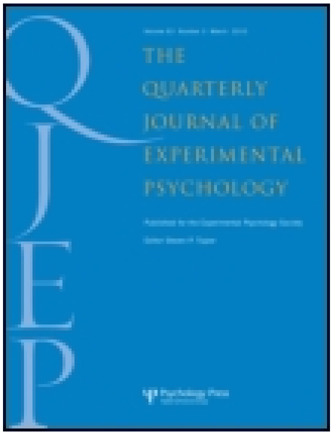

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Children's use of language context in lexical ambiguity resolution

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Children's use of language context in lexical ambiguity resolution

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Lexical ambiguity resolution was examined in children aged 7 to 10 years and adults. In Experiment 1, participants heard sentences supporting one (or neither) meaning of a balanced ambiguous word in a cross-modal naming paradigm. Naming latencies for context-congruent versus context-incongruent targets and judgements of the relatedness of targets to the sentence served as indices of appropriate context use. While younger children were faster to respond to related targets regardless of the sentence context, older children and adults showed priming only for context-appropriate targets. In Experiment 2, only a single-word context preceded the homophone, and in contrast to Experiment 1, all groups showed contextual sensitivity. Individual working-memory span and inhibition ability were also measured in Experiment 2, and more mature executive function abilities were associated with greater contextual sensitivity. These findings support a developmental model whereby sentential context use for lexical ambiguity resolution increases with age, cognitive processing capacity, and reading skill.

Keywords: Lexical ambiguity; Language context; Executive function; Development; Children.

Very young children must rely heavily on context to learn the words in their language. In fact, children as young as 19 months produce adult-like N400 (a semantic anomaly effect in event-related brain potentials recorded from the scalp) when they hear an anomalous word in an otherwise normal sentence (Friedrich & Friederici, 2005). And as they learn to read, many children rely on contextual cues (including pictures, sentence context, and narrative structure) to guess the

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identity of printed words. Perhaps not surprisingly then, a number of researchers have found that early readers show more context sensitivity than skilled readers (e.g., Perfetti, Goldman, & Hogaboam, 1979; Schwantes, 1981, 1982; Stanovich, Nathan, West, & Vala-Rossi, 1985; Stanovich, West, & Feeman 1981; West & Stanovich, 1978).

Nonetheless, there is also evidence that young elementary-school children do not exploit context as completely, using all the same cognitive mechanisms, as adults. For example, Booth, Harasaki, and Burman (2006) found that sentence-level context effects actually increased from age 9 to 12, while lexical-level context effects decreased. Furthermore, Simpson and colleagues found facilitatory effects of congruent, single-word context for both younger (aged 7 to 10) and older children (aged 11 to 12), but inhibitory, incongruent context effects only for older children (Simpson & Foster, 1986; Simpson & Lorsbach, 1983).

This research suggests that some mechanisms supporting context usage are late developing, possibly including executive function processes. In some research, proficient inhibition has been linked to reading ability, above and beyond age-related differences in maturation. For example, Gernsbacher, Varner, and Faust (1990) found that more skilled adult readers are better at suppressing contextually inappropriate meanings than are poor adult readers. For young elementary-school children, reading fluency varies widely, even within a single grade level, with the result that the same reading paradigm may be quite easy for some students and beyond the capacity of others. Thus, to tease apart maturational differences in context use from cognitive load differences related to reading fluency, it would be advantageous to use a paradigm that includes little or no reading.

We investigated context effects on spoken homophone resolution for children in Grades 2 through 4 (aged 7 to 10), focusing on how task demands impact successful context use. We selected this age group for several reasons. First, the early elementary-school years encompass the transition from being a beginning reader to being a fluent reader, as well as encompassing substantial advances in executive function. Second, previous research suggesting a deficiency in the use of sentence context for lexical ambiguity resolution has used slightly older children: Booth et al. (2006) had 9- to 12-year-olds perform a read-aloud task. We suspected that younger children might look more adult-like in their use of context if we used a less demanding, cross-modal naming task as our primary measure of context sensitivity. In Experiment 1, we examined context use at the sentence level, while in Experiment 2, context use was examined in single-word contexts. In each experiment, we compared the pattern of naming latencies for the elementary-school children with that of college students.

