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Psychology
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Title
Bilingualism and Children's Attention to Facial Expressions that Conflict with Lexical Content

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Abstract
Due to the experience of managing two simultaneously competing languages, bilingual children show an advantage in controlled attention and more specifically in interference suppression. Such an advantage has been seen in various domains, for instance in bilingual children’s abilities to read vocal tone when this conflicts with lexical content – despite the fact that young children normally display a lexical bias in such emotionally ambiguous situations. The current study examined whether this bilingual advantage generalizes to attending to happy and sad facial expressions when these are congruent or incongruent, respectively, to happy and sad lexical content. Data from thirty preschoolers showed that all children performed better in the congruent condition regarding number of correct responses, but reaction time (RT) was not significantly different between conditions. No main effect of language group and no interaction effect between language group and condition was found. It might be that the bilingual advantage only generalizes to some domains. However, the current study was limited in its statistical conclusion validity, as participants were heterogeneous. Thus, this study may suggest that not all bilingual experiences lead to a bilingual advantage in interference suppression in all domains. A replication should use a more homogeneous sample. Future research could further investigate which specific experiences lead to an advantage in interference suppression and in which domains.
Bilingualism and Children's Attention to Facial Expressions that Conflict with Lexical Content

Up until the 21st century, research on bilingualism was scarce. Paradis, Genesee and Crago (2011) describe how it used to be believed that bilingualism would hinder a child's cognitive development. Being exposed to two languages was feared to lead the child to getting confused and not being fully competent in either language (Paradis et al., 2011). While bilingual preschoolers tend to have smaller receptive and expressive vocabularies in each of their languages in comparison with monolingual preschoolers (Bialystok, Barac, Blaye, & Puling-Dubois, 2010; Mahon & Crutchley, 2006), bilinguals tend to outperform monolinguals in tasks requiring metalinguistic awareness, controlled attention, working memory and abstract and symbolic representation skills (Adesope, Lavin, Thompson, & Ungerleider, 2010).Furthermore, Siegal, Iozzi and Surian (2009) argue that in the context of today's globalization, where bilingualism is becoming more prevalent, the effects of bilingualism on child development should be even better understood.

Benefits from being bilingual can be seen even in people not learning their second language from birth (Kalashnikova & Mattock, 2014; Poarch & van Hell, 2012a; Vega-Mendoza, West, Sorace, & Bak, 2015). However, learning a second language as early as possible creates a special impact on neural and cognitive development (Bialystok, Craik, Green, & Gollan, 2009; Hull & Vaid, 2007; Kapa och Colombo, 2013; Kroll & Bialystok, 2013; Luk, DeSa, & Bialystok, 2011; Olsen et al., 2015; Struys, Mohades, Bosch, & van den Noort, 2015).

For instance, a meta-analysis (Hull & Vaid, 2007) showed that early bilinguals (i.e. those who learn the second language before the age of six) show a more bilateral activation for both acquired languages. In late bilinguals (i.e. those learning the second language after the age of six), both languages are lateralized to the left hemisphere (Hull & Vaid, 2007) – a pattern that is in line with the left hemispheric language lateralization in monolinguals (Breedlove, Watson, & Rosenzweig, 2010). Thus, learning the second language while brain plasticity is at its highest can have dramatic effects. There is no definite conclusion to why the right hemisphere is more involved in language use for early bilinguals than for late bilinguals and for monolinguals (Hull & Vaid, 2007). One of the possible explanations is the early bilinguals' greater metalinguistic awareness, as such awareness is associated with right hemispheric activation (Hull & Vaid, 2007).

When completing metalinguistic tasks, attention plays a large role. For instance, attentional activation is more related to metalinguistic tasks than it is to tasks only placing demands on basic speech perception (Astheimer, Janus, Moreno, & Bialystok, 2014). Furthermore, abilities of controlled attention can help children think metalinguistically when encountering a linguistic stimulus, as they are better able to suppress attention from moving to the very salient concrete meaning of the linguistic stimulus (Bialystok, 2009). More specifically, controlled attention is the ability to monitor the environment, selectively allocate attention to specific aspects of a representation and to inhibit attention from moving to irrelevant aspects of a representation (Bialystok et al., 2009). Lastly, controlled attention plays into the cognitive flexibility that enables effective attentional switching between different aspects of a representation (Bialystok et al., 2009).

Bilingual children frequently outperform monolingual children in tasks placing demands on controlled attention (Bialystok et al., 2009). As controlled attention is part of the executive functions (EF) associated with prefrontal regions, and those regions are not fully developed until young adulthood (Taylor, Doesburg, & Pang, 2014), such tasks are...
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usually very difficult for children to succeed in.

The exact mechanisms for why bilingualism affects controlled attention are still under debate (Kapa & Colombo, 2013). Green (1998) suggests that bilinguals always have both language systems active. Thus, child bilinguals exercise their abilities of controlled attention from an early age, as they regularly need to monitor the linguistic context and attend to the appropriate language system while suppressing concepts from the language that is not presently relevant (Green, 1998).

Subsequent research has indeed shown that bilinguals experience coactivation of languages, causing competition between language systems and thereby causing a need to attend to one language system while inhibiting the system that is not relevant in a particular linguistic context (Costa, Miozzo, & Caramazza, 1999; Hermans, Bongaerts, de Bot, & Schreuder, 1998; Hermans, Ormel, Van Besselaar, & Van Hell, 2011; Kroll, Bobb, & Wodniecka, 2006). Examining coactivation closer, it can be seen that all bilinguals, even those not very proficient in their second language, experience coactivation when exposed to their non-dominant language (Poarch and van Hell, 2012b; van Hell & Tanner, 2012). Proficient bilinguals experience coactivation of languages not only when exposed to their non-dominant language but also when exposed to their dominant one (Poarch and van Hell, 2012b; van Hell & Tanner, 2012).

Furthermore, many of the brain regions involved in language selection (see Luk, Green, Abutalebi, & Grady, 2012 for a meta-analysis) are in frontal regions where EF has its base (Breedlove et al., 2010). It has also been shown that damage to the left dorsolateral prefrontal cortex causes bilinguals to suffer difficulties in selecting the correct language in a given linguistic context (Abutalebi, Miozzo, & Cappa, 2000; Fabbro, Skrap, & Aglioti, 2000).

Summarizing the above, there seems to be a relationship between the bilingual experience of language management and EF. However, it has been questioned whether the advantage in controlled attention should really be attributed to bilingualism per se or whether the relationship may be confounded by such factors as culture or socioeconomic status (SES; Barac & Bialystok, 2012; Morton & Harper, 2007).

To test the effects of background culture, of similarity between children's two languages and of language of schooling on children's abilities of task switching, Barac and Bialystok (2012) compared three bilingual groups of six-year-olds who differed from each other on the aforementioned grounds as well as one monolingual group of six-year-olds. Results showed no difference in performance between the bilingual groups. However, all bilingual groups performed better than the monolingual group (Barac & Bialystok, 2012).

To rule out effects of immigration when comparing bilingual children with different cultural backgrounds, Bialystok and Viswanathan (2009) compared a bilingual group currently living in India with a bilingual group living in Canada as well as a monolingual group living in Canada. Both bilingual groups performed equally on controlled attention, and both outperformed the monolingual group (Bialystok & Viswanathan, 2009).

