

Comparing off- and on-line measures of AAE- and SAE-speaking children's comprehension of SAE tense

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Recent methodological advances have made it possible to investigate how children process language and arrive at sentence-level meaning on-line. For example, eye-tracking enables analysis of how individual words and morphemes are interpreted during comprehension. This allows results from traditional off-line measures to be integrated with on-line measures leading to a more complete understanding of how language processing operates.

The data presented here are drawn from a larger project investigating how speakers of African American English (AAE) comprehend Standard American English (SAE), the standard variety of English used in the US. Although the two varieties share many phonological forms, the grammars differ substantially. For example, SAE 3rd person singular present -s, future contracted 'll, and past allomorphs -t/-d do not regularly appear in the surface form of AAE. This, among other evidence, suggests that while these morphemes carry tense information in SAE, they may not in AAE. An important question therefore becomes how speakers of different varieties of English utilize SAE tense morphology during comprehension. The present study investigates how 1st and 2nd grade AAE- and SAE-speakers interpret SAE morphology during comprehension using off-line and on-line measures.

For the off-line measure, participants are asked to select one picture from a set that best matches a spoken SAE sentence. Some sentences contain explicit temporal words (e.g., yesterday), but in others, SAE morphology provides the only temporal information. The data show that when correct picture identification requires an understanding of SAE tense morphology, both 1st and 2nd grade AAE-speakers show lower comprehension scores than 1st and 2nd grade SAE-speakers. However, this general pattern is modulated by the particular SAE element tested: AAE-speakers show lower comprehension for -ed and 'll, but not present -s. Interestingly, for -s, 1st grade SAE-speakers also show chance performance, whereas 2nd grade SAE-speakers show higher comprehension, suggesting that an understanding of present -s is developing during this time for SAE-speakers.

The off-line measure shows global comprehension patterns that accord with differences in the morphological systems of the children's native language varieties. However, it does not tell us whether both groups of speakers are noticing the same information but are using it in different ways. For example, the off-line data suggests that AAE-speakers either (1) do not notice SAE tense marking during comprehension, or (2) notice SAE tense marking but are unsure of how to utilize it during comprehension, possibly showing slowed processing. In contrast, SAE-speakers are expected to utilize SAE tense marking during comprehension. In order to address this question, data from on-line measures are required.

For the on-line measure, participants are presented with the same stimuli but are eye-tracked during comprehension and picture selection. Preliminary data show that 1st and 2nd grade SAE-speakers interpret certain SAE tense morphemes correctly (i.e., past tense -ed), and utilize this information to rapidly select appropriate pictures and arrive at sentence-level meaning. Data collection for AAE-speakers has just begun and will provide information about how SAE morphological elements are interpreted on-line, and are used to arrive at sentence-level meaning.

**Sound and language discrimination studies in early development:
Do visual fixation measures reflect processing differences between preterm and full term infants?**

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Behavioural measures of attention towards auditory material of different level of complexity (single word-form stimuli or three-sentence passages) have been obtained in a sample of preterm infants (gestational age <32 weeks and birth weight <1,500g, with no congenital, physical or severe neurological anomalies) and a control group of full-terms, by 4 and 6 months of age (corrected age for preterms). Infants are participants in a broader prospective study of speech perception/discrimination abilities and lexical development over the first two years of life. Although differences between full term and preterm infants in attention, recognition memory and processing speed for visual stimuli have already been shown (Rose et al., 2001; 2002; Lawson & Ruff, 2004), data regarding possible differences in speech and language perception abilities in the first year of life are still scarce. This is a relevant area of research since language development is likely to be compromised in children born preterm with very low birth weight (Jansson-Versakalo, et al., 2004).

Speech sound discrimination and native versus non-native language differentiation have been assessed through the familiarization-preference procedure. This paradigm includes an extended familiarization phase, with presentation of the auditory stimuli contingent on infants' looking behavior and a test phase in which listening times to contrastive materials are monitored. Familiarization in this paradigm was fixed up to two minutes. A decline in attention was expected to happen during the second minute of repeated exposure to the familiarized material, as an indication that processing of the stimuli has been completed. Groups of preterm and full term infants were compared on both attention time during familiarization phase (processing) and attention time to same and switch test trials (discrimination) in three different experiments: /o/-/u/ and /s/-/f/ discrimination in non-words and native versus non-native language differentiation.