The adult lexical ambiguity literature emphasizes the relative frequency of alternative meanings as well as the interaction between contextual bias and frequency (e.g., Binder & Rayner, 1998; Chen & Boland, 2008; Duffy, Morris, & Rayner, 1988; Onifer & Swinney, 1981; Simpson & Krueger, 1991; Vu, Kellas, & Paul, 1998). It is possible to examine frequency effects in children as well, but younger participants are not very sensitive to frequency differences among alternative meanings (e.g., Booth et al., 2006; Marmurek & Rossi, 1993; Simpson & Foster, 1986). For children in our target age range, ambiguous words with two familiar meanings are likely to be equivalent to balanced ambiguous words (those with two meanings of equal frequency) in the adult literature. When adults read balanced ambiguous words in a biasing context, they use the context to immediately select the appropriate meaning (e.g., Duffy et al., 1988; Pacht & Rayner, 1993). However, the mechanisms supporting context use are a matter of debate, even in the adult literature. A full discussion of the possible mechanisms is beyond the scope of this paper. Instead, we briefly contrast a single-mechanism account with dual-mechanism accounts.

Kawamoto (1993) proposed a single-mechanism account, modelled as a dynamical system with attractor basins corresponding to alternative meanings of homonyms. With experience, dominant meanings develop deeper and wider basins than do subordinate meanings and therefore exert a gravitational advantage, even in neutral contexts. The role of context is to initially position the system closer to the basin corresponding to the supported meaning, with stronger contexts able to position the system nearer the centre of the attractor basin. Homonyms with two equiprobable meanings (or two recently learned meanings) would have two symmetrical basins, and therefore the state of the system relative to the two meanings could be easily influenced by sentential context. In such a model, it is clear how the meaning frequency effects would develop with increasing language experience. Booth et al. (2006) suggested that the impact of sentence context would also change, at least in the reading modality, with beginning readers less able to extract appropriate cues from the sentence context. However, as noted above, even very young children must have some cognitive mechanisms by which they can use context to assign meanings to words, detect semantic anomalies, and identify words in print. It is not clear how Booth et al.'s account would explain these phenomena during reading, though we grant that extracting appropriate contextual cues is likely to be easier in the spoken modality until children become fluent readers.

Gernsbacher and colleagues (e.g., Gernsbacher, 1993; Gernsbacher & Faust, 1991; Gernsbacher et al., 1990) have proposed a two-mechanism account of lexical ambiguity resolution in which individual differences among adults have been emphasized. In the version implemented computationally in Gernsbacher and St. John (2000), the first mechanism is described as the bottom-up, frequency-weighted activation of all homonym meanings, and the second mechanism is the top-down suppression of contextually irrelevant meanings. It is this second mechanism that Gernsbacher has linked to individual differences in reading skill, with less skilled adult readers having less efficient mechanisms for suppression. This account makes no predictions about how children use context to learn new words or to detect semantic anomalies, but it does predict that children will have difficulty with lexical ambiguity resolution because top-down mechanisms for suppressing irrelevant meanings are not yet well established.

As described below, a number of prior studies investigating context use in children have assumed a two-mechanism account that is similar to Gernsbacher's account of lexical ambiguity resolution (Gernsbacher, 1993; Gernsbacher & Faust, 1991; Gernsbacher et al., 1990; Gernsbacher & St. John, 2000). Following in this tradition, we assume a dual-mechanism account. However, as outlined in the General Discussion, our experiments also have implications for theories that do not compartmentalize context use in this manner (e.g., Kawamoto, 1993; MacDonald, Pearlmutter, & Seidenberg, 1994).

