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**Exploring the Relationship between Metalinguistic Awareness and Executive Functions in Bilinguals versus Monolinguals**

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## Literature Review

Current research demonstrates that childhood bilingualism may enhance cognitive processing in the area of executive functions, as well as certain metalinguistic skills like phonological awareness. This has been labelled 'the bilinguals advantage'. The current study will test EF and phonological awareness in bilinguals and monolinguals in search for the cognitive advantage in these two domains. It will also test whether the bilingual advantage in phonological awareness may be predicted by levels of executive functioning and whether its manifestation interacts with language-specific linguistic structure. In the following section, we will discuss the concepts of executive functions, phonological awareness, and bilingualism as well as the literature that has examined the relationships among them.

The definition of bilingualism is communicating in two languages and having the ability to control between them in accordance with topic, listener and psycholinguistic and socio-pragmatic motivations (Walters, 2005). Bilingual children can be balanced or dominant; that is, they can show varying linguistic proficiency in both languages (Iluz-Cohen & Armon-Lotem, 2013). In this study, bilinguals will be characterized as those who acquired both languages simultaneously in early childhood and who continue to use both languages.

Research demonstrates that both languages are active at all times in the mind of a bilingual (Kroll, Bobb and Wodniecka, 2006; Kaushanskaya and Marian, 2007). Data from cross-linguistic priming and repetition tasks illustrate that semantically related words are accessed in both languages simultaneously (Duyck, 2005). An additional example can be seen by Lemhofer & Dijkstra (2004). They found that English-Dutch bilinguals recognized cognates quicker than the control groups. They also discovered that homographs, orthographically identical words across languages, showed no effects compared to the Dutch controls. It seems that facilitation for the bilingual comes from cognates as they share meaning in both languages. We can deduce from the above example that the meaning of the cognate word was co-activated in both languages thereby confirming simultaneous activation of both languages in the mind of a bilingual.

Given the fact the both languages are active, it has been suggested that bilinguals might develop more efficient control systems over linguistic processing than monolinguals, likely on account of their need to constantly control for two languages (Bialystok & Martin, 2004, Bialystok & Shapero, 2005, Carlson & Meltzoff, 2008). The simultaneous activity of both languages creates competition between the two languages thereby forcing the bilingual to resolve this struggle. According to the Inhibitory Control Model (Green, 1998), bilinguals use various levels of control between the two languages in order to distinguish between them. In particular, inhibition is used to ignore the non-targeted language. This results in enhanced executive functions.

Two models explain how language selection occurs in bilinguals: the Language Selective Model (La Heij, 2005) and the Competition for Selection Model (Costa, 2005; Finkbeiner, Gollan, & Caramazza, 2006). According to the LSM model, bilinguals are capable of stopping the non-target language from activating (La Heij, 2005) or of disregarding the non-target language if it is activated (Costa, 2005). To test this hypothesis, less proficient and highly proficient bilinguals were required to name pictures in either their L1 or L2 in a language switching task. The results demonstrated that there were larger switch costs for the L1 or dominant language in the less proficient participants while there were symmetrical switch costs for the highly proficient bilinguals. While it may seem counterintuitive to have larger switch costs for one's dominant language or L1, it seems reasonable because one has to inhibit their dominant language even more, therefore leading to larger switch costs. In contrast, the highly proficient subjects did not have to inhibit one language more strongly than the other. This finding was interpreted as evidence that the non-target language does not compete for selection in highly proficient bilinguals.

In contrast, the Competition for Selection model (Costa, 2005; Finkbeiner, Gollan, & Caramazza, 2006), argues that both languages are activated and compete for selection (Abutalebi et al, 2008; Kroll, Bobb, Misra, & Guo, 2008). In support of this model, Meuter & Allport (1999) conducted a study using language switching tasks where subjects were required to name digits that were presented to them visually in either their first language (L1) or in their second language (L2). Larger switch costs were observed for the dominant or L1 than the less dominant or L2. This illustrates that both languages are simultaneously activated, but because the L1 is more dominant, it needs to be inhibited more strongly than the weaker L2. Similar results were reported in Philip, Gade, & Koch (2007). Though the two models vary with respect to how bilinguals may process two languages, they both explain the need for enhanced control skills.

