory recall rates from Stadler et al.'s (1999) article were used. Each critical lure (window, smell, cold, rough, cup, soft and anger) had ten strongly associated items in the encoding list. The encoding phase had 70 study words, but not the critical lures. The norms of probability of false

recognition are included for each critical lure in bold in Appendix D. The critical lures in English have probabilities from 79% to 84% with a mean of 82.4% (*SD*= 1.90). The Turkish critical lures have generation probabilities from 71% to 84% with a mean of 78.1% (*SD*= 5.15). The probabilities in the two languages were equated as much as possible based on the norms, however, there is still a statistics difference between the probabilities, t (6)= 3.24, p= .02, d= 1.11, with higher probability of false recognition in English than in Turkish, which may create difficulty in obtaining our hypothesis.

The recognition test list included the seven target word lists that were presented at encoding from Stadler et al.'s (1999) article in the order of highest false recognition rate to the lowest. The lists were put into position and numbered from one to ten. The recognition task words were selected from the positions of 1, 8, and 10 from each list and their critical lure words were also added. A total of 56 encoding task words were included. In the recognition phase there was a total of 28 words: 21 study words and 7 critical lure words.

2.2.3. The Deese-Roediger McDermott (DRM) task in Turkish

The Turkish DRM lists were obtained from Yüvrük et al.'s (2019) article and the critical lure norms that were similar to the English DRM task were chosen for this study. The recognition list was structured by gathering the seven non-presented word lists from Yüvrük et al.'s (2019) article in the order of highest false recognition rate to the lowest. The lists were put into position and numbered from one to ten. The recognition task words were selected from the positions of 1, 8, and 10 from each list

and their critical lure words were also added. In the encoding phase a total of 56 words were included. In the recognition phase, there were a total of 28 words: 7 critical lures and 21 study words.

2.2.4. English Word Test

The seventy-seven English words presented in the encoding phase with the critical lures were put in random order and presented to the subjects after the recognition task. The subjects were asked to translate the English words to Turkish. Seventy-five percent and above accuracy was required to be included in the study. The accuracy of the responses was checked from Cambridge University Press (2021) online dictionary. Participants that wrote the dictionary definition received a point for each word. The incorrect definitions or the words that were left blank did not receive a point. The English word test is in Appendix E.

2.3. Procedure

The study was approved by Bahçeşehir University Ethics Committee. Before the application of the experiment, informed consent was obtained from the participants. The consent form was prepared in Google Documents and the link is sent to the participants. Upon the completion of the informed consent, the rest of the study was done with the TeamViewer program to remotely access the experimenter's computer. The LHQ 3.0 questionnaire was done with the instructions of the experimenter to keep it standardized because, the questionnaire was not user friendly.

The DRM task was conducted by the PsychoPy3 software (Peirce et al., 2019). In the encoding phase of the study, there were a total of 140 study words (70 from the English DRM task and 70 from the Turkish DRM task). First the word lists in Turkish, then the word lists in English were presented and the words within in each list were presented in random order. Within the encoding phase, there was an inter-stimulus interval of one second between the words and a delay of two seconds between the lists. For the presentation of the visuals, black background and Arial font (letter position 0, 0 and letter height in 3.0) in white was chosen. The words were presented in the center of the screen with lower case letters.

The instructions on the DRM task were given in Turkish. In the encoding phase the instructions read, “Please memorize the words on the screen. After the study, there will be a memory test. To start please press the spacebar”. Each participant was tested individually.

The recognition phase was done right after the Encoding phase by the PsychoPy3 software program (Peirce et al., 2019). The recognition task word lists were the highlighted words located on the 1st, 8th and 10th row of the words lists, with the inclusion of the critical lure words in the Appendix section. The highlighted words on the appendix section were randomly presented to the participant one by one in Turkish and in English (Appendix D). If the word was on the presented list, the participant pressed “e” as in yes in Turkish and if the word was not on the list, the participant pressed “h” as in no in Turkish.