Prior research on context use in children

The few studies that have investigated children's context use have all used reading paradigms. A pioneering series of read-aloud studies by Stanovich, West, and colleagues examined children's context use for unambiguous words in related, neutral, and unrelated sentence contexts. These researchers assumed that there is an automatic spreading activation mechanism (Collins & Quillian, 1969) and a resource-demanding process that focuses attention on the contextually relevant portion of the semantic network (Neely, 1977; Posner & Snyder, 1975a, 1975b). Children (approximately aged 8 and 10 years) appeared to use both mechanisms to guide lexical access (Stanovich et al., 1985; Stanovich et al., 1981; West & Stanovich, 1978). Stanovich's interactive–compensatory model of context use proposes that, because young children have still-developing semantic networks, they must heavily rely on the top-down process and, thus, show even more context sensitivity than do adults. However, because the related sentences were highly constraining and contained lexical associates of the target word, their effects potentially can be explained by spreading activation alone (e.g., Gottlob, Goldinger, Stone, & Van Orden, 1999; Seidenberg, Tanenhaus, Leiman, & Bienkowski, 1982; Simpson, Peterson, Casteel, & Burgess, 1989; Van Petten, Weckerly, McIsaac, & Kutas, 1997). Another issue is that the interactive–compensatory model was developed to explain reading development specifically rather than language processing across modalities. Thus, it is an open question whether the two cognitive mechanisms proposed by this model would function differently during spoken language processing.

In contrast to the Stanovich group, Simpson and Lorsbach (1983) and Simpson and Foster (1986) reported greater reliance on spreading activation, without inhibition from top-down processes in their youngest participants. In Simpson and Lorsbach's read-aloud, one-word context task, 2nd and 4th graders (7–8- and 9–10-year-olds) had facilitated naming latencies for words preceded by related words, but no inhibition for words preceded by unrelated words. The older participants (6th graders and adults) experienced both related facilitation and unrelated inhibition. Simpson and Foster tested the same age groups, using the same paradigm with lexically ambiguous context words. Their Experiment 2 manipulated the time between presentation of the homograph and the target, and the resulting data pattern suggested that the 6th graders initially were accessing both meanings, but quickly inhibiting the subordinate (less frequent) meaning, while the subordinate meaning remained active for younger participants. Contrary to Stanovich's account, but consistent with Gernsbacher's suppression hypothesis, Simpson and Lorsbach proposed that the top-down suppression process develops with age and reading experience. We call this the *contextual development* account.

In fact, Simpson and Foster (1986) suggest that even young participants (i.e., 7- to 10-year-olds) may have the ability to use the top-down process, but only if they are able to allocate sufficient cognitive processing to the task, and possibly well after initial lexical access. Reading requires the child to use knowledge of grapheme-to-phoneme correspondences to access the phonological code of the word and/or retrieve the lexical entry. These processes may be difficult for young readers, causing them to recruit extensive executive function resources and leaving few resources for contextual processing (e.g., via the top-down process).

The goal of Booth et al. (2006) was to examine, separately, the influences of lexical-level and sentence-level context effects on homonym meaning assignment in children. In their experiment, 9-, 10-, and 12-year-old children read aloud sentences that were either neutral or related to the dominant or subordinate meaning of a polarized homonym (e.g., *The refrigerator needed a new bulb*, or *The father planted the bulb*, respectively). One second after reading aloud each sentence, participants read aloud a target word that was related to either the dominant or the subordinate meaning of the homonym or to an unrelated control word (e.g., *light, flower*, or *month*, respectively). Analyses were first conducted with age serving as the grouping variable, and then a second set of analyses were conducted using reading skill as the grouping variable. In the age analyses, the two younger groups named both the dominant-related and the subordinate-related targets faster than the controls, regardless of sentence context type. A similar pattern of lexical-level context effects without sentence-level context effects was shown by the least skilled readers in the reading-skill analyses. In contrast, the older readers (12-year-olds in the age analyses) and more skilled readers (in the reading-skill analyses) exhibited sentence-level context sensitivity, without consistent lexical-level context effects. Booth et al. interpreted their findings in terms of the distributed attractor model proposed by Kawamoto (1993), but their findings are also consistent with a contextual development account, in which top-down context use develops with age and reading skill.

Taken together, the results of Simpson and Lorsbach (1983), Simpson and Foster (1986), and Booth et al. (2006) suggest that it is difficult for children to use the proposed top-down mechanism during reading until the age of 11 or 12. Unfortunately, each set of studies has factors that could have prevented full use of context by the children. Simpson and colleagues controlled the interval between presentation of the context word and presentation of the target word (e.g., 500 ms in Experiment 1 of Simpson & Foster, 1986), which may have left insufficient time for the mechanisms supporting context use to operate in younger participants. In contrast, Booth et al. used a very long stimulus onset asynchrony of 1,000 ms between the time the reader finished reading the sentence-final homonym and the onset of the target. But even so, the executive function demands of reading aloud both the sentence and the target may have overwhelmed their younger participants.