The control facet of bilingual processing has also been proposed by Bialystok (2001), who claims metalinguistic awareness requires two processes: analysis and control. *Analysis* is the process of creating mental representations that record detailed, explicit and abstract information. As these representations are analyzed, knowledge can be grouped around abstract categories and particulars accessed regardless of their contexts. *Control* of attention is the selective direction of attention towards particular aspects of a representation. Problem solving requires that attention be purposefully directed to some types of information and diverted from others. This selective attention is made more difficult when a habitual or salient response contradicts the optimal one and therefore must be inhibited; thus, inhibition constitutes a critical component of control (Bialystok & Martin, 2004). Furthermore, Bialystok (2001) maintains that a bilingual advantage is demonstrated in tasks that require a higher level of control over processing when performance depends on attention to subtle aspects of the language.

Some scholars argue that the control advantage may reflect "cognitive flexibility" (Hakuta and Diaz (1985). This was argued in a number of studies. For example, bilinguals may exhibit superior metalinguistic awareness (Bialystok, 1987, 1988, 2001b; Diaz, 1985; Ricciardelli, 1993), stronger symbolic representation and abstract reasoning skills (Chan, 2005; Diaz, 1985), and enhanced problem-solving abilities because of their facility to pay attention to relevant information and ignore irrelevant information (Bialystok, 1999, 2001a,; Bialystok & Majumber, 1998).

Metalinguistic awareness is defined as the ability to think about and reflect on language in contrast to speaking or using language; it is an awareness of language. In order to evaluate metalinguistic awareness, phonological and syntactical awareness tasks are often used (Bialystok & Herman, 1999). Research has shown that bilingualism might play a role in increasing a child's metalinguistic awareness and advance the development of an analytical meta-cognitive and reflective approach to linguistic input (Cummins, 1978; Bialystok & Craik, 2010; Kogan, 2011). The likelihood that bilingualism may aid children's metalinguistic development was first put forward by Vygotsky (1962) who argued that the controlling of two language systems may facilitate bilinguals in understanding that the relation between form and meaning in language is arbitrary. Ben-Zeev (1977a) corroborated the latter argument, reporting an advantage in Hebrew-English bilinguals in a series of symbol substitution tasks. Additional research by Bialystok has also supported this argument. For instance, Bialystok (1986) tested the ability of bilinguals to recognize the difference between the form and meaning of language in a set of grammaticality judgment tasks. She credits advantage to the cognitive flexibility in bilinguals, which stems from their constant practice of resolving the conflict between form and meaning (Bialystok, 1986).

Kuo and Anderson (2010) propose a slightly different conceptualization of the source of the bilingual advantage in their Structural Sensitivity hypothesis. They argue that bilinguals are forced to represent structural similarities and differences between their languages and this enables bilinguals to form representations of language structure at a level that is more abstract (Kuo & Anderson, 2010). In a series of onset, rime, and tone awareness tasks amongst Taiwanese children, they found that the bilinguals consistently outperformed the monolinguals on phonological awareness tasks that called for segmenting and comparing onsets and rimes in novel syllables. The researchers were able to attribute this finding abstract linguistic representation and heightened structural sensitivity because of similar syllabic structure of Mandarin and Southern-Min.

Phonological awareness is a subsection of metalinguistic awareness and is defined as the ability to manipulate and reflect upon units of sound (Bialystok, 2001, 2002). Research has shown that bilinguals might have heightened phonological awareness. Yet the research on this issue provides a mixed picture. This is partly because the construct of PA is not clear and therefore the

tasks that tap it range on the analysis-control continuum. Also, PA is affected by experience with literacy and this might vary in different types of writing systems.