Preliminary results from the younger groups tested for vowel discrimination reveal significant differences in attention time during the familiarization phase and in the ability to perceive a vowel change in the test phase. Attention time decrement during familiarization phase is non-significant in the preterm group. Vowel discrimination in the test phase is not achieved. By 6 months of age, however, differences in attention time during the familiarization phase have disappeared and, when tested for fricative sound discrimination, similar results have been observed in both groups of infants (although no evidence of novelty reaction to a fricative sound change [s-f] in the test phase has been obtained so far). As for language discrimination abilities at 6 months of age, a significant difference between groups has been found, with full-terms showing shorter attention time throughout the whole test. However, both groups are able to differentiate native versus no-native language utterances and they do not differ in number of trials in the familiarization, nor in the amount of decrement in fixation time between first and last trials in that phase. The connection between processing time monitored during familiarization and discrimination outcomes in the test will be further discussed. Medical and cognitive factors for the at-risk population under study will also be considered.

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Mouse-tracking the visual world can illuminate syntactic processing in young to very young children

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Recently, studies of online syntactic processing in young children have been made possible by monitoring eye-movements in relation to real scenes. Although eye-tracking children has provided invaluable child-performance data, the technique can be expensive, it can involve slow hand-coding of data, and can sometimes be perceived as objectionable by parents.

As a supplement to eye-tracking, we demonstrate here that monitoring the continuous nonlinear trajectories recorded from the streaming x,y coordinates of computer-mouse movements can serve as an informative indicator of the cognitive processes underlying children's syntactic processing. In contrast to self-paced reading data, which affords ~2 data points (RTs) per second, and to eye-movement data, which allows for approximately 2-4 data points (saccades) per second, "mouse-tracking" yields somewhere between 30-60 data points per second, depending on sampling rate.

Since arm movements are relatively continuous and can be smoothly redirected mid-flight, mouse-movements can be used as a potential index of the activation (or attractor-strength) of alternative interpretations during spoken language comprehension (Spivey et al., 2005).

Mouse-tracking is a viable method for examining on-line language processing in a wide-array of cognitive tasks and across a relatively large age-range. Through a large-scale survey of children's computer use, Calvert et al. (2005) found that the mean age of the onset of autonomous computer use was 3.7 years. Moreover, the mean age at which a child was able to point and click a computer mouse was 3.5 years, suggesting that experiments employing the mouse-tracking procedure could be feasible with children as young as 3-and-a-half to four years.

In the current experiment, we utilize the continuous nature of mouse-tracking to explore five-year-old children's sentence processing abilities in the visual world paradigm (Spivey, et al., 2002; Tanenhaus et al., 1995).

(1a) Put the apple on the towel in the box.

(1b) Put the apple that's on the towel in the box.

Children heard either an ambiguous (1a) or unambiguous (1b) spoken command while viewing a display that contained either one referent (e.g. one apple) or two referents (e.g. two apples). In the critical instructions, the object to be moved (e.g. the apple) always appeared in the top-left portion of the screen and the correct destination (e.g. the box) always appeared in the bottom-right. Streaming x,y coordinates, sampled at ~ 36 Hz, were recorded during the movement of the referent to its destination. A wide variety of filler objects and movement directions were included to prevent anticipatory movements.

Results indicate that children as young as five can not only complete the task, but can even produce smooth and interpretable trajectories exhibiting spatiotemporal properties comparable to those of adults. Findings are interpreted with respect to theoretical claims regarding integrated use of visual context and verb structure preferences to resolve syntactic ambiguity (Snedeker & Trueswell, 2004).

We observe here that streaming x, y coordinates of goal-directed hand movement recorded via mouse-tracking provide information that can supplement data gathered through eye-tracking experiments. Notably, this technique can be used with very young children and in a wide-array of situations and locations, either by itself or in conjunction with eye-tracking methods.

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Auditory phonological priming effects during word repetition by children and adults

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Findings on spoken word recognition in adults suggest that when a word is heard, not only are memory representations of the word itself and its constituent phonemes/sublexical units activated, but also, to lesser extent, representations of similar-sounding words and their constituent parts. These different activations appear to interact with each other in complex ways. Additionally, this activity persists for some non-negligible amount of time and can influence the way new incoming speech information is processed.