The assumption that executive control development is a limiting factor for context use in children is motivated both by the adult literature and by the developmental literature. In the adult literature, Gernsbacher finds that a deficit in suppression is largely responsible for differences between more and less skilled readers, both in college age adults and in elderly populations with dementia (Faust, Balota, Duchek, Gernsbacher, & Smith, 1997; Gernsbacher et al., 1990). In a developmental study, Trueswell, Sekerina, Hill, and Logrip (1999) maintained that one reason young children have difficulty with syntactically ambiguous sentences is limited executive control. Similar conclusions about executive functioning in children have been drawn by several researchers using other dependent measures (Gibson, Breen, Rohde, & Rozen, 2006; Nation, Marshall, & Altmann, 2003).

The current experiments minimize reading demands by using a cross-modal paradigm with relatively young child participants. (groups of 2nd graders, 7–8-year-olds; 3rd graders, 8–9-year-olds; and 4th graders, 9–10-year-olds). An auditory semantic context (a sentence in Experiment 1: *At recess, the children played;* or a word in Experiment 2: *laser*) preceded the auditory presentation of an ambiguous word (i.e., a homophone, e.g., *tag*). This was immediately followed by a visually presented target word that was congruent (*grab*), incongruent (*shirt*), or irrelevant (*boat*) to the ambiguous word meaning supported in the context.

EXPERIMENT 1: SENTENCE CONTEXT USE IN CHILDREN AND ADULTS

The first experiment was designed to assess children's and adults' ability to use a spoken sentential context to resolve the meaning of a spoken homophone. An example set of stimuli is given in Table 1. The visually presented target word (e.g., *grab*) was preceded by an auditory context sentence that ended in either a related homophone or an unrelated homophone. For conditions containing a related homophone, the carrier sentence was congruent with the meaning represented by the target word, incongruent, or neutral. The same neutral carrier sentence was used in one of the unrelated conditions.

In composing the sentence contexts, we avoided using contexts that were highly predictive of the target word or that contained lexical associates of the target. Thus, under a two-process account, the top-down mechanism should be required for contextually appropriate meaning selection. Spreading activation alone would yield facilitation for the congruent, incongruent, and neutral conditions compared to the unrelated conditions, because recognition of the homophone should automatically activate all associated words. If both spreading activation and the top-down process are used, the congruent condition should be faster than the incongruent condition, but the incongruent condition may be no different from the unrelated conditions (Balota & Duchek, 1991). Such a pattern would occur if the facilitation from spreading activation and inhibition from the top-down component cancelled each other out in the incongruent condition.

The most important predictions in this experiment concern the differences between the older

Table 1. *Conditions in sentence context experiment in Experiment 1*

Type	*Sentence*	*Homophone*	*Target*
Congruent	At recess, the children played...	tag	grab
Incongruent	Jerry was bothered by the shirt's...	tag	grab
Neutral	Melanie told her husband the word was...	tag	grab
Unrelated	Kirk's clothes get tighter when he gains...	weight	grab
Neu-Unrel	Melanie told her husband the word was...	weight	grab

Note: Neu-Unrel = neutral–unrelated.

and younger children. All of our children are younger than the 12-year-old group that successfully used sentence context in Booth et al. (2006). Thus, if switching from a reading paradigm to a spoken-language paradigm has no impact on a participant's ability to use context, then none of our child participants should pattern like adults, with the most priming in the congruent condition. Rather, we should see equivalent priming in the congruent, incongruent, and neutral conditions, reflecting lexical-level spreading activation alone. However, we expect the change in stimulus modality to reduce overall cognitive load and allow children to use context successfully at a younger age than Booth et al. (2006) found, while we still expect that younger children will use the top-down process less than their older counterparts. Thus, our contextual development account predicts that the younger participants will show priming in target naming latencies for both the congruent and the incongruent conditions, while older children will show priming only in the congruent condition. In contrast, if we extend the predictions of Stanovich and colleagues' interactive–compensatory model to include spoken-language processing, it predicts that all groups will disambiguate the homophones, and that the youngest children should display the greatest use of the top-down process (Stanovich et al., 1985, 1981). That is, there should be a larger difference in naming latencies between the congruent and the incongruent conditions for the younger children than for the older children.