In the recognition test the participants were instructed in Turkish, “You will see words on the screen, if you recognize the word from the previous session, please

press “e” as in yes in Turkish and if the word is new then, please press the left arrow key. Please answer as quickly and accurately as you can”. The recognition task included the highlighted words and their critical lure. There were a total of 56 words in the recognition task: 7 critical lures with 21 study words from each DRM task.

In the English word test, the English DRM task words were presented to the participants in random order and the meaning of each word was asked. This procedure was done to make sure that the participants know the meaning of each presented word. The accuracy of the responses was checked from Cambridge University press (2021) online dictionary. Participants that wrote the dictionary definition received a point for each word. The incorrect definitions or the words that were left blank did not receive a point. All participants were debriefed.

CHAPTER 3

RESULTS

Only the participants who reached a criterion of 75% in the correct responses for the meaning of the words were included in the analysis. The study was conducted on 54 participants but, a participant was removed due to the low score of 51% in the English word test. Therefore, the sample is left with 53 participants. A paired samples t-test was conducted on Turkish and English speaking bilinguals to check the conditions of false recognition of critical lures. False recognition was defined as the percentage of non-presented critical lures reported by the subjects as an old item. As expected, the subjects reported higher false recognition in the Turkish (M= 60.38, SD= 22.87) word lists compared to the English (M= 43.13, SD= 26.06) word lists, $t(52) = 4.50$, $p < .001$, d= 0.50. It should be noted that this is despite the higher false recognition rate of the English items in the norms.

The hit rate or the correct recognition of studied words was measured out of 21 studied words in L1 and L2. The hit rate in English (M= 75.74, SD= 12.85) was

reported higher than hit rate in Turkish (*M*= 62.17, *SD*= 14.45). Subjects recognized the studied words significantly better in English than in Turkish, *t*(52)= 6.49, *p* <.001, *d*=0.70.

False alarm rate was measured by evaluating the participants' responses given as "old" to new words in the recognition task. The false alarm rate was measured out of 28 given words within each word list. Both the Turkish and the English recognition words were included in the analysis. Subjects reported higher false alarms in Turkish (*M*= 43.33, *SD*= 10.99) than in English (*M*= 29.31, *SD*= 10.28), *t*(52)= 7.68, *p* <.001, *d*=0.93, once more confirming higher false recognition in L1.

Table 3.1.
Mean percentages of false recognition and recognition accuracy of Turkish (L1) and English (L2) speaking bilinguals (n=53)

		Mean	SD
L1	False Recognition	60.38	22.87
	Hit Rate	62.17	14.45
	False Alarm	43.33	10.99
L2	False Recognition	43.13	26.06
	Hit Rate	75.74	12.85
	False Alarm	29.31	10.28

The response time of the recognition task was measured by the key response data of the PsychoPy3 software. For this part, from time the word appeared, to the time it took for the participant to make an evaluation is recorded. When the participant pressed "e" for yes or "h" for no, the key press forced the end of the routine, registering the response time data. The response time of the recognition task was measured by the mean of the median to evaluate the difference between the L1

and the L2 without the influence of the outliers. The response time is measured in milliseconds. L2 has a slightly lower response time (M= 1060, SD= 320) than L1 (M= 1220, SD= 540). There is a significant difference between the L1 and L2 response times $t(52)= 2.74$, $p<0.01$, $d= 0.36$.

A further analysis was conducted to check if the age of the participants would have an effect on false recognition and recognition accuracy. For this purpose, age was entered as a covariate to the analyses above. The interactions between age and false recognition, $F(1, 51)= 0.73$, $p> .05$, correct recognition $F(1, 51)= 3.49$, $p> .05$, false alarm rate, $F(1, 51)= 1.25$, $p> .05$ and response time, $F(1, 51)= 0.25$, $p> .05$ were all non-significant. The covariance analysis showed that having a wide age range did not have an effect on the results.

As a reference for future studies, the frequency of generating each critical lure was analyzed to give a better understanding which words were more likely to be falsely recognized by the bilingual subjects. The English and the Turkish word lists used in this study have the false recognition probability norms gathered from monolingual subjects. In Table 3 and Table 4, the false recognition probabilities of the bilingual subjects in the present study are included along with the norms for comparison.