In the present study, 30 children (ages 7-11 years) and 20 adults, all with normal hearing and typical language, were presented with recorded pairs of familiar CVC words. The offset of the first word and the onset of the second word were separated by 50 ms of silence. The children were instructed to ignore the first word (the prime) and to repeat the 2nd word (the target) as soon as they knew what the word was. The time taken to initiate repetition was measured. Three conditions were tested. In one condition the word pairs shared no phonemes. In another, the words rhymed. Under a third condition, the word was repeated. In this 'repeated word' condition, because our interest was in phonological, not acoustically-based priming, two different recorded instances of the word were used.

As in previous studies, reaction times were measured from the onset of the target word and each target word was tested under all three experimental conditions. Inter-stimulus intervals of 50 ms pose no difficulty to individual word identification, are brief enough to discourage strategic processing, and have been the most widely used delay in previous research on short-term phonological priming.

Both groups, on average, produced targets preceded by a rhyme or repetition reliably faster than targets preceded by a dissimilar-sounding word. These results replicate previous findings in the adult literature, although no study that we are aware of has examined these effects in children, nor included both a repetition prime and a rhyme prime condition in the same study. Reaction times in the rhyme and repetition conditions did not differ reliably from each other in either group. The size of the priming effect was larger in children than in adults, both in terms of absolute value and also when analyzed as a proportion of the average total response time.

One issue raised by these data is how use of a repeated stimulus token in past studies may have influenced results, specifically the degree to which acoustically-based representations might have enhanced facilitatory effects. An additional experiment therefore addressed the issue of whether acoustic-level equivalence is necessary to elicit reliably greater facilitation in a repetition condition than in a rhyme-prime condition. In the absence of acoustic equivalence, we hypothesize that only phonological overlap in rhyme drives the facilitation effect in both repetition and rhyme prime conditions. That is, we argue that initial segment overlap in the repetition condition did not contribute to the facilitatory effect observed in our first experiment. Data from a new sample of normal-hearing children will be presented.

Comprehension of case marking and word order cues by German preschoolers

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Two key cross-linguistic cues are word-order and case-marking. Studies within the framework of the Competition Model have examined which cue speakers follow when the two conflict in identifying different noun phrases as e.g., agent. However, previous such studies with German children have used known verbs so that it is impossible to determine whether the use of such cues is based on abstract grammatical knowledge about the transitive construction (Lindner, 2003; Schaner-Wolles, 1989).

Therefore, we conducted a pointing comprehension experiment using novel verbs to examine whether German children are able to use these grammatical cues to interpret semantic roles and whether they weigh these two cues differently across development.

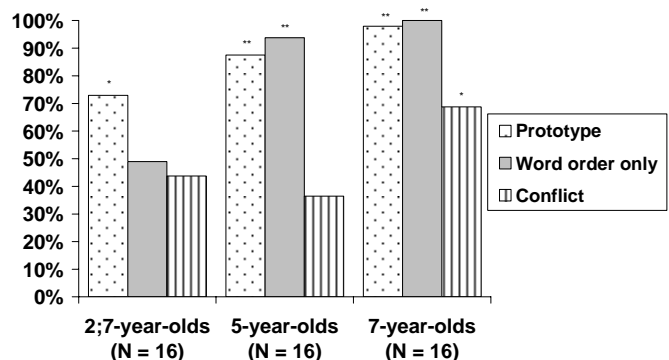
We tested 16 2;7-year-olds, 16 4;10-year-olds and 16 7;3-year-olds in three within-subjects conditions: The “prototype-condition” in which both case-marking and word-order refer to the first NP as agent (e.g., ‘the(+NOM) dog is weefing the(+ACC) lion’), the “conflict-condition” in which word-order refers to the first NP as agent but case-marking to the second NP (e.g., ‘the(+ACC) bear is weefing the(+NOM) tiger’), and finally the “word-order-only-condition” in which case-marking is ambiguous, i.e., through use of feminine or neuter articles (e.g., ‘the(-CASE) sheep is weefing the(-CASE) horse’). During the test the children heard a pre-recorded linguistic stimulus: ‘Look, the dog is weefing the lion’ while watching two simultaneous scenes with the same action but reverse agent and patient roles. Afterwards the children were asked to point to the correct still picture (e.g., ‘Show me: where did the dog weef the lion’).