Regarding SES, this is known to affect cognitive functioning (Bradley & Corwyn, 2002). Results from studies examining the role of SES in the bilingual advantage, have been mixed. Morton and Harper (2007) conducted a study with six- and seven-year-olds, and showed that the bilingual advantage disappeared when they controlled for SES. However, other studies, where low SES child bilinguals have been compared to middle class or high SES child monolinguals, have instead shown that even low SES bilinguals do in fact outperform higher SES monolinguals in tasks placing demands on controlled attention.
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(Carlson & Meltzoff, 2008; Engel de Abreu, Cruz-Santos, Tourinho, Martin, & Bialystok, 2012; Mezzacappa, 2004). Calvo and Bialystok (2014) set out to examine the roles of SES and bilingualism, respectively, in the bilingual advantage in completing EF tasks. It turned out that both SES and bilingualism had main effects, that is, independent effects, on children's EF (Calvo & Bialystok, 2014).

In sum, there is evidence for a bilingual advantage associated with the training of language management from a young age. This advantage does not seem to be due to cultural effects. While high SES can contribute to better abilities of controlled attention, it does not explain the bilingual advantage. Instead, both SES and bilingualism seem to independently affect abilities of controlled attention.

A closer examination of the bilingual advantage reveals that it can be seen in a variety of domains. As stated earlier, controlled attention helps children attend to one aspect of a linguistic presentation while ignoring another (Bialystok, 2009). For instance, Bialystok (1988) showed that six- and seven-year-olds detected a larger number of grammatical errors than their monolingual peers in a task where they needed to attend to grammar while ignoring distracting, absurd lexical content.

Looking at non verbal task performance, three tasks are frequently used to examine the bilingual advantage in controlled attention, namely the Stroop task, the Simon task and the Flanker task. Regarding the Stroop task (Stroop, 1935), where automatic processes interfere with controlled processes, there has been some inconsistent results. Bilingual children do not tend to outperform monolingual children on a version often used with preschoolers, namely the Day/Night Stroop (Martin-Rhee & Bialystok, 2008; Siegal et al., 2009). The Day/Night Stroop (Gerstadt, Hong, & Diamond, 1994) requires children to respond with the word “day” when shown a picture of a moon, and vice versa respond with “night” when shown a picture of a sun. Esposito, Baker-Ward and Mueller (2013) argue that this Stroop paradigm cannot be used to test children's abilities of controlled attention, as it rather tests response inhibition.

In the adult Color/Word Stroop (Stroop, 1935), participants are instead asked to state the color of words, while ignoring the salient lexical content – which happens to read the name of a color that is either congruent or incongruent with the color that the word is in. Adult bilinguals do in fact manage to state the colors in the incongruent condition faster than adult monolinguals, implying that bilinguals are better at ignoring the interference from the lexical content (Hernández, Costa, Fuentes, Vivas, & Sebastián-Gallés, 2010). Indeed, bilinguals seem to particularly have an advantage in tasks where they are simultaneously presented with two conflicting stimuli (i.e. placing demands on a part of controlled attention called interference suppression; Bialystok et al., 2009; Bialystok & Viswanathan, 2009; Carlson & Meltzoff, 2008; Esposito et al., 2013; Martin-Rhee & Bialystok, 2008).

While response inhibition and interference suppression are closely related, as they are both cognitive control EF (Bunge, Dudukovic, Thomason, Vaidya, & Gabrieli, 2002), they are indeed two dissociated EF (Brydges et al., 2012; Luk, Anderson, Craik, Grady, & Bialystok, 2010). In light of this, Esposito et al. (2013) had monolingual and bilingual children between ages three and five complete the common Day/Night Stroop that tests response inhibition, as well as a newly developed Bivalent Shape Stroop that tests interference suppression. Bilinguals and monolinguals did not differ on the Stroop testing response inhibition, neither in the congruent nor incongruent condition. Group performances also did not differ on the congruent condition in the Bivalent shape Stroop, but bilinguals performed significantly better than monolinguals in the incongruent condition.
(Esposito et al., 2013). Furthermore, Poulin-Dubois, Blaye, Coutya and Bialystok (2011) showed that a bilingual advantage in a Stroop task placing demands on interference suppression, can be seen already at the age of two.

In the Simon Task (Simon, 1969), interference is caused when the target stimulus' spatial location conflicts with the location of the correct response. While there are some variants of the Simon task, Martin-Rhee and Bialystok (2008) asked bilinguals and monolinguals around the age of five to identify the direction of an arrow showed on a screen. Children were to provide an answer by pressing the left or the right mouse button. Each button corresponded to a specific arrow direction. Meanwhile, the stimulus could appear on either the right or the left side of the screen. The location of the target stimulus was irrelevant, but when this location conflicted with the location of the button that corresponded to the correct identification of the arrow's direction, all children performed worse than in the congruent condition. Overall, however, bilinguals had faster reaction times (RT) than monolinguals in the congruent condition as well as in the incongruent condition, where they were better able than monolinguals to resolve the interference (Martin-Rhee & Bialystok, 2008).

In the Flanker task (Eriksen & Eriksen, 1974) participants need to focus on a central stimulus while ignoring surrounding, misleading, stimuli. In a child version of this, participants need to identify the direction of a fish and ignore other simultaneously presented fishes, whose directions are either congruent or incongruent with the central fish's direction (Carlson & Meltzoff, 2008; Yang, Yang, & Lust, 2011). Bilinguals between ages four and seven tend to show faster RTs in the incongruent condition in comparison with monolinguals (Carlson & Meltzoff, 2008; Yang, Yang, & Lust, 2011).

Moving on to the realm of socially and emotionally oriented tasks, Bialystok and Senman (2004) compared bilingual and monolingual four- and five-year-olds on two theory of mind tasks. One task mainly placed demands on representational ability, while the other placed demands on interference suppression as it involved conflicting representations and misleading cues. While bilinguals and monolinguals performed equally on the task only placing demands on representational abilities, bilinguals outperformed monolinguals in the task requiring interference suppression (Bialystok & Senman, 2004).

Furthermore, Yow and Markman (2011) showed that bilingual four-year-olds outperformed their monolingual peers in ability to attend to the target stimulus of vocal tone when this was incongruent with lexical content. Specifically, children were exposed to sentences consisting of happy lexical content as well as sentences consisting of sad lexical content. These sentences were presented in either a congruent condition, where lexical content matched the vocal tone of the voice reading the sentence, or in an incongruent condition, where lexical content did not match vocal tone. All children performed better in the congruent condition than in the incongruent. Bilinguals and monolinguals performed similarly in the congruent condition regarding number of correct responses as well as RT for responding. While there was no difference in RT between monolinguals and bilinguals in the incongruent condition, an interaction effect between language group and condition was found regarding number of correct responses; bilinguals performed significantly better in this condition than monolinguals did. It is worth mentioning that bilinguals only performed as good as someone who would have guessed throughout the incongruent trials. However, monolinguals performed well below chance level in the incongruent trials (Yow & Markman, 2011).