Table 3.2.
Frequency of subjects who judged the item to be old on the English recognition test, with lists ranked from highest to lowest recognition.

List	Bilingual Recognition	Monolingual Recognition
Rough	70.00%	83.00%
Window	49.00%	84.00%

Smell	49.00%	84.00%
Cold	40.00%	84.00%
Soft	38.00%	81.00%
Cup	34.00%	82.00%
Anger	28.00%	79.00%

Note: Monolingual recognition is taken from Stadler et al. (1999).

Table 3.3.
Frequency of subjects who judged the item to be old on the Turkish recognition test, with lists ranked from highest to lowest recognition

List	Bilingual Recognition	Monolingual Recognition
Yangın	94.00%	84%
Korkunç	72.00%	82%
Arkadaş	62.00%	80%
Uyku	62.00%	79%
Bina	55.00%	80%
Tatil	43.00%	71%
Barış	34.00%	71%

Note: Monolingual recognition is taken from Yüvrük et al. (2019.)

Table 3.4.
Calculated d' values for the Turkish (L1) and English (L2) items in the recognition test

		Mean	SD
L1	d' Prime	0.51	0.67
L2	d' Prime	1.36	0.77

D prime (d') was calculated to measure L1 and L2's ability to discriminate between the new and old information. The d' score of 0 means that the outcome is due to chance and the highest score of 4.65 equals to highest perfect value (Keating,

2005). The d’ analysis measures whether decision making was due to chance or sensitivity. The d’ values were calculated from participants hit rates and false alarm rates by using the formula d' = z(H) - z(F) in which z(H) and z(F) refer to the z transformations of hits and false alarms respectively (Keating, 2005). The means and standard deviations are presented in Table 3.4. According to the results, L2 significantly has higher d’ value than L1, showing that L2 is more sensitive to the stimulus, $t(52)= 7.19$, $p<0.05$, $d= 1.18$ thus, in the recognition task L2 discriminated between the old and new information better than L1.

CHAPTER 4

DISCUSSION

To our knowledge, the present study is the initial study that investigated the magnitude of false recognition in L1 and L2 in the DRM paradigm in Turkish and English bilinguals.

4.1. General Overview of the Study

The aim of the present study was to examine the effects of L2 processing in bilinguals with regards to false memory errors and biases in decision making. The false memory paradigm was used to investigate the false recognition and correct recognition in Turkish and English speaking bilinguals.

4.2. False Memory Effect

As expected, the results of the present study replicated the presence of the false memory paradigm in bilinguals. The hypothesis for the false memory effect was confirmed. The L2 language was less prone to selecting the critical lures than L1.

Additionally, L2 was less prone to false alarms than L1. The results indicate that the bilinguals' second language provides veridical recognition and reduces the effect of false recognition. The use of L2 did not entirely diminish false recognition but, it reduced it.

With the inclusion of the false memory effect, the bilingual's information processing is analyzed by further evaluating the RHM and BIA+ models. The RHM's contribution to bilingualism was to set the foundation for the developmental aspect of bilingualism. The model explained the asymmetries between the L1 and the L2 information processing. Additionally, the model stated that there are separate lexicons for L1 and L2 which were selectively accessed. In explaining the information processing, the RHM indicated that there is longer translation latency from L1 to L2 (forward translation) compared to L2 to L1 (backward translation) because of the language asymmetry and the strength of the connection between the words in the bilingual's languages. Thus, L1 has the priority in accessing the meaning (semantics) and the L2 requires mediation through the L1 translation (Kroll et al., 2010). The selective activation is restricted to the target language, inhibiting the irrelevant information. While the RHM demonstrates that the lexical activation and selection is limited to one language, the BIA+ model takes into account the task dependence of information processing, which theorizes that language is non-selective and there is a competition for lexical selection, posing a demand for the inhibition of the non-target language (Kroll et al., 2010). The BIA+ is a word recognition model and it does not explain the development of the L2 information processing but, it

gives a more throughout explanation of the information flow of the bilingual's lexical processing.