Laurent & Martin (2010) compared PA abilities of French monolingual children to French-Occitan bilinguals using a series of PA tasks like syllable deletion, phoneme deletion and permutation of both syllable and phoneme, demonstrating that bilinguals score progressively higher than monolinguals as the children age: in third grade, no significant differences were seen between the groups; in fourth grade, bilinguals scored higher in most tasks, matching their monolingual peers; by fifth grade, bilinguals outscored monolinguals in medial phoneme deletion tasks as well as phoneme and syllable permutation tasks. These findings may be indicative of a bilingual advantage (Martin, 2011). Additional research by Marinova-Todd et al (2010) reported a clear advantage in PA ability for five and six year old Mandarin-English bilinguals over their English and Mandarin monolingual peers. All participants were tested on a range of phonological awareness tasks where the bilingual group showed superiority over English monolinguals on elision and blending tasks and outperformed Mandarin monolinguals on onset-rime combination tasks, initial sound identification tasks, and rhyme detection. This research suggests bilingual PA may be elevated because of their unique ability to control and shift between languages.

Additional research demonstrating that bilinguals show an advantage in phonological awareness implies that the languages seem to incorporate the following features: simpler or more regular phonological structure, more salient segmental units, or a more transparent orthography (Kuo and Anderson, 2010). For example, Bruck & Genesee (1995) found that English speaking children attending a French immersion school showed more advanced syllable awareness than the first grade monolinguals due to the fact that syllables are more salient in French than they are in English. In addition, Campbell and Sais (1995) showed that Italian-English bilinguals outperformed the English monolingual group on a phonemic odd-one-out-task and a syllable deletion task despite the fact that they were slightly younger. They explained that Italian was probably helpful because Italian has a more regular syllable structure than English.

It is important to note that some research demonstrates that bilingual advantage might disappear with reading acquisition (Bruck & Genesee, 1995). Indeed, Yelland et al (1993) administered sound structure judgment tasks to English-Italian bilingual children and found that the initial advantage for bilinguals in kindergarten disappeared in first grade. From the above examples, we can see that it is unclear where the advantage lies for bilinguals. Certain phonological advantages may be attributed to bilingualism in general or to the advantages of knowing a language emphasizing specific structures (Bialystok et al, 2003). The current study will be using pre-literate children as the aim is to find bilingual advantages before children are formally exposed to literacy.

The onset rime sub-syllabic structure (C-VC) has been shown to be a useful framework for understanding the development of phonemic awareness and possibly explain the bilingual advantage. For instance, children were found to be able to access and manipulate onset phonemes more easily in English than rime-coda phonemes (Goswami, 2002; Treiman, 1983, 1985). Treiman (1983) ascertained that participants made fewer inaccuracies when asked to divide the syllable at the onset-rime boundary than at the body-coda boundary. She also showed that after a few trials, the subjects reached ceiling performance on the onset-rime sub-syllabic division over the body-coda division. This was argued to support the psychological reality of the onset-rime structure in English and also the rime cohesion hypothesis (Fudge, 1969; Goldsmith, 1990).

In contrast with English speakers, research has shown that phonological awareness in monolingual Hebrew speakers reveals a different underlying sub-syllabic structure: the body –coda (CV-C). This was based on the finding that children found final phonemes easier to isolate than initial phonemes (Saiegh-Haddad, 2007b, Kogan, 2011) and on evidence that children found it easier to split CVC syllables at the boundary between the body and the coda than between the boundary of the onset-rime (Share and Blum, 2005, Kogan, 2013). For instance, Kogan (2011) found a general facility for Hebrew and Russian monolinguals on a final phoneme isolation task over an initial phoneme isolation task. Both the Hebrew and Russian monolinguals found it easier to isolate the phoneme when the target was in the final position as opposed to the initial position. This has implications for both the CV phonological unit in Hebrew and Russian as well as the cohesiveness of the body-coda psycholinguistic structure of the syllable in Hebrew and Russian.