The aforementioned experiment poses a situation that is notably difficult for children
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that young. Children, even infants, can in fact attend to paralanguage (e.g. vocal tone and facial expression) to discern someone's attitude (Baldwin, 2000; Moses, Baldwin, Rosicky, & Tidball, 2001). However, children who have acquired language, demonstrate a lexical bias when paralanguage conflicts with the lexical content of words, as children interpret words literally in such emotionally ambiguous situations (Demorest, Meyer, Phelps, Gardner, & Winner, 1984; Friend, 2000; Morton & Trehub, 2001; Reilly & Muzekari, 1979; Rotenberg, Simour, & Moore, 1989). Even if children clearly remember instructions to focus on paralanguage in such situations, they have a hard time voluntarily modulating their responses in accordance (Morton, Trehub, & Zelazo, 2003).

Adults on the other hand, attend even more to paralanguage in emotionally ambiguous situations in order to identify the correct emotion of the person they are communicating with (Reilly & Muzekari, 1979; Rotenberg et al., 1989). This tendency was demonstrated in a study where adults were tested on a Stroop paradigm where positive or negative facial expressions were presented simultaneously with positive or negative emotionally valenced words in text (Beall & Herbert, 2008). In the congruent condition, the word matched the facial expression. In the incongruent condition, the word conflicted with the facial expression. In some trials, participants were instructed to focus on faces, while they were instructed to focus on the words in other trials. Regardless of whether the face or the word needed to be ignored, RTs were slower in the incongruent condition. The key finding, however, was that RTs were especially slow when participants needed to attend to words when faces were distracting. Thus, adults seemed to process facial expressions more automatically than they did emotionally valenced words (Beall & Herbert, 2008).

The tendency to attend more to paralanguage in emotionally ambiguous situations facilitates an understanding of such social interactions as joking, pretending or using irony (Eskritt & Lee, 2003). Indeed, children up to around six or eight years old find it difficult to understand someone's intent when they are ironic (Ackerman, 1981; Demorest et al, 1984). Wang, Lee, Sigman & Dapretto (2006) had adults and children between nine and fourteen watch cartoon drawings and listen to sentences while instructed to either attend to facial expression or vocal tone. Their task was to determine whether the lexical content in the sentence was ironic or sincere. Results showed that when children were asked to attend to paralanguage instead of lexical content, they recruited frontal areas more strongly than adults, while adults showed a stronger posterior occipitotemporal activation. This was interpreted as children needing more deliberate effort in order to attend to paralanguage, while this had become automatized in adults (Wang et al., 2006).

Concluding from the study of Yow and Markman (2011), the bilingual advantage seems to generalize to abilities in four-year-old bilinguals to read paralanguage operationalized as vocal tone in emotionally ambiguous situations. It is, however, not clear whether the advantage generalizes to reading paralanguage operationalized as facial expressions when these conflict with lexical content. As recently mentioned, ability to understand ironic remarks seems to develop after the age of six or eight (Ackerman, 1981; Demorest et al, 1984). In line with this, Morton and Trehub (2001) found that the ability to attend to vocal tone when it conflicts with lexical content, gradually diminishes between ages five and ten, where children eight or younger more often attend to lexical content than paralanguage. Such a detailed understanding of the developmental process of the lexical bias in relation to facial expressions remains unknown (Morton & Trehub, 2001). However, people in general seem to have an easier time identifying and agreeing on facial expressions presented alone than vocal tone presented alone (Russell, Bachorowski, & Fernández-Dols,
The ability to read facial expressions when these are presented in isolation, is fully developed in adulthood (Knudsen & Muzekari, 1983). Children's abilities seem to develop until they are around ten years old (Baudouin, Durand, & Gallay, 2008; Durand, Gallay, Seigneuric, Robichon, & Baudouin, 2007). However, happy and sad facial expressions seem to be the earliest ones that children can discriminate (Camras & Allison, 1985; Durand et al., 2007; Walden & Field, 1982). Furthermore, while it can be difficult to freely name facial expressions, children as young as three have been seen to understand the emotional meaning in various facial expressions (Russell & Widen, 2002).

The current study examines whether the bilingual advantage in interference suppression generalizes to preschoolers attending to happy and sad facial expressions when these are congruent or incongruent, respectively, to happy and sad lexical content. Summarizing from earlier congruent-incongruent tasks, it has been seen that incongruent tasks are more difficult than congruent tasks for all children. However, bilinguals tend to outperform monolinguals in the incongruent conditions – but often not in the congruent conditions. In light of this, the current study hypothesizes that all children will perform better in the congruent condition than in the incongruent one. Furthermore, it is hypothesized that bilinguals will outperform monolinguals in the incongruent condition but not in the congruent condition.
Method

Participants
Thirty-one children (13 female and 18 male) were recruited in seven preschools ($n = 28$) and through personal contacts ($n = 3$). Out of these, the data from one male child was removed altogether from the study due to disturbances during test administration. The remaining children were between ages 3.67 and 6.42 ($M = 5.09; SD = 0.71$).

Regarding language groups, 16 of the children were monolingual while 14 were bilingual. Both bilingual and monolingual children were spread across the different preschools. In order to be placed in the bilingual group, parents needed to report that their child was currently, on average, exposed to a second language at least 15 percent of all time. Previous studies have used between 20 and 40 percent as the cut off limit (e.g. Poulin-Dubos et al., 2011; Namazi & Thordardottir, 2010). Cut off was lowered in this particular study due to the relatively large amount of children exposed to a second language 15 percent of the time ($n = 4$). As these particular children reportedly themselves at times initiated conversation in the second language, they were included in the bilingual group instead of the monolingual group. Children exposed to a second language more seldom (e.g. 1-10 % of the time; $n = 3$), practically never initiated conversation in the second language, and were placed in the monolingual group.

The bilingual children were on average exposed to the second language 26.80 percent of the time ($SD = 11.90$; ranging from 15 to 50 percent). All participating bilingual children were early bilinguals, but only five had learned the second language from birth. The remaining eight bilinguals had learned the second language later on (age of acquisition ranging from 1.00 to 5.33; $M = 2.42; SD = 1.46$).

All bilingual children were proficient in Swedish. However, they differed from each other regarding which second language they were proficient in (e.g. English, Kurdish, Turkish, Amharic, Farsi, Arabic, Spanish, Italian, Somali and Syriac). While most ($n = 11$) were literally bilingual, three trilingual children were included in the bilingual group, as trilinguals show the same advantage (Poarch & van Hell, 2012b).

Lastly, ten children (two bilinguals and eight monolinguals) had great difficulties navigating the touch pad used in the experiment. This led to partial attrition, where these participants' RT performances could not be used. Thus, in analyses of RT, participants consisted of twelve bilingual children (seven female and five male) and eight monolingual children (two female and six male). Mean total age here was 5.25 ($SD = 0.68$; ages ranging from 3.75 to 6.42).

Procedure

The children's parents were given written information about the study. This included information regarding confidentiality and how data would be stored and used, as well as information regarding the concrete test procedure with the children and regarding the possibility of both parents and children to terminate participation. If parents provided their written informed consent and thereby chose to sign up their child to the study, they were requested to fill out a questionnaire where they provided demographic information and information about their child’s language development (see Appendix). While one preschool administered the questionnaire to the parents in paper versions, the other preschools were provided with an Internet link to forward to parents.