The language proficiency plays a crucial role in the information processes in bilinguals and the effect of the language proficiency poses a shortcoming of the RHM; which states that with balanced bilinguals (high proficiency in L2), both the L1 and the L2 would be sensitive to the semantics. Thus, instead of the lexical mediation from L2 to L1, both directions of the translation can be accessed and become similar to one another (Kroll et al., 2010). In the present study, even though the participants were balanced bilinguals, the L1 words were more likely to be falsely recognized than the L2 words. This effect could result from the higher usage of Turkish than English for the participants. The participants use English only when needed such as in an academic setting or at work but, throughout the day- at home and with their friends- Turkish is utilized more. The language proficiency remains intact with usage and throughout time and if it is not utilized it can decline- especially in the case of L2 language processes. In this case, the L1 mediation is required to access the L2. While RHM explains the asymmetries in the lexical connections, the BIA+ model emphasizes that both L1 and L2 remain active during language production.

With regards to the current study, the RHM model supports the idea of semantic connections, better explaining our results. The RHM explains the bilingual's language processes in the false memory effect more thoroughly than the BIA+ model. According to the RHM, there is a difference of the semantic relationship in L1 and L2 and this has an effect in the false recognition of

information (Basnight-Brown, 2014). There is a strong reliance to L1 lexicon in interpreting the information. Furthermore, the L1 lexical organization highly effects the L2 vocabulary development. The weaker-links hypothesis suggests that the bilingual's exposure and proficiency in a language influences their lexical processes (Francis & Strobach, 2013). Having less exposure to L2 words than to L1 words indicate that the L2 words have less frequent usage compared to L1 words, influencing the connection of the lexical links between the two languages (Francis & Strobach, 2013). The strength of the lexical links range from L2 to L1 and on this note, the L2 networks is not as strong as the L1 networks (Basnight-Brown, 2014). As explained by the RHM theory, the L1 vocabulary has the priority in accessing the meaning of the semantic concepts (Basnight-Brown, 2014). Having strong semantic connections on the L1 network suggests that the native language is more prone to false memory phenomenon. The generation of false memory is lower in L2 as a result of having weak semantic connections, which also shows that RHM's information processing model is better suited theoretical framework for the false memory effect. Additionally, despite the bilingual participants' high proficiency in L2, they falsely recognized the words in L1 than L2. The results from the present study demonstrated that recognition performance in L2 has higher accuracy than L1-stemming from L2 having fewer semantic memory connections.

The findings are backed by Francis and Strobach's (2013) study, which implied higher accuracy in L2 recognition performance compared to L1. The study conducted a within subjects design including 32 English dominant and 32 Spanish dominant participants, with the use of 80 words (40 high frequency and 40 low

frequency). The participants were asked to memorize the words and a yes-no recognition task was administered. The results showed that the false alarms were lower in L2 than L1 and the hit rates were lower in L1 than L2. According to Francis and Strobach (2013), the recognition performance is affected by the frequency of the L1 and the L2 words. The low frequency words are better recognized, while the high frequency words are not as well recognized. The Source-of-Activation-Confusion Theory indicates that there are two reasons for better recognition performance (Francis & Strobach, 2013). Firstly, low frequency words have fewer episodic contexts, lower contextual competition, eliciting the increase of recollection and hit rates (Francis & Strobach, 2013). Secondly, low-frequency words have a diminished strength in the memory. Therefore, familiarity-based false alarms will be less likely to occur.

The bilingual's recognition performance is influenced by the differences in contextual interference between the language sets. A bilingual has more exposure to L1 words compared to L2 words, so the L2 words have a lower frequency than L1 words. Similarly, L2 has an advantage over L1 on the fact that it is not prone to the contextual interference effect as there are less episodic memory connections in L2 (Francis & Strobach, 2013). By the same logic, while the L1 has the most episodic input, the L2 has fewer episodic contexts, which would elicit a reduced familiarity-based context for L2 recognition performance, it is also likely for L2 to show lower false alarms and higher hit rates, compared to L1 recognition performance (Francis & Strobach, 2013). This is because the recognition performance is highly influenced by the familiarity based, specific item-processing. The words in L2 have a less baseline

familiarity level. Therefore, the decrease in the false alarms in L2 is due to the low familiarity-based word lists.