In choosing our child participant groups, we wanted to examine an interesting subsection of the developmental trajectory of context effects in lexical ambiguity resolution. Thus, we wanted our sample to encompass children who are experiencing substantial growth in their language and reading abilities as well as growth in their executive-functioning abilities. Chall (1983) and Adams (1990) have argued that children transitioning between the 3rd and 4th grades (in America, traditionally 8- to 10-year-olds) experience an important change in which they move from learning how to use language and how to read to learning content knowledge from language and reading. In addition, these ages fall into a timeframe in which the prefrontal cortex and the corresponding executive functions are in a phase of rapid growth and improvement, although the prefrontal cortex and these executive functions do continue to mature into early adulthood. Much of the relevant research is summarized by Diamond (2002, 2006). In fact, Diamond (2006) cites the years from 5 to 11 as marking substantial improvements in cognitive flexibility, working memory, and processing speed. Tasks that require inhibitory processing, such as the antisaccade task and the directional Stroop task, show sharp improvements in this age range, as does the Wisconsin Card Sort Test, a classic test of prefrontal function, and complex span tasks that require manipulating information held in working memory. More specifically, Brocki and Bohlin (2004) found a transition in executive-functioning ability for children between ages 7 and 9.5 years on measures of working memory, inhibition, and speed of processing.

We decided to include children in our experiment that ranged in age from 7 to 10 years in order to encompass these major transitions in language and reading processing as well as the developmental transitions in executive functioning. Moreover, we considered school experience relevant as well. According to Chall (1983) and Adams (1990), many curricular materials are designed with a shift of emphasis on treating language and reading as the focus of study (before and during 3rd grade) to using language and reading as the media to study other content (beginning in 3rd grade and into the higher grades). In order to capture these transitions, we decided to divide the children into two groups for most analyses, Grades 2–3 (7–9-year-olds) and Grade 4 (9–10-year-olds). We also included an adult sample in order to compare the context use of our two child groups with the mature context use of adult readers.

Method

Participants

Our sample of children included 50 students who were drawn from academic summer and after-school programmes in the Charleston, South Carolina metropolitan area. There were 11 second-graders (average age: 7.5 years), 15 third-graders (average age: 8.8 years), and 24 fourth-graders (average age: 9.8 years). These students attended schools serving lower-middle to middle-class neighbourhoods. Before working with any students, we obtained permission from the Charleston County School District and from the coordinators of these after-school and summer programmes. We also obtained parental consent prior to working with each student. Our adult sample was composed of 26 participants drawn from the introductory psychology pool at the College of Charleston in Charleston, South Carolina. Average age was 19.2 years. Adult participants were given course credit for their participation.

Materials

Participants heard sentences ending in a homophone and then read aloud target words varying in their relationship to the sentence-final homophone. The sentences were presented as digital audio recordings in which the sentence, including the homophone, was recorded by a female speaker in a continuous audio file. As described below, there were 10 practice trials and 60 trials in the primary experiment. Each of the 60 trials was one of the five types illustrated in Table 1: (a) congruent—the sentence context and the target word were related to the same meaning of the homophone; (b) incongruent—the sentence context and the target word referred to opposing senses of the homophone; (c) neutral—the sentence did not bias either meaning of the homophone; (d) unrelated—the sentence context and homophone were unrelated to the target; and (e) neutral–unrelated—the neutral sentence was paired with a homophone that was unrelated to the target. The fifth condition was not theoretically interesting, so the corresponding data are not reported. It was included so that neutral sentence context (which did not vary across items) would be associated with a related target only half the time. As shown in Appendix A, 60 target words, each associated with a unique homophone, were distributed across five lists so that each of the target words appeared in each of the different context types equally often across the lists. This organization of lists allowed a complete counterbalancing of targets across lists and across participants. That is, each participant received an equal proportion of the five context types, and each of the targets was presented within each context type across participants.