Our results show that by 2;7 German children can identify the agent of a novel verb when both word-order and case-marking collaborate in referring to it. Between 4-5-years of age the single word-order cue is sufficient for agent identification and reliance on word-order is stronger than on case-marking. However, only at around seven years can children weigh cues in relation to their reliability and appropriately resolve sentences with conflicting cues (see figure 1).

We compared our results to findings from a corpus study in which we investigated the use of these cues in the input (six German mothers; age of children: 1;8 and 2;5). In most of the transitive sentences (68%) both cues refer to the first noun as agent (subject-first order, marked with nominative). But 21% of the transitives in German CDS appear in object-first order, so that children have to rely on case-marking rather than on word-order to interpret semantic roles. The remaining 11% of the transitives in CDS show ambiguous case-marking for agent and patient and therefore children can only rely on word-order to find out that the first noun of the sentence is the agent. Cue validities calculated from this input data were found to be 86% for case-marking and 68% for word-order.

This comparison suggests that the order of acquisition is not entirely predictable from the input cue validity of single cues in isolation (Bates & MacWhinney, 1987). Rather, the important factor is whether available cues support each other or conflict with each other (McDonald, 1986).

Figure 1. Mean proportion of correct points to the target screen.



On-line resolution of pronominal anaphora in written discourse: A developmental approach in French

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The Centering Theory (Gordon et al. 1993; Walker et al. 1998) predicts a maximized local coherence when discourse is centered on the most salient entity: 1) continuing the grammatical subject is better than shifting to the object; 2) continuing with a pronoun is better than repeating a name. In English, Song & Fisher (2005) show that 3-year-old children interpret pronouns with this continued-subject bias. The present study tests these predictions in French children and adults, addressing the controversial question whether sentence process in discourse follows a continuous development.

The time course of the interpretation of anaphoric elements is examined in discourse transitions (continue and shift) with a reduced left context. A non-cumulative self-paced reading task is used in a moving-window condition. Reading times and answers to comprehension questions are analyzed. The general hypotheses for adults are: 1) a pronoun is easier to process than a repeated expression in the continue-condition; 2) the penalty of repeated names can be extended to non-repeated anaphoric NPs; 3) reading times are faster when no gender ambiguity occurs. We also predict that children are sensitive to the same factors, but are slower in reading. 50 children (10;6) selected on their reading ability and 25 adults participated in two experiments.

In experiment 1¹, pronouns and repeated first-names refer to entities of same or different gender. For adults, a repeated-name penalty is observed in the continue-condition ($F(1(1-24))=7.09; p<.01$, $F(1(1-46))=3.86; p<.05$), although it also occurs in the shift-condition ($F(1(1-24))=5.14; p<.03$, $F(1(1-46))=2.82; p<.09$). Processing utterances in the continue-condition is easier with names of different gender ($F(1(1-24))=18.91; p<.0002$, $F(1(1-46))=4.51; p<.03$). For children, the repeated-name penalty is only observed in the continue-condition ($F(1(1-49))=3.98; p<.04$; $F(1(1-46))=2.27; p<.1$) where reduced times are obtained with names of different gender ($F(1(1-49))=4.68; p<.03$, $F(1(1-46))=1.58; p<.2$).

Experiment 2² uses the same syntactic structure but without gender ambiguity. It manipulates the semantic relations between the antecedent and the anaphor. Pronouns (she) are compared to repeated nouns (the violinist), intermediate nouns (the musician) and basic nouns (the woman). The adults' reading times show that the repeated-name penalty can be extended to a repeated-definite-NP-penalty both in the continue-condition ($F(1(1-24))=91.27; p<.00001$, $F(1(1-23))=34.63; p<.00001$) and in the shift-condition ($F(1(1-24))=25.52; p<.00001$, $F(1(1-23))=10.92; p<.003$). The same extended repeated-penalty exists in children in the continue-condition ($F(1(1-49))=65.25; p<.00001$, $F(1(1-23))=11.74; p<.002$) and in the shift-condition ($F(1(1-49))=32.33; p<.00001$, $F(1(1-23))=11.88; p<.002$). Moreover, basic nouns are significantly easier to process than other NPs with children and adults in both conditions.