4.3. Acquisition Onset of Language

The age of onset of L2 acquisition is an important measure to consider in bilingualism research. The critical period hypothesis is taken into consideration to explain the differences between bilinguals. The literature on bilingualism indicates that there is a critical period for native-like L2 acquisition and the cut-off for language acquisition onset is at the age of 12, 15, 16 or 18 years (Muñoz & Singleton, 2011). Lenneberg's (1967) critical period for language acquisition is between two years to the age of puberty (around the age of 14) but, his findings were from monolingual participants. There is some vagueness in the critical age of onset but, the studies show that there is a critical time for learning L2.

According to Abrahamsson and Hyltenstam (2009), the native like language production for adult learners in L2 is possible but, the probability of attaining the linguistic mastery is close to zero. In Abrahamsson and Hyltenstam's (2009) study, the L1 was Spanish and L2 Swedish. A total of 195 participants with age of onset below 11 years (mean age 28-29) and above 12 years (mean age 41-42) were selected. Self report measures of daily language usage in L1 and L2 was taken by the participants. The speech production of participants was evaluated by 10 judges (native Swedish speakers) out of three measures: participant is native from the Stockholm area, the participant is Swedish but, not from Stockholm, lastly, the participant is not Swedish. The results indicated that participants with age of L2

onset of 11 and below were perceived as native speakers of Swedish but, the majority of late learners of 12 and above were not perceived as native Swedish speakers. Out of 88 of the late L2 learners (age of onset 12-47years), 6% were perceived as native speakers rated by 9 out of 10 judges.

In further research, late learners of L2 between the ages of 13-19 did not show native-like language processing such as speech production, formulaic language and morphosyntax (Abrahamsson & Hyltenstam, 2009). The perceived native-like speech production reduced at around the acquisition onset of 12 years.

Additionally, the early learners of L2 do not qualify as native speakers. In child early L2 learners, 41 of the 107 participants were perceived as non-native Swedish speakers. In speech production with the assessment of perception, children were evaluated as native L2 speakers but, in other domains of language production native-like language production is greatly reduced (Abrahamsson & Hyltenstam, 2009). According to Schulz and Grimm (2019), L2 acquisition onset in children at the age 6 to 7 years perform similar to adult learners but, different than the early language acquisition whose age is between 2 and 4 years.

In the present study the age of onset of English learning was between the ages of 4 to 17. Three participants had an onset above the age of 12. Even though the language acquisition was at a later age, similar results in false recognition were obtained. The participants with the English acquisition onset of over the age of 12 were older and had more experience in utilizing L2. According to Abrahamsson and Hyltenstam's (2009) study, there is a very slim chance that the participants would show native-like language processes, which is the same in the case of adult and early

onset of L2, thus, whether the participant's onset was 4 years or 17 years, it does not make a profound difference in L2 language processes.

The literature on bilingualism (Abrahamsson & Hyltenstam, 2009; Schulz & Grimm, 2019) indicates that there is a critical period of L2 language acquisition but, the probability of having native-like L2 will be very slim. If the discrimination of the L1 and L2 language modalities are done with demanding tasks, L2 language will be far from native speaker's level of proficiency (Abrahamsson & Hyltenstam, 2009).

With regards to age of onset of bilingualism, L2 will be less developed than L1; this is unless the L2 is acquired simultaneously with L1. With regards to the RHM, the literature on the age of onset of L2 acquisition indicates that there is a very small probability that L2 will have native-like language processes. Even though with the increase of L2, less mediation from L1 will be required. In the case of early bilinguals, L2 lacks the native-like language modalities of phonetic production, perception, grammaticality judgments, lexical and semantic inferencing, formulaic language (consisting of proverbs and idioms) (Abrahamsson & Hyltenstam, 2009). Going back to the false memory effect, since the false memory phenomenon is based on semantic relatedness, the language that has lower semantic connections will produce less false memories. The semantic connections in L2 are lower than L1 thus, L2 is less susceptible to the false memory effect.