The registered children were asked personally if they would like to participate in the study, and were promised a small toy after experiment participation. In the case of children recruited from preschools, the study took place at preschool in a quiet place. In the case of
children recruited through personal contacts, the study took place in their home in a quiet
place.

As the children were to later click on schematic faces on a computer screen to provide answers regarding identified facial expressions in the experiment, each child began participation by practicing identifying the emotions of two schematic faces; one sad and one happy. Practice was conducted by the researcher holding up laminated paper version of the schematic faces, one at a time, and asking the child to identify the emotion in the face. If no answer was given, the researcher gave the child the correct answer. Practice was deemed successful when the child could correctly identify the emotions of both schematic faces.

The child was then instructed that they would see pictures of girls’ faces (one at a time) on the screen and that they were to look at a face closely and try to figure out the emotion in the face. They were told that they would hear a short story at the same time. They were further told that they would then see two schematic face pictures on the screen (the schematic pictures were, however, not named in dialogue with the child; instead, the researcher held up the laminated paper versions to refer to the schematic faces). They were to use the touch pad to click on the schematic face that best fit the feeling they had identified in the girl’s face.

Second, the child got four practice trials, with the purpose of practicing navigating the touch pad and get an idea of how the experiment worked. While no feedback was given regarding whether the child responded correctly, appraisal for effort was given. Before moving to the experiment trials, the child was reminded to choose the schematic picture that best fit the feeling they saw in the girl’s face.

The child was then presented with 32 experiment trials, which followed the same structure as the practice trials. Each trial consisted of the child seeing an actress displaying either a happy face or a sad face, while at the same time hearing a sentence (the story). The sentence contained either happy lexical content or sad lexical content, though vocal tone was held neutral. Exposure time for a picture was identical to the length of the sound stimulus that was matched to that picture. When the sound was over, the picture disappeared from screen and was replaced by the two schematic faces. These were placed next to each other on screen, though they switched places with each other in a randomized order across trials (i.e. moving from the left side to the right side and vice versa). The child got one point for each correct answer (maximum 16 per condition). RT was automatically measured in milliseconds (ms) from onset of the schematic faces on screen, until the moment when the child clicked on one of the schematic faces.

In total, the experiment trials consisted of eight various sentences containing happy lexical content and eight various sentences containing sad lexical content. Each sentence was presented twice during the experiment; once in a congruent experimental condition (i.e. in combination with a facial expression matching the sentence’s content) and once in an incongruent condition (i.e. in combination with a facial expression at odds with the sentence’s content). As such, 16 pictures of happy faces and 16 pictures of sad faces were included in the experiment.

Sentences were presented in a randomized order throughout the experiment. Furthermore, the first time one specific sentence was presented, it was randomized whether the sentence would be presented in a congruent or incongruent condition. The second time that same sentence was presented, it was presented in the condition opposite of the one it had been presented in the first time. If, for instance, the sentence “My dog ran away” was randomly assigned to be presented in a congruent condition (i.e. together with a sad face) the
first time that sentence was presented, the same sentence was automatically presented in an incongruent condition (i.e. together with a happy face) the second time that particular sentence was presented. Lastly, through a pool of 32 faces, the software randomly selected one of the faces that would fit whichever condition was about to be presented; incongruent or congruent.

**Material**

The questionnaire given to parents, was a modified version of the Experience and Proficiency Questionnaire (LEAP-Q; Marian, Blumenfeld, & Kaushanskaya, 2007). The original LEAP-Q has been examined through two subsequent studies using factor analysis. Results showed consistent factors across studies, indicating internal validity. Furthermore, each factor has been examined regarding internal consistency. While Cronbach's alpha was only .31 and .50, respectively, for two of the factors and could not be concluded for two other factors, it varied between .77 and .92 for the four remaining factors. Criterion-based validity has been established using multiple regression and correlation analyses between self-reported language abilities and objective behavioral language performance in various domains. With few exceptions, self reports correlate to actual performance (r varying between .34 and .74; Marian et al., 2007).

While the LEAP-Q overall is a valid and reliable questionnaire, it is a self evaluation questionnaire for adults, and it does not exist in Swedish. For the purpose of the current study, it was adapted to a version where parents could fill in information about their children (Örnkloo, 2014). The modified questionnaire was made available in English as well as in Swedish. The online version of the questionnaire was built in the program Mod_Survey (Palmius, 2004).

As for the children's task, stimuli were presented using E-Prime 2.0 software (Psychology Software Tools, 2012). The audio recorded sentences were based on those used by Morton and Trehub (2001) when comparing children and adults on ability to attend to vocal tone when this is congruent or incongruent, respectively, to lexical content. The same sentences were also used by Morton et al. (2003) when examining the sources of children's lexical bias, and by Yow and Markman (2011) in their investigation of monolingual and bilingual children's abilities to attend to vocal tone in congruent and incongruent conditions.

Only 18 of the original 20 sentences were used in the current study. Furthermore, of these 18 sentences, two were used in the practice trials. This means that 16 of the sentences were used in the experimental trials (see Table 1), rendering 32 experimental presentations instead of the 40 that Morton and Trehub (2001) and Yow and Markman (2011) used. This adjustment was made since some of the participants in the current study were very young and could possibly lose focus fast. Furthermore, the sentences were translated into Swedish and some were adjusted to better fit Swedish cultural conditions. A back translation was done by a colleague fluent in both Swedish and English.
Table 1

Sixteen of the original sentences used by Morton and Harper, and the sixteen adjusted sentences used in the current study’s experimental trials, here back translated

<table>
<thead>
<tr>
<th>Original Happy lexical content</th>
<th>Adjusted Happy lexical content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. My momm[289]gave me a treat.</td>
<td>1. My mom gave me candy.</td>
</tr>
<tr>
<td>2. My soccer team just won the championship.</td>
<td>2. My team won the soccer game.</td>
</tr>
<tr>
<td>3. I got an ice cream for being good.</td>
<td>3. I got an ice cream because I was nice.</td>
</tr>
<tr>
<td>4. I came in first place in a race today.</td>
<td>4. I won a running competition today.</td>
</tr>
<tr>
<td>5. Dad gave me a new bike for my birthday.</td>
<td>5. My dad gave me a bike for my birthday.</td>
</tr>
<tr>
<td>6. I am having a party and all my best friends are coming.</td>
<td>6. I am going to have a party, and all my best friends are going.</td>
</tr>
<tr>
<td>7. My teacher says that I’m the smartest in the class.</td>
<td>7. My teacher told me I am excellent.</td>
</tr>
<tr>
<td>8. I had my favourite cake for desert.</td>
<td>8. I had my favorite cake for desert.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sad lexical content</th>
<th>Sad lexical content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. My dog ran away from home.</td>
<td>1. My dog ran away from home.</td>
</tr>
<tr>
<td>2. My bike is broken so I can’t go riding with my friends.</td>
<td>2. My bike is broken, so I can’t bike with my friends.</td>
</tr>
<tr>
<td>3. I lost my baseball glove today.</td>
<td>3. I lost my ball today.</td>
</tr>
<tr>
<td>4. I lost my sticker collection.</td>
<td>4. I lost my stickers.</td>
</tr>
<tr>
<td>5. I am not allowed to go outside and play with my friends.</td>
<td>5. I don’t have time to go out and play with my friends.</td>
</tr>
<tr>
<td>6. My best friend doesn’t like me anymore.</td>
<td>6. My best friend is angry at me.</td>
</tr>
<tr>
<td>7. I fell off my bike and everyone made fun of me.</td>
<td>7. I fell off my bike and hurt myself.</td>
</tr>
<tr>
<td>8. I lost the toy that my grandmother gave me for Christmas.</td>
<td>8. I lost a Christmas present I got from grandma.</td>
</tr>
</tbody>
</table>