Although research into phonological awareness in English and Hebrew reveals that children may have different underlying representations of the syllable in both English and Hebrew, it is also possible that a bilingual's languages may influence one another (Simani, 2011). The concept of transfer has been a well-known theory in second language learning (Geva & Wang, 2001; Saiegh-Haddad & Geva, 2010). This is illustrated by Simani (2011) when she tested three groups of Hebrew speaking children at various ages. She showed that while the children were generally using the Hebrew sub-syllabic structure (CVC) in both languages, four years following exposure to English, Hebrew native speaking fourth graders demonstrated significant increases in rime facility. This can be attributed to the restructuring of the underlying representation of the Hebrew syllable to that of the English one. This implies that a Hebrew speaker learning English as a foreign language may alter the psycholinguistic representations of the syllable to those of the English language to aid their decoding of words in English (Simani, 2011).

Nonetheless, Kogan (2011) provides evidence for a bilingual advantage due to a bilingual's ability to control for attention as opposed to language transfer. Kogan' study revealed that Hebrew-Russian bilinguals outperformed their peers on tasks requiring them to split

monosyllabic words into the onset-rime boundaries despite the fact that the psycholinguistic representation of the syllable in both Hebrew and Russian is body-coda. Kogan (2011) ascribes this advantage to Bialystok's control of attention hypothesis. These bilinguals, while not having been exposed to the onset-rime representation of the syllable in their languages, were able to succeed in the task due to a cognitive advantage outside the realm of linguistic knowledge. This may shed light on bilingual advantage because tapping a less salient unit requires greater inhibition.

Executive functions is an umbrella term for cognitive processes that regulate, control, and manage information processing, and they include planning, working memory, attention, problem solving, verbal reasoning, inhibition, mental flexibility, and task switching. There are a number of studies that demonstrate this facility in EF advantage in bilinguals. In one study testing task switching (Bialystok et al, 2004), the dimension-change card sort task (Zelazo, Frye, & Rapus, 1996) was given to bilingual and monolingual children (Bialystok, 1999; Bialystok & Martin, 2004). The participants were given instructions to first sort by one dimension, but then later asked to switch to the other dimension. The bilinguals showed an advantage in switching to the second dimension even once the rule had been changed. This evidence is in line with the experience of a bilingual as they have to constantly switch between two languages. This ability to shift tasks may signify higher levels of executive control in this area for bilinguals.

In an additional study, 6-year-old children were given the Children's Embedded Figures Task to determine whether they were able to see the alternate image in a reversible figure (Bialystok and Shapero, 2005). The children were asked to find a hidden shape in a complex drawing. It was found that the bilinguals were more capable of changing their interpretation of an ambiguous figure (ex. the duck-rabbit) in order to differentiate it from the other image (Bialystok & Shapero, 2005). The latter task utilizes the executive function of inhibition as the task necessitates inhibiting the original meaning of the stimulus. This too may be in line with the way a bilingual mind works in that they may have to inhibit information from the non-target language when the target language is in use (Bialystok, (2001). As mentioned, Bialystok & Martin (2004) ascribe such bilingual advantage in executive control to an enhanced propensity to juggle two language systems in their brain. Bilinguals are in a unique situation as both languages are active and accessible simultaneously, and a problem of attention control is generated for the bilingual. In order to resolve any problems, bilinguals learn how to control for each language, and this ability of attention control for language appears to carry over into non-verbal, executive control functions.