Substantial effort was made to ensure that the materials were appropriate for children of this age and geographic region. We consulted existing norms for children (Zeno, Ivens, Millard, & Duvvuri, 1995) and adults (Nelson, McEvoy, & Schreiber, 1998) as well as collecting our own word association norms from a group of children similar to our participant population.[1] We did this to ensure that our child participants were familiar not only with the target words, but also with the two meanings for each homophone.[2]

[1] First, we only used homophones in which two meanings were generally known by 7–8-year-olds in our association norms, described in Footnote 2. Second, this same set of association norms was used to generate the targets used in the main experiment. (The selected targets were also listed as associates of the homophone in the Nelson et al., 1998, norms, except for two verb homophones that were not included in the Nelson stimuli.) Third, we consulted the Zeno et al. (1995) word frequency guide for Grades 2 through 4. Inclusion in the word frequency guide is evidence that the words are in the average American reading vocabulary for these grade levels. All homophones but two (*miss, rap*) and all targets but three (*roach, swatter*, and *bland*) were listed in Zeno et al. for the selected grade levels.

[2] To collect association norms, 100 homophonous words were read to 7–8-year-old participants ($N = 10$, mean age 7.7 years) drawn from the same population as that for Experiment 1 participants. After hearing each word, the participant stated the first word that came to mind. This free association was used as an indication of which homophone meanings were known by the children in this sample. Homophones were included in the experiment if several children reported one meaning, and several other children reported the other meaning. Only words that were approximately balanced in frequency (cf. Pacht & Rayner, 1993; Rayner & Frazier, 1989, who suggest that balanced homophones have ratios of no more than .6/.4 for Meaning 1/Meaning 2) toward each homophone meaning as indicated by the children in the norming study were used in the present experiment.

Table 2. *Example of rating in sentence selection experiment in Experiment 1*

	At recess, the children played...	
	tag (a game)	*tag (a label)*
How well does each word complete the sentence?	not at all 1 2 3 4 5 6 7 very well	not at all 1 2 3 4 5 6 7 very well

For each homophone that met these criteria, sentences were created that supported only one meaning of the homophone. However, in order to avoid interlexical priming, these sentences included only words that were not lexical associates of the target word according to the Nelson et al. (1998) norms. To assess the bias of our contexts, we conducted a sentence selection experiment with 25 University of Michigan undergraduate students. In this sentence selection experiment, each sentence was presented to participants with the final (homophonous) word absent. The homophone and both of the homophone meanings were listed below each sentence. Participants were to rate on a 7-point scale (1, not at all, to 7, very well) how well each homophone meaning completed the sentence (see Table 2). From this pool of sentences, we selected only those sentences in which the contextually congruent meaning was given an average rating of 5 or higher, and the incongruent meaning was given an average rating of 2.5 or lower. From the 70 sentences that met these criteria, the 60 that led to the highest ratings for the context-congruent homophone and to the lowest ratings for the context-incongruent meanings were selected for the critical trials. The remaining sentences were used for the 10 practice trials.

Procedure

Each participant was tested in a quiet room on a laptop computer equipped with headphones and a microphone that interfaced with the laptop computer via a stimulus response box. There were 10 practice trials and 60 experimental trials. In each trial, participants heard a sentence with a sentence-final homophone (e.g., *At recess, the children played tag*). The participant then read aloud, as quickly and accurately as possible, a target word that appeared on the computer monitor (e.g., *grab*) at the offset of the homophone.

The child participants completed an additional comprehension task on each trial. After reading aloud the target word, they then reported whether the target word was related to the sentence that they heard. The experimenter recorded the target naming accuracy and the relatedness judgement on each trial. The latter was coded as "yes" (the target and context are related) responses or as "no" responses. Rather than the relatedness judgement, the adults completed a sentence recognition task at the end of the experiment. This task included 30 sentences, half of which were included in the experiment; participants indicated whether each sentence had been present in the experiment.

Results and discussion

Overall accuracy and naming latency results

All responses that resulted in a voice key error were eliminated. Next, all responses that had naming latencies of less than 250 ms or greater than 5,000 ms were discarded before an initial mean naming latency and standard deviation were calculated for each participant. Then, all responses that were 2.5 standard deviations above or below each participant's mean naming latency were discarded. The voice key errors and outliers accounted for 4% of the responses. For the children, relatedness judgements that were associated with these naming latency trials were also discarded.