All sentences were read by one and the same person. Importantly, happy and sad lexical content sentences did not differ from each other regarding sentence length ($t_{14} = 0.79$, $p = .44$; happy lexical content: $M = 1994.38$ ms, $SD = 400.81$; sad lexical content: $M = 2181.50$ ms, $SD = 537.17$), preventing a systematic bias in exposure time for certain trials. The woman recording the sentences was a radio talker used to reporting in an objective tone of voice, and she was here instructed to hold a neutral tone. Furthermore, a panel of five colleagues judged the sentences on basis of vocal tone. Those sentences that were not deemed to be neutral were re-recorded.

As all sentences were read in a female voice, only pictures of females were used in the presentations (in order not to trigger attention from moving from the task to the potentially salient discrepancy of a female voice in combination with a male face). Pictures were taken, with permission, from the Radboud Faces Database (RaFD; Langner, Dotsch, Bijlstra, Wigboldus, Hawk, & van Knippenberg, 2010). The pictures in this database have been validated and the overall agreement between pictures’ intended emotional display and test participants’ identification of emotion is 82 percent. An even higher agreement rate is found for happy facial expressions (98 percent) and sad facial expressions (85 percent; Langner et al., 2010).

Lastly, the schematic faces used by children to give their answers regarding the emotion of the presented face, were validated in adult populations in three different countries. Four faces for each emotion were used in the validation process, and the faces
that participants most accurately labeled correctly, and that had the least mixed labels attached to them, were used in the current study.

**Data analysis**

Most analyses in the current study were straightforward and do not need further presentation. However, the positive skew normally found in RT data distributions (Wheelan, 2008), must be addressed. When dealing with RT data, RTs can reflect the process of interest as well as other processes; while fast RTs can reflect guessing, slow RTs can reflect fatigue or loss of focus (Wheelan, 2008).

While the risk of type I errors is minimal if one decides to simply perform an ANOVA on such data without further preparation (Ratcliff, 1993), such a procedure can reduce statistical power (Wilcox, 1998). There are three common ways to deal with the problem of skewed data and outliers in RT distributions; eliminating data outside of certain cut off points, data transformation that normalizes the distribution and simply reporting the median instead of the mean (Ratcliff, 1993; Wheelan, 2008). Using cut off points is the approach that best maintains power (Ratcliff, 1993), and was the approach chosen in the current study.

However, if the compared conditions differ from each other regarding the parameters of the long right tail in the distributions (tau), power will be reduced due to the mistake of eliminating a higher degree of genuine RTs in one of the conditions (Ratcliff, 1993). Researchers typically choose to eliminate RTs above and below ± 2 SD or ± 3 SD around the grand mean (Lachaud & Renaud, 2011). However, choosing cut off points around the grand mean does not take into account that the amount of variation can differ among the various subdistributions (Lachaud & Renaud, 2011) – thus risking the aforementioned situation where genuine RTs in one condition are eliminated, while genuine RTs in another are preserved.

In the current study, two approaches were undertaken in order to reduce the risk of such a bias. First, the filtering of RTs was done already at the level of distribution by condition and by participant. Such an approach increases reliability of the results (Lachaud & Renaud, 2011). The filtering itself was done using cut off points based on median absolute deviation (MAD). The measure of MAD is robust and less sensitive to outliers than the SD, thus reducing the risk of eliminating genuine RTs (Lachaud & Renaud, 2011; Leys, Ley, Klein, Bernard, & Licata, 2013). In the current study, RTs above and below 3 MAD were eliminated. Such a cut off level is considered to be conservative, reducing the risk of eliminating genuine RTs (Miller, 1991). After elimination of outliers using these approaches, each participant's RTs were aggregated into means for each condition and those means were used in the subsequent analyses of groups and conditions. The aggregated means only included RTs from trials in which the child had answered correctly.
Results

Background Variables

Age. T-tests were performed in order to investigate whether the two language groups differed from each other regarding age distribution. Age distribution in the entire bilingual group \((M = 5.29, SD = 0.72)\) and in the entire monolingual group \((M = 4.92, SD = 0.68)\) were not different from each other \((t_{27} = 1.40, p = .17)\). Kolmogorov-Smirnov test of normality showed that both groups consisted of children with normally distributed ages (age distribution for monolinguals: \(K-S = 0.10, p = .20\); age distribution for bilinguals: \(K-S = 0.13, p = .20\)).

Comparing only those children included in analyses of RT performance, a t-test revealed that age distribution in this group of bilinguals \((M = 5.41, SD = 0.60)\) and age distribution in this group of monolinguals \((M = 5.00, SD = 0.77)\) did not differ from each other \((t_{18} = 1.34, p = .20)\). Kolmogorov-Smirnov test of normality showed that both groups consisted of normally distributed ages (age distribution for monolinguals: \(K-S = 0.25, p = .15\); age distribution for bilinguals: \(K-S = 0.17, p = .20\)).

Gender. A Chi-square analysis on gender distribution in the language groups, showed that the relative distributions of girls and boys were equal across language groups \((\chi^2(1, N = 30) = 2.04; p = .15)\). A Chi-square analysis on gender distributions in the language groups when only including those children included in the RT analyses, showed a similar result. Girls and boys were equally distributed across language groups \((\chi^2(1, N = 20) = 2.16; p = .14)\).

Educational level of parents. Mann Whitney U-tests were employed to test whether educational level of parents differed between language groups. First, looking at the entire bilingual group and the entire monolingual group, educational level did not differ between groups, neither when looking at educational level of the parent with the most education \((U = 96.50, p = .74)\) nor when looking at the average educational level of both parents \((U = 96.50, p = .76)\).

Second, looking at the bilinguals and monolinguals included in the RT analyses, a similar result was found. Educational level did not differ between groups, neither when looking at educational level of the parent with the most education \((U = 32.00, p = .23)\) nor when looking at the average educational level of both parents \((U = 43.50, p = 1.00)\).

Main Analyses of Language Groups' Effect on Test Performance

Number of correct responses. A two-way 2x2 mixed ANOVA was performed. Levene's test showed violations to the assumption of homogeneity of variance. In this particular analysis, alpha level was set to .01 to reduce the risk of type I error that can accompany such a violation (Tabachnick & Fidell, 2014). Results showed a significant main effect of condition \((F_{1,28} = 39.04, p < .01; \eta_p^2 = .58)\), where children more frequently answered correctly in the congruent condition \((M = 13.31, SE = 0.51, CI(95%) = 12.49-15.51)\) than in the incongruent condition \((M = 6.9, SE = 0.89, CI(95%) = 4.13-9.44)\). However, no main effect of language group was found \((F_{1,28} = 0.29, ns)\; descriptive statistics in Table 2), nor was there any interaction effect between language group and condition \((F_{1,28} = 0.29, ns)\).