It is not clear which specific executive functions are 'boosted' by bilingualism. The early studies have focused on inhibition in bilinguals (Morales et al, 2013) and advantages were found. Studies of bilinguals from varied language backgrounds substantiated the results mentioned above that bilinguals display an advantage on tasks requiring inhibition, attention control, and working

memory. For example, a bilingual advantage was illustrated in the Simon task where there is a special conflict between stimulus and response (Bialystok, Martin, & Viswanathan, 2005) as well as the ambiguous figures task (Bialsystok & Shapero, 2005). In both studies bilinguals showed an advantage over monolinguals at being able to ignore distracting information and selectively attend to a stimulus. In addition, research has demonstrated a bilingual advantage for working memory (Blom et al, 2014).

**Research Goals:** In light of the previous review of the literature, the current study aims to test EF and phonological awareness in (English-Hebrew) bilingual children in Israel and two groups of monolinguals (Hebrew speaking in Israel and English speaking in the US) in search for the cognitive advantage in these two domains. The study will also test whether the bilingual advantage in phonological awareness may be predicted by levels of executive functioning in the two groups and whether the manifestation of an advantage in phonemic awareness interacts with language-specific linguistic structure, in particular in the psycholinguistic representation of the syllable (onset-rime in English and body-coda in Hebrew).

**Hypotheses:** ***Hypothesis* I:** *English-Hebrew Bilinguals will outperform both monolingual groups (English and Hebrew speaking) in both phonological awareness and executive function tasks;* ***Hypothesis* II:** *Performance on executive function tasks in both monolingual and bilingual children will correlate with phonological awareness levels;* ***Hypothesis* III:** *The performance of monolingual children on parallel phonological awareness tasks in Hebrew and in English will reflect the underlying psycholinguistic representation of the syllable in these languages. Specifically, a) Hebrew speakers will show a preference in their phonological awareness for the body-coda (CV-C) structure. In contrast, English speakers will show a preference in their phonological awareness for the onset-rime (C-VC) structure. b) The performance of English-Hebrew bilinguals might reveal evidence in support of availability of both representations: onset-rime and body-coda and facility with phonemic awareness tasks that tap both structures.*

**Method:** **Participants:** The sample of the study will consist of 60 pre-literate kindergarten children between 4-5 years of age: 20 monolingual English speakers from Boston, United States, 20 monolingual Hebrew speakers from central Israel, and 20 bilingual Hebrew-English from central Israel. Parents will be consulted for approval and written permission prior to administration of the test battery. Participation in the study will be completely anonymous.

**Materials and Procedure:** Oral language - All participants will be administered a noun-verb picture naming task as a language proficiency test to determine their language proficiency levels. Bilinguals will be tested in both languages. The noun-verb test (adopted from Kauschke 2007; Kauschke & Stan, 2004) will consist of drawings of objects as well as drawings of actions

(transitive and intransitive verbs). Practice trials will be administered prior to the tests. The total score will be the number of pictures named correctly. (Kogan, 2011)

**Task Cluster I: Phonological awareness:** Four phonological awareness tasks (two syllable splitting and two phoneme isolation) will be administered. In all of the tasks only monosyllabic CVC items will be utilized as that form exists in both English and Hebrew. In addition the tasks will be offered in two conditions: real words and pseudo words. There will be two kinds of syllable splitting tasks: unstructured (open-ended) and structured (modeled after Share & Blum (2005). All of the Hebrew stimuli were developed by Kogan (2011). The aim behind the use of the syllable splitting tasks is to study the children's phonological awareness at the sub-syllabic level. 1. Unstructured Syllable Splitting task: in this task, the participants will be required to divide CVC syllables into two parts. No guidance or feedback will be given regarding the way the words should be split. The task will be given in two conditions: real words (ten items) and pseudo words (ten items). The children will be administered trials to familiarize them with the concept of splitting syllables. This will be followed by a linguistic example of breaking up a compound word, כדורסל */kadur-sal/* 'basketball', into two components: */kadur/* and */sal/*. Then, a bi-syllabic word, פרפר */parpar/* 'butterfly', was divided into two syllables: */par/* and */par/*. The test items will be enunciated one at a time and repeated if necessary (Kogan, 2011). 2. Structured Syllable Splitting: the structured task will consist of two subtasks: onset-rime (twenty items) and body-coda (twenty items). The onset-rime and the body-coda subtasks will be administered in two conditions: real words (ten items) and pseudo words (ten items). The first subtask requires division of a syllable into onset and rime units (C-VC). In the second subtask, the children will be asked to separate a syllable into the body and the coda units (CV-C). Each subtask will be preceded by four practice trials, pronounced one at a time and repeated if necessary. Correct splitting of a target word or pseudo word will merit 1 point, otherwise 0 will be given. The score for the task is the total points (0-40) (Kogan, 2011). Two phoneme isolation tasks will be employed: initial phoneme isolation and final phoneme isolation. The phoneme isolation tasks will assess children's phonological awareness at the phonemic level. 3. Initial Phoneme Isolation: the initial phoneme isolation task will be given in two separate conditions: real words (ten stimuli) and pseudo words (ten stimuli). The participants will be presented orally with a real or pseudo monosyllabic CVC word and requested to repeat it. Following successful production of the stimulus item, the child will be required to isolate the initial consonantal phoneme from the stimulus and pronounce it. For example, in the real word נר */ner/* 'candle', the initial phoneme is */n/*, and in the pseudo word

גוז */goz/*, the initial phoneme is */g/*. Instructions will be given before giving the task. Correct phoneme isolation will merit 1 point, otherwise 0 will be given. The score for the task is the total points (0-20) (Kogan, 2011). 4. Final Phoneme Isolation: the final phoneme isolation task will be given in two conditions: real words (ten items) and pseudo words (ten items). The children will be presented orally with a real or pseudo CVC word and requested to repeat it. After the stimulus item has been successfully produced by a child, he or she will need to isolate the final consonantal phoneme from the stimulus and articulate it. For instance, in the real word כוס */kos/* 'glass', the final phoneme was */s/*, and in the pseudo word תוץ */tuts/*, the final phoneme was */ts/*. The instructions given will emphasize operation of the final phoneme. Correct phoneme isolation will merit 1 point, otherwise 0 will be given. The score for the task is the total points (0-20) (Kogan, 2011).

**Task Cluster II: Executive Functions:** Two EF tasks will be used that measure inhibition and shifting. 1. The Embedded Figures task (taken from Peri-Iluz Cohen's Phd, which was adapted from Piaget & Inhelder, 1967; Pascual-Leone, 1989; De Avila and Duncan, 1980) will be administered to test inhibition. The child will be presented with ten pictures. Each picture will contain an embedded mouse that the child will be requested to spot as quickly as possible. Each picture shown will progressively increase in its level of complexity. Time will be measured, and errors, failures, and successes will be recorded. The degree of inhibition ability in the present study is represented by the number of correct answers, ranging from 0-10 points. 2. A Classification Task (taken from Peri-Iluz Cohen's Phd, which was adapted from Ben-Zeev, 1977a) will be used to test shifting. In this task a child will be shown 18 cards that consist of three different shapes; circle, triangle, and square, as well as three different patterns for each shape; no color, partially colored, and fully colored. Nine cards out of the eighteen will include three items of each shape (to represent 'many'), and nine cards include on item of each shape (to represent 'one'). The children will be asked to classify the cards into two or three groups, in a novel way on three separate trials. The degree of shifting ability comprises the average degree of success in shifting in the three trials of classification, which is a function of whether the child will succeed, required a few hints, or will fail. The degree of shifting ability ranges from 0-3.

**Data Analysis:** Statistical analysis will be performed using the SPSS package. Correlation tests and Analysis of variance procedures with Sheffe post-hoc testing will be used address the research questions. Specifically, repeated measure ANOVA with repeated measures on the various PA and EF tasks, and with group (bilinguals, monolingual Hebrew and monolingual English) will be used to test for main effects and interactions. Sheffe post-hoc test will be used to test the source of the interactions.

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