The mean naming latencies and standard error rates by condition are displayed in Table 3. Condition means by participant and by item were submitted to 3 (age group) by 4 (context

Table 3. *Naming latencies for each condition in Experiment 1*

Age group	*Congruent*	*Incongruent*	*Neutral*	*Unrelated*
7–9-year-olds	1,666 (82)	1,610 (81)	1,656(81)	1,751 (76)
9–10-year-olds	1,106 (82)	1,232 (87)	1,113 (67)	1,216.61 (90)
Adults	476 (12)	526 (12)	489 (16)	539 (16)

Note: Naming latencies in ms. Standard errors in parentheses.

type) analyses of variance (ANOVAs) for each of our three dependent variables.

There was no interaction between age group and context type in target naming accuracy. However, there was a main effect of age group, such that the younger children (7–9-year-olds) were less accurate (.83) than the older children (9–10-year-olds; .92) who were less accurate than the adults (.998), $F_1(1, 74) = 27.51$, $MSE= 0.013$, $p < .05$; $F_2(2, 176) = 14.21$, $MSE = 0.068$, $p < .05$. There was also a main effect of context type, $F_1(3, 222) = 4.30$, $MSE = 0.013$, $p < .05$; $F_2(3, 528) = 3.68$, $MSE = 0.026$, $p < .05$; congruent targets were named accurately more often than either the incongruent targets or the unrelated targets, $t_1(76) = 2.10$, $p < .05$; $t_2(178) = 1.53$, $p = .128$, and $t_1(76) = 1.34$, $p = .184$; $t_2(179) = 2.88$, $p < .05$, respectively, and the neutral targets were named accurately more often than the incongruent targets or the unrelated targets, $t_1(76) = 2.40$, $p < .05$; $t_2(178) = 1.68$, $p = .10$, and $t_1(76) = 2.65$, $p < .05$; $t_2(179) = 2.69$, $p < .05$, respectively.

There was a main effect of age group on naming latency, $F_1(2, 73) = 88.35$, $MSE = 402{,}327$, $p < .05$; $F_2(2, 171) = 15{,}447$, $MSE = 55{,}728$, $p < .05$, with longer latencies for the youngest group (1,671 ms) than for the older children (1,167 ms) who were slower than the adults (505.5 ms). There was also a main effect of context type, $F_1(3, 219) = 9.39$, $MSE = 12{,}638$, $p < .05$; $F_2(3, 513) = 6.921$, $MSE = 38{,}669$, $p < .05$, and an interaction, $F_1(6, 219) = 3.99$, $MSE = 12{,}638$, $p < .05$; $F_2(6, 513) = 3.02$, $MSE = 38{,}669$, $p < .05$, indicating that the effect of context differed between the age groups. Additional tests were conducted to understand the pattern of facilitation and inhibition across the age groups.[3]

First, for each age group we compared each of the congruent, incongruent, and neutral context conditions to the unrelated condition, as in previous research on context use in children (cf. Simpson & Lorsbach, 1983; Stanovich et al., 1985). We expected spreading activation alone to result in shorter naming latencies for the congruent, incongruent, and neutral conditions than for the unrelated condition. In fact, this was the pattern observed for only the youngest children. The left panel of Figure 1 shows that the 7–9-year-old children exhibited facilitated naming latencies in the congruent, $t_1(25) = 2.22$, $p < .05$; $t_2(59) = 2.50$, $p < .05$, incongruent, $t_1(25) = 3.74$, $p < .05$; $t_2(58) = 2.98$, $p < .05$,

[3] We were also interested in how well reading skill could influence appropriate context use. To examine this, we divided the participants into reading-skill groups based on their average naming latencies, such that we had an efficient readers group composed of children who had relatively short naming latencies and a struggling readers group that was composed of readers who had relatively long naming latencies. These groups were very similar to the reported age groupings with the majority of the 7–9-year-olds having longer average naming latencies than the 9–10-year-olds, although we did find that there were some 7–9-year-olds who were efficient readers and some 9–10-year-olds that were slower readers. However, the pattern of the context use analyses produced using reading-skill groups did not differ from the pattern produced in the age-based analyses. That is, the slower readers produced less context use than did the efficient readers just as the younger participants showed less context use