The expected repeated-name penalty is found in the continue-condition in French adults as well as in children. Nevertheless, our results do not support some hypotheses of the Centering Theory. The reduced left context is not sufficient to improve the salience of a unique entity, leading to a generalized repeated-noun penalty in adults (experiments 1&2) and in children (experiment 2). In the second experiment, we demonstrate that the first-name cannot represent the whole class of anaphoric expressions which have to be ranked according to their ability to refer to a salient entity: pronoun < basic noun < intermediate noun and repeated expression. Taken together, the results show continuity in the development of written sentence processing in discourse.

1. André - a cherché - Mario/Elisa - devant l'aéroport.

Il/André/Mario/Elle/Elisa - a posé - les valises - sur un chariot.

(André - picked up - Mario/Elisa - in front of the airport. He/André/Mario/She/Elisa - put - the cases - on a trolley.)

2. La violoniste - a rencontré - le gardien de but - à Paris.

Elle/ La violoniste/ La musicienne/ La femme - a parlé - de sport - avec difficulté.

(The violinist - met - the goalkeeper - in Paris. She/ The violinist/ The musician/ The woman - talked - about sports - with difficulty.)

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Reading in child and young-adult bilinguals: An fMRI study

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Previous work in our laboratory has found that Spanish-English bilingual children transition from Spanish dominance in early childhood to English dominance by early adolescence. In addition, neuroimaging studies with bilinguals have shown that language proficiency is an important modulator of neural activity. The purpose of the present study was to use functional magnetic resonance imaging (fMRI) to examine how language proficiency modulates neural activity in a group of child and adult bilinguals. Participants were shown words that were both low and high frequency in separate Spanish and English blocks. For adults the results revealed larger frequency effects in Spanish than in English. In Spanish, the less dominant language there was increased activity in the left and right thalamus and the left medial frontal gyrus for high frequency words. Low frequency words elicited increased activity in the right anterior cingulate gyrus and middle frontal gyrus. In English, high frequency words revealed increased activity in the left angular gyrus and the right occipital-temporal juncture at the midline. However, no areas revealed increased activity for low frequency words in English. Hence, adult bilinguals revealed larger frequency effects in Spanish the less dominant language than in English the more proficient language. Preliminary results from a group of 12-year-old Spanish-English bilinguals revealed important differences when compared to adults. Specifically, younger bilinguals revealed more activity in the frontal lobes in both languages for low frequency words. These results are consistent with the view that child bilinguals are more balanced in their proficiency profile during development. The results will be discussed with regard to current emergentist views of bilingual language development.

**Children's understanding of "some":
Exploring real-time processing of semantic and pragmatic interpretations**

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Understanding language not only involves identifying words and determining the structural relations between them, but also making pragmatic inferences that allow us to determine the speaker's intended meaning. This division between semantics and pragmatics raises the question of how these processes unfold over time. Does semantic processing always precede pragmatic enrichment or are interpretations of words guided by pragmatics from the moment they are encountered? We explored this question through a well understood test case of pragmatic enrichment, scalar implicature. Horn (1972) noted that scalar quantifiers like some have distinct readings that reflect these two interpretive levels. Semantically, some does not possess an upper-bound, making it compatible with the total quantity, thus I can say "I ate some, in fact all, of the candy." However typically, interpretations involve a pragmatic implicature which adds an upper-bound excluding the total set, thus "I ate some of the candy" usually implies "not all"

If children's acquisition of words and structures are initially guided by the understanding of speaker's intent (Tomasello, 1998), we might expect that children would be more inclined to interpret words pragmatically or might initially misinterpret the upper-bound as part of the word's meaning. In contrast, studies using explicit judgment tasks suggest that children are more literal than adults (Noveck, 2001; Papafragou & Musolino, 2003). We investigated the time-course of semantic and pragmatic processing by employing the visual-world eye-tracking paradigm. Adults and five-year-olds were presented with four characters: girl with two socks, boy with two socks, girl with three soccer balls and boy with none. During critical trials, participants were asked to select the target character, e.g. "Point to the girl that has some of the socks." These instructions were initially semantically ambiguous—in the absence of an implicature the sentence is consistent with both girls prior to the phonological disambiguation of the noun. However pragmatically, these instructions uniquely identify a target (girl with two socks) from the onset of the quantifier. During control trials, participants heard identical instructions using words with semantically specified upper-bounds (e.g. two, three, all). This comparison verifies whether interpretations of some parallel or diverge from cases where meanings are unambiguously determined.