4.4. Decision Making and False Memory Effect

The decision making theories support the results of the differences between the L1 and the L2 word recognition. The recognition performance requires more

deliberate, attentive and less automatic information processing in which the bilingual's L2 elicits. The results for low false recognition and false alarms show that there is a foreign language effect. According to Keysar et al. (2012), L2 provides accurate judgments by reducing decision-making biases and the findings from this study shows that the second language does not rely on the emotional resonance of words. Emotional reaction plays an important role in making accurate judgments and reducing bias. For example, in the framing effect there was an increased activation of the amygdala, which demonstrates that there was a heightened emotional reactivity to definite gains and losses (Kahneman & Frederick, 2007). The foreign language lessened the emotional resonance of the words, so the responses were not integrated with emotional reactions (Kahneman & Frederick, 2007). Therefore, it can be stated that the decision making is influenced by the word processing in bilinguals, which shows the effects of the foreign language and semantic relatedness (Khateb et al. 2015).

Similarly, Costa et al. (2014) assessed the effect of foreign language on promoting better reasoning capabilities. Keysar et al.'s (2012) study on the framing effect was replicated and the loss aversion was lower when problems were presented in the foreign language. The findings indicate that the use of L2 leads to lower rates of heuristic biases in decision making.

4.5. Response Time

The assumption of L2 having slower response time was made in accordance to bilinguals having persistent competition between switching of the languages.

While switching between the languages, executive functions are utilized to inhibit the language that is not used. The reliance on the inhibitory mechanisms enhances conflict management in bilinguals. The ability to inhibit competing information and activate the target information creates a cognitive load (Keysar, Hayakawa, & An, 2012). This study investigated whether switching between the languages would result in slower response time in the non-dominant language and a faster response time in the dominant language.

A comparison was made in the L1 and the L2 response time evaluation of the recognition task. Participants recognized L1 words slightly slower compared to the L2 words. This finding was unexpected because, according to the dual processing model, L2 resides in the system 1, allowing the slow information processing. Therefore, the L2 word recognition should require more attentional resources than the L1.

The discrepancies in the response time findings could be influenced by the language dominance of the participants. Response time is highly influenced by the proficiency of the bilingual and in the present study, as indicated by the results of the LHQ 3.0 questionnaire all of the participants were balanced bilinguals. The RHM explains the information processing differences in L1 and L2 with regards to the bilingual's language proficiency. The RHM indicates that there are asymmetries between the L1 and the L2 processes, which shows that the native language has the priority access to the lexical processes of the language. The meaning of the L2 word is accessed through L1 to L2 processes. To further elaborate, L2 words are accessed through the mediation of the L1 words in the initial stages of the L2 acquisition. As

the proficiency in L2 increases, the L1 mediation is not a prerequisite. Therefore, according to the RHM theory, until the proficiency in L2 is achieved, the information processing in L2 could be slower compared to L1 processes. In the case of the balanced bilinguals, the meaning of the words can be accessed without the L1 mediation. In this study, there was a slightly increased response time in L1 compared to L2.

Another factor that has influence on the response time is when there is a time limiting situation. According to Kroll and Ma (2017), the semantic access to the L2 can be done without the translation mediation of L1 when there is a time limit. English learners of the Spanish language are selected in a translation recognition task to judge whether the given translations in English are done correctly. The behavioral data collected through the event-related potentials readings demonstrated that meaning of the L2 can be accessed without the mediation of the L1 (Kroll & Ma, 2017). In the case of the late second language learners, the semantic network in L2 can be activated without the activation of the L1 network. Even though the language proficiency plays an important role in determining the response time of the bilingual, time limited tasks also affects the language processing, especially without the influence of the language proficiency.