Further examining the effects of condition, two one sample t-tests were performed, showing that children's number of correct responses in the congruent condition were higher than chance performance \((t_{29} = 10.29; p = <.01; d = 1.88)\). Number of correct responses in the incongruent condition did not differ from chance performance \((t_{29} = 1.23; p = .23)\).

Reaction time. Another two-way 2x2 mixed ANOVA was performed. Results
showed a trend towards better performance in the incongruent condition ($M = 3276.07, SE = 275.59, CI(95%) = 2467.39-3976.56$) than in the congruent condition ($M = 3503.18, SE = 230.31, CI(95%) = 2709.62-3970.81; F_{1,17} = 3.41, p = .08, \eta^2_p = .17$). No main effect of language group was found ($F_{1,17} = 0.19$, ns; descriptive statistics in table 2), and no interaction effect between language group and condition was found ($F_{1,17} = 0.78$, ns).

Table 2

<table>
<thead>
<tr>
<th>Condition</th>
<th>Language group</th>
<th>Mean correct responses</th>
<th>Mean RT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congruent</td>
<td>Monolinguals</td>
<td>12.63 (3.48)</td>
<td>3626.97 (826.19)</td>
</tr>
<tr>
<td>Incongruent</td>
<td></td>
<td>7.06 (3.75)</td>
<td>3395.55 (1054.79)</td>
</tr>
<tr>
<td>Congruent</td>
<td>Bilinguals</td>
<td>14 (1.57)</td>
<td>3248.90 (953.07)</td>
</tr>
<tr>
<td>Incongruent</td>
<td></td>
<td>6.79 (5.87)</td>
<td>3221.97 (1284.28)</td>
</tr>
</tbody>
</table>

*Mean number of correct responses out of 16 per condition, and mean RT measured in ms (SD in parentheses)*
Discussion

The current study examined whether the bilingual advantage in interference suppression generalizes to attending to happy and sad facial expressions when these are congruent or incongruent, respectively, to happy and sad lexical content. The hypotheses stated that all children would perform better in the congruent condition than in the incongruent one and that bilinguals would outperform monolinguals in the incongruent condition but not in the congruent condition.

In line with the first hypothesis, all children correctly identified a larger number of facial expressions in the congruent condition than in the incongruent condition. This main effect of condition was a large one. Furthermore, compared to chance performance, all children performed better in the congruent condition. In the incongruent condition, children performed at chance level. While there was no statistically significant difference in RT between the congruent and the incongruent condition, results showed a trend towards better performance in the incongruent condition. The effect size was moderate.

As bilinguals were only hypothesized to outperform monolinguals in one of the conditions but not in overall performance, it is not surprising that no main effects of language group was found. However, contrary to what was hypothesized, there was no interaction effect between language group and condition. This means that no bilingual advantage was found in the incongruent condition.

Returning to effects of condition, the trend towards better RT performance in the incongruent condition contradicts the better performance in number of correct responses in the congruent condition. However, while the difference in performance regarding number of correct responses was statistically significant, the difference in performance regarding RT was not. The effect of condition on number of correct responses was also larger than the effect of condition on RT performance. Furthermore, RT performance should be interpreted cautiously, as sample size was particularly small in the RT analyses and as RT does not seem to be a valid outcome measure in this study (a discussion on RT interpretation will follow later in the discussion).

Focusing on performance regarding number of correct responses in the incongruent condition, bilinguals in the current study did not perform worse than bilinguals in Yow and Markman's study (2011) did. Yow and Markman (2011) also found a chance level performance by bilinguals when lexical content was incongruent with paralanguage. However, their monolingual participants performed significantly below chance level, demonstrating a strong lexical bias. As the current study's participants had a mean age of five (and even included some six-year-olds) instead of four as Yow and Markman's (2011) had, it may not be surprising that the current monolingual sample showed neither a strong lexical bias nor consistent attention to paralanguage. After all, the lexical bias seems to diminish gradually with age (at least in relation to vocal tone; Morton & Trehub, 2001) and ability to read facial expressions develops with age (Baudouin et al., 2008; Durand et al., 2007). Furthermore, facial expressions might be easier to read than vocal tone (Russel et al., 2003).

If the relatively good performance by the current monolingual sample (not below chance level) is in line with what can be expected at this age, then the current sample of bilinguals should have performed even better if there was in fact a bilingual advantage to this task. There are many possible reasons why the current study could not find a bilingual advantage. Such reasons will be explored below, followed by a discussion on how the present results relate to the research field of bilingualism in general and to child emotional
The Study's Limitations and Strengths

The sample and its effect on internal and statistical conclusion validity. First, a discussion of the study's limitations and strengths is in order, as these affect the probability of finding a difference between groups if there was one. Beginning with an examination of internal validity, selection can of course be hypothesized to pose a problem as the study was quasiexperimental and vulnerable to the influence of extraneous variables.

As recently mentioned, a higher age probably leads to better performance in studies like this (Baudouin et al., 2008; Durand et al., 2007). Furthermore, there could be an effect of gender as female children seem to have a small advantage in reading facial expressions (Chaplin & Aldao, 2013). However, these variables were included in the study and have in fact been outruled as extraneous variables. Specifically, the groups did not differ in age distributions or in gender distributions.

An advantage in EF can also be seen in people with high SES (Calvo & Bialystok, 2014; Morton & Harper, 2007). While the language groups did not differ from each other regarding parental educational level, this is only one aspect of SES. Due to ethical concerns, information about parental income level or occupation was not collected. Thus, SES cannot be outruled as a potential confounder. If the bilinguals come from homes with lower SES compared with the monolinguals, a bilingual advantage could have been confounded by the monolinguals' hypothetical SES advantage. However, the risk for selection bias in SES would have been larger if all bilinguals and all monolinguals had been entirely separated by different preschools in different areas. Instead, bilinguals and monolinguals were spread across the preschools.

Continuing with an examination of the statistical conclusion validity, important limitations of the study was the small sample and the fact that this sample was heterogeneous. Importantly, the bilingual group was very heterogeneous. Bilingualism itself is a heterogeneous concept, as bilinguals can differ from each other in proficiency, for instance as a result of differences in age of second language acquisition or frequency of second language exposure (Marian et al., 2007). To illustrate the diversity in the bilingual population, one bilingual might have been exposed minimally to a second language from birth, while another might have been exposed to a second language 50 percent of the time since the age of three. While both may be considered bilingual, they have quite different linguistic experiences.

While all participating bilinguals were early bilinguals, only five had learned the second language from birth. Very recently, Struys et al. (2015) showed that bilinguals who have learned their second language from birth seem to outperform other bilinguals in the incongruent condition of the Simon task. Thus, as only a minority of the bilingual children in the current study had learned both languages from birth, this can explain why the bilingual group as a whole did not show an advantage.