We found that both adults and children preferred to look at the target that matched the quantifier after hearing two, three, and all, indicating early disambiguation via lexical semantics. However, upon hearing some, participants initially looked equally often at the girl with some socks and the girl with all the soccer balls, resulting in a significant difference between some and the other quantifiers ($p < .01$). Nevertheless, adult preference for the target on critical trials preceded phonological disambiguation of the noun, suggesting on-line calculation of pragmatic implicatures ($p < .05$). Children, in contrast, failed to disambiguate the target until well after the completion of the noun, demonstrating considerable reliance on lexical information ($p < .01$). These results demonstrate that both children and adult's initial interpretations of words are predominately guided by lexical semantics with limited application of even the most robust pragmatic inferences.

Cross-modal picture naming detects antecedent reactivation in children with low verbal memory span

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Introduction. Cross-modal lexical priming has been adapted to children by replacing lexical decisions with picture categorization tasks (Love & Swinney, 1997; McKee, Nicol, & McDaniel, 1993). However, such tasks place a heavy burden on children's processing resources. For example, (Roberts, Marinis, Felser, & Clahsen, 2004), using this method, observed antecedent reactivation only in participants with high verbal working memory. To address this issue, we modified the task by using picture-naming instead of picture categorization. Naming is fast, effortless and natural for children, and should require less working memory resources during divided attention tasks.

Method. 20 typically developing children (half boys, mean age 9.2, range 8-11) participated in an antecedent reactivation experiment. Design and sentence materials were adapted from (Love & Swinney, 1997), with pictures from (Rossion & Pourtois, 2001; Snodgrass & Vanderwart, 1980). Each auditorily presented sentence was matched to a primed picture and a control picture in either a control position or a gap position:

"The bear that the gorilla in the mist [BEAR/TIGER] had scared [BEAR/TIGER] by accident went swimming in the pool."

Pictures were presented for a maximum of 2 seconds. Naming latencies were recorded with voice key. After every experimental sentence, the child answered a comprehension question (asking "who did what to whom"). 128 sentences (mixed with fillers) were counterbalanced across four sessions.

Results. Trials with naming errors (10%) and 4 items with mean naming accuracy below 90% were removed, as well as fast outliers. We then removed trials with incorrect comprehension question answers, which left subjects with an average of 45% of the original trials. This resulted in the following cell means and standard deviations:

	Control pictures	Primed pictures
Control position	901 (134)	842 (127)
Gap position	914 (148)	784 (125)

In order to compare our results with (Roberts, Marinis, Felser, & Clahsen, 2004), we divided the subjects into a low and a high verbal working memory group on the basis of the group median score (2.5) from the Competing Language Task (Gaulin & Campbell, 1994). This placed 9 children (5 girls) in the low, and 11 children (5 girls) in the high verbal memory span group. Each subject's cell means were then computed and used as within-subject dependent measures in a 2 (Probe) x 2 (Position) mixed factorial repeated measures ANOVA, with memory span group as between-subjects factor. This resulted in a main effect of Probe ($F(1,18)=21.9$, $p<.001$), and an interaction Probe X Position ($F(1,18)=4.74$, $p=.043$; observed power: 0.54), such that the difference between primed and control probes were greater at the gap position. There were no main effects or interaction involving working memory group. Bonferroni-protected pairwise comparisons confirmed that the priming effect was significant at the gap but not control position in both groups (low memory span: $p < 0.015$; high memory span: $p < 0.039$.) We also performed an analysis where we included all correct naming trials but also trials with incorrect comprehension questions. In this case, we only observed a main effect of Probe (i.e., priming).

Discussion. First, cross-modal picture naming can be used as an alternative to binary categorization tasks for measuring antecedent reactivation during children's processing of filler-gap sentences. Second, it proved critical to use comprehension questions to filter out trials where subjects apparently did not pay attention to the sentence meaning. Third, and most importantly, whereas the cross-modal picture categorization task requires high verbal working memory span, the current method did not show any effect of differences in verbal memory span. Therefore, the method should also be applicable to populations with low verbal working memory span, such as children with Specific Language Impairment (Marton & Schwartz, 2003).

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