4.6. Neuropsychological Factors in False Memory Effect

The difference between bilingual and monolingual speech production is that bilinguals need to maintain their attention in the target language and inhibit the irrelevant language (Bialystok, 2009). According to the literature, bilinguals have an

enhanced inhibitory control and attentional facilities to switch between the languages when required (Bialystok, 2009). The non-target language is inhibited by executive functions, which is located in the prefrontal cortex, controlling inhibition, attention and conflict resolution. Bilingualism is associated with increased frontal lobe activations and according to Hernandez, Martinez and Kohnert (2000), language switching activates the dorsolateral prefrontal cortex (DLPFC): the region associated with higher cognitive functions, such as conflict resolution, working memory and attention.

The weaker-links hypothesis postulates that there bilingual have a disadvantage compared to monolinguals (Gollan et al., 2008). Bilinguals use L1 and L2 less frequently than monolinguals thus, leading to less practice in each language. In time, there would be weaker links between the phonology and semantics in each lexicon. The weaker links hypothesis emphasizes that frequency of use determines proficient lexical accessibility (Gollan et al., 2008). Even though this seems to be a disadvantage, in the false memory effect, the low frequency language (L2) has higher recognition than the high frequency language (L1; Francis & Strobach, 2013). This is because L2 has weaker semantic memory connections than L2. To tie it altogether, verbatim information processing relies on the decreased activation of semantic associations and gist traces rely on semantic activations (Storbeck & Clore, 2011). The weaker-links hypothesis provides the explanation for higher recognition accuracy in L2 than L1.

Additionally, bilinguals experience the interference effect when using one language and inhibiting the other, causing tip-of-the-tongue states (Gollan & Acenas,

2004) and in the presence of noise, resulting in the poor ability of word identification (Rogers et al., 2006). Bilinguals also experience high interference effect in the lexical decision making tasks (Ransdell & Fischler, 1987). The interference effect shows that there is competition between L1 and L2. The involvement of the higher cognitive functions manages this interference effect. The executive functions of attention, inhibition and conflict resolution provides the language processes in the target lexicon. Therefore, the frontal lobe functions provide the key connections in the false memory performance. This is especially evident in the management of interference of both languages and in the weaker links.

4.7. Limitations and Suggestions for Further Research

The present study has a few limitations. The limitations are influenced by the current pandemic conditions which could have influenced the factors regarding attention. Because of the pandemic, the main contamination would be due to anxiety and depression level of the participants. Participants were not given a test of to measure their mood. Despite, the results of the study were mainly in the expected direction.

The participants were planned to be randomly selected from the English speaking schools in Istanbul but, with the closing of the schools, the study had to be tested online. Each participant participated from their house by remote connection. This may have resulted in unknown distractions. Fortunately, this potential problem did not prevent the confirmation of our main hypotheses.

Additionally, since this study was done online and the participants were selected randomly by snowball sampling, some subjects participated from outside of Turkey. During the pandemic time individuals switched countries and moved to where their families were. This was a variable that could not be controlled at the time of the study. Initially, the study was supposed to take place in English speaking high schools in Istanbul. This way, the study could have been conducted in a face-to-face setting. Additionally, the variable of age, education level and the country subjects live could have been better controlled. However, the data on subject's LHQ 3.0 score and the word test were all in the same range. Even though some participants were living outside of Turkey, this did not influence the collected data. Each participant's first language was Turkish and second language was English. As indicated by the LHQ 3.0 questionnaire, all participants scored around the same range on measurements of bilingualism.

This study focused on the recognition performance of the false memory paradigm and there was no recall task. There were no norms for recall lists in Turkish to be matched with the English word lists norms. The inclusion of the free recall task could give more insight into the bilingual's language performance. Further research can give more insight into the L2 processes regarding recall measures.

4.8. Contributions of the Present Research

The present study aims to make contributions to the literature by demonstrating the effects of the L2 language processes in the false memory effect in bilinguals. This study showed that language has a profound influence over the

memory processes. When making critical decisions L2 can be utilized to increase recognition accuracy. Especially in the case of eye witness testimony, bilinguals can use their L2 to make better judgments.

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