Furthermore, the bilingual children were heterogeneous regarding how long they had been exposed to a second language. There is not much research done on the effects of length of language exposure, as this is confounded by age of acquisition (Hull & Vaid, 2007). However, it does seem like children who have only managed two languages for a brief amount of time do not have the same controlled attention advantage as children who have managed two languages for a long time (Kapa & Colombo, 2013; Poarch & van Hell, 2012a; Luk et al., 2011). Lastly, the cut off limit regarding exposure to a second language, was very low at 15 percent exposure time. Ideally, higher demands on second language development in general.
exposure frequency and on age of acquisition would have been stated in the study. This was, however, not possible due to recruitment difficulties.

A low frequency of second language exposure and a high age of second language acquisition, could indicate low second language proficiency. It is important to remember that when second language proficiency is low, coactivation of languages only happens when the bilingual is exposed to their non-dominant language (Poarch & van Hell, 2012b; van Hell & Tanner, 2012). Furthermore, if children are not exposed to this non-dominant language very often, less coactivation of languages is a natural consequence. This means that low proficiency bilinguals do not have to manage the same amount of language competition as high proficiency bilinguals. The implications for the current study is that, since many of the participating bilinguals had a low second language proficiency, it is not surprising that the current bilingual group showed no interference suppression advantage.

Heterogeneity is not just a problem specifically in the bilingual group, but the entire group of children was heterogeneous regarding age. Again, in order to get an acceptable sample size, the age span needed to be wide. As the exact developmental progression of children’s ability to read facial expressions when these conflict with lexical content is unknown (Morton & Trehub, 2001), it could be that a bilingual advantage only shows in a specific age window. Since so few children from each age group participated, effects of age could not be examined.

Parental reports of language experience and proficiency as potentially problematic. Categorization of monolinguals and bilinguals was conducted on the grounds of parental reports on second language exposure frequency, frequency of conversation initiation in the second language and age of acquisition. However, it can be hypothesized that parental reports are inadequate. If this is the case, then the categorization of monolinguals and bilinguals has been conducted on insufficient grounds. For instance, one parent might underestimate the frequency of second language exposure while another might overestimate it. If differences between monolinguals and bilinguals are to be explored, children’s language experiences and proficiency must first be accurately measured.

The original LEAP-Q has been validated, meaning that adults can accurately self-report their own language proficiency. As the children in the current study were very young and therefore often accompanied by their parents when not in preschool, it is possible that parental reports can in fact accurately indicate child language proficiency. However, it remains problematic that the modified version of the LEAP-Q used in the current study has not been validated.

RT as a problematic outcome measure. First, as children used a computer touch pad instead of using touch screen or simply pressing a key to provide an answer, RTs were longer than normal. However, all children got to practice using the touch pad.

A more important discussion on RT concerns the long exposure time for the stimulus presentations. As each presentation was as long as one sentence, children had the opportunity to decide on an answer even before a stimulus presentation was finished. Therefore, it would not be correct to assume that the measurement of RT was in fact a valid reflection of genuine decision making processes. As results showed a trend of better RT performance in the incongruent condition, the interference from the lexical content are not reflected in RT results, even though the incongruent condition was very difficult as evident by number of correct responses. While Yow and Markman (2011) did find a difference in RT between their incongruent and congruent condition, no RT difference between language groups was found in their incongruent condition, even though their bilingual children had a
greater number of correct responses in this condition. Hence, it seems to be difficult to consistently find an interference effect reflected in RT in this type of task where exposure time is long.

**Choosing the Correct Emotion in the Incongruent Condition - a Valid Test of Interference Suppression?** The fact that all children found the incongruent condition to be more difficult as seen by number of correct responses, and that all children performed at chance level in this condition, reinforces the idea that it placed high demands on children's cognitive abilities. It was indeed difficult to consistently override the lexical bias even when instructed to do so. However, as bilinguals in general have been found to outperform monolinguals in such incongruent conditions placing demands on interference suppression, it is natural to question whether the current study did in fact succeed in placing demands on interference suppression specifically.

The current study differed from that of Yow and Markman's (2011), where differences between language groups was found regarding reading paralinguistic cues. While Yow and Markman (2011) operationalized paralanguage as vocal tone, the current study focused on facial expressions. It could be a complicating factor that the children received input through two different modalities. Thus, while children could hold the verbal content in the phonological loop, they could simultaneously hold the image of the facial expression in the visuospatial sketchpad.

Following this, the current study's internal validity can be discussed. If the children could in fact attend to both stimuli and have both active in working memory when choosing a response, could it be that the task placed demands on response inhibition instead of interference suppression? It could be argued that, as children did not actively have to select only one stimulus to attend to, they instead needed to suppress answering in a habitual way (e.g. in line with their lexical bias). As mentioned earlier, response inhibition and interference suppression are two dissociated EF (Brydges et al., 2012; Luk et al., 2010), and bilingual children do not seem to have an advantage in response inhibition (Bialystok et al., 2009; Carlson & Meltzoff, 2008; Esposito et al., 2013; Martin-Rhee & Bialystok, 2008) – which could explain the absence of such an advantage in the current study.

However, while it is possible to divide attention between the visual and the verbal stimulus, this was not what the children were instructed to do. The children were explicitly and repeatedly instructed to provide an answer in line with the facial expression. As attention can be controlled to favor selection of one modality over another and maintain attention there (Talsma, Kok, Slagter, & Cipriani, 2008), someone who has well developed abilities of controlled attention would probably succeed in such a selection. Furthermore, even if attention would initially be divided, it would at some point need to be directed towards the mental representation in the visuospatial sketchpad in order to achieve the goal of providing an answer in line with the facial expression. The key element in interference suppression tasks, is that controlled attention must be employed in face of the simultaneous presence of two conflicting stimuli where one needs to be ignored if the task is to be resolved in an accurate way (Bunge et al., 2002). Such a paradigm is, after all, present in the current study.

It could, then, be argued that the children simply did not understand or remember the instructions. If so, they might have failed at recognizing which stimulus was the target stimulus and therefore had trouble consistently overriding the lexical bias. It is of course not possible to be entirely certain that all children understood or remembered the instructions. While Morton et al. (2003) measured how well children had understood their congruent-
Bilingualism and ambiguous emotional cues

incongruent vocal tone task, the current study did not. However, even when children do understand and remember instructions, they still find these type of tasks difficult (Morton et al., 2003).

The Result in the Context of the Research Field of Child Bilingualism

Does bilingualism help children attend to facial expressions when these conflict with lexical content, even if young children normally have a strong lexical bias? The current study cannot reject the null hypothesis of no difference between language groups in this sort of task. Furthermore, as this is yet an unexplored area, the answer to such a question lays in future research. While Yow and Markman (2011) did find a difference between language groups regarding vocal tone in emotionally ambiguous situations, this has not yet been replicated. As such, it cannot yet be stated with much confidence that the bilingual advantage does generalize to affecting children's emotional development regarding reading facial expression specifically or paralanguage in general in emotionally ambiguous situations.

Though a bilingual advantage has been found in many interference suppression tasks (Bialystok et al., 2009; Bialystok & Senman, 2004; Bialystok & Viswanathan, 2009; Carlson & Meltzoff, 2008; Esposito et al., 2013; Martin-Rhee & Bialystok, 2008; Poulin-Dubois et al., 2011; Yang, Yang, & Lust, 2011; Yow and Markman, 2011), it does not necessarily mean that the advantage generalizes to situations where attention needs to be maintained at facial expressions. Whether or not it does, could lead to a better understanding of how the bilingual advantage works. If it is present in some domains but not in others, does that mean that some moderating variable affects the relationship between bilingualism and the advantage in interference suppression? As the mechanisms behind the bilingual advantage are still under debate (Kapa & Colombo, 2013), such knowledge could contribute to a better understanding of what causes the bilingual advantage. Furthermore, as the current study demonstrates heterogeneity in the bilingual sample and fails to find a bilingual advantage, this could lead to a better understanding of which specific bilingual experiences, at which intensity, do in fact lead to a bilingual advantage.

As discussed, the heterogeneity of ages and second language proficiency in participants makes it hard to draw any conclusions from this study. What is clear, is that a lot of earlier research has pointed towards a bilingual advantage in interference suppression (Bialystok et al., 2009; Bialystok & Senman, 2004; Bialystok & Viswanathan, 2009; Carlson & Meltzoff, 2008; Esposito et al., 2013; Martin-Rhee & Bialystok, 2008; Poulin-Dubois et al., 2011; Yang, Yang, & Lust, 2011; Yow and Markman, 2011) and also to an advantage in other domains such as metalinguistic awareness, working memory and abstract and symbolic representation (Adesope et al., 2010). Regardless of whether the bilingual experience also strengthens children's abilities to read paralanguage or specifically facial expressions in emotionally ambiguous situations, bilingualism has already been seen to come with many advantages – especially when a child learns the language from an early age and gets the opportunity to become proficient in both languages (Bialystok et al., 2009; Hull & Vaid, 2007; Kapa och Colombo, 2013; Kroll & Bialystok, 2013; Luk, DeSa, & Bialystok, 2011; Olsen et al., 2015; Struys et al., 2015).

The Result in the Context of the Research Field of Child Emotional Development

While the current study had a focus on the effects of bilingualism on reading facial expressions in emotionally ambiguous situations, a bonus result regards how the entire group of children performed in the incongruent condition. As mentioned, monolinguals and bilinguals performed at chance level in this study, though the monolinguals in Yow and
Markman’s (2011) study performed significantly below chance level — indicating a strong lexical bias.

The better performance by the current study's monolinguals have been discussed in relation to their older age and in relation to that it might be more easy to read facial expressions than vocal tone. However, while the developmental process of how the lexical bias in relation to vocal tone diminishes with age, has been studied, it is not yet known how the lexical bias in relation to facial expressions diminishes (Morton & Trehub, 2001). It is therefore difficult to know for sure whether the performance of children in the current incongruent condition was age appropriate or not. Thus, the current study could lead to a hypothesis of the lexical bias to start diminishing at the age of five, as this was the mean age of the children and as the children relied equally on lexical content as on facial expressions at this age.

**Conclusions and Future Directions**

In sum, the current experiment placed demands on interference suppression, an EF that bilinguals have repeatedly proved to outperform monolinguals in. Such a bilingual advantage was, however, not found in the current study. It might be that the advantage only generalizes to some domains but not to all domains. Whether or not the advantage generalizes to the development of ability to read paralanguage in emotionally ambiguous situations, such knowledge could lead to a better understanding of the mechanisms behind the bilingual advantage.

The current study was limited in its statistical conclusion validity, as there was great heterogeneity in participants. As this study implicates that not all bilingual experiences may lead to a bilingual advantage in interference suppression, future research should aim at further investigating which specific experiences lead to an advantage in interference suppression and in which domains.

Furthermore, this study can be viewed as a pilot in researching interference suppression in the specific situation of reading facial expressions in emotionally ambiguous situations. Future similar studies should either control for the effects of second language proficiency and second language age of acquisition or recruit a more homogeneous sample to begin with, both regarding bilingualism and age of participants. Future studies should also better control for SES.
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Bilingualism and ambiguous emotional cues


Bilingualism and ambiguous emotional cues


Bilingualism and ambiguous emotional cues


Siegal, M., Iozzi, L., & Surian, L. (2009). Bilingualism and conversational understanding in
Bilingualism and ambiguous emotional cues


Appendix

Modified version of the LEAP-Q

Please answer to the following questions.

1. Please list all the languages that your child knows in order of dominance, i.e. the language that your child knows best, second best, etc. (if your child knows more than five languages, list the five languages that your child knows best).

1. __________________________________________
2. __________________________________________
3. __________________________________________
4. __________________________________________
5. __________________________________________

2. Please list all the languages that your child knows in order of acquisition, i.e. your child's first language, second language, etc. (if your child knows more than five languages, please sort the five languages that you listed in the question above).

1. __________________________________________
2. __________________________________________
3. __________________________________________
4. __________________________________________
5. __________________________________________

3. Please list what percentage of the time your child is currently and on average exposed to each language (the total should be 100 percent). Use the same order as in question 1.

Language 1 _____ %
Language 2 _____ %
Language 3 _____ %
Language 4 _____ %
Language 5 _____ %

4. When playing, in what percentage of the total time does your child use each language (the total should be 100 percent)? Use the same order as in question 1.

Language 1 _____ %
5. In what percentage of the total time does your child start a conversation in each language (the total should be 100 percent)? Use the same order as in question 1.

<table>
<thead>
<tr>
<th>Language</th>
<th>_____ %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

6. How old was your child when he/she started to learn his/her first second language (if it was from birth, please write 0 year(s) and 0 month(s))? ___ year(s) ___ month(s)

7. In which environment(s) does your child usually come in contact with each language? Use the same order as in question 1.

<table>
<thead>
<tr>
<th>Environment</th>
<th>Language 1</th>
<th>Language 2</th>
<th>Language 3</th>
<th>Language 4</th>
<th>Language 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the country where you reside</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>At home with the family</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>At daycare</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>At friends' homes</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

8. On a scale from 0 to 10 (where 0 = not at all and 10 = very much), how much do the following factors contribute or did contribute to your child's language learning?

<table>
<thead>
<tr>
<th>Factor</th>
<th>0</th>
<th>1</th>
<th>2</th>
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<td>Interaction with family and relatives</td>
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<td>Interaction with daycare staff</td>
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Through various media such as TV, computer, movies, radio, etc.

9. Your child's daycare: _________________________

10. Your child's family name: _________________________

11. Your child's given name: _________________________

12. Your child's birth year and birth month (YY-MM): ___ ___ - ___ ___

13. Your child's gender:
   □ Boy
   □ Girl
   □ Other / I do not want to answer

14. You are the child's:
   □ Mother
   □ Father
   □ Other, please specify: _________________________

15. What year were you born? _________

16. What year was the child's other parent born? _________

17. What is your highest completed education level?
   □ No formal education
   □ Elementary school or lower
   □ High school
   □ Professional training
   □ College or university
   □ I don't know
   □ Other, please specify: _________________________

18. What is the child's other parent’s highest completed education level?
   □ No formal education
   □ Elementary school or lower
   □ High school
☐ Professional training
☐ College or university
☐ I don't know
☐ Other, please specify: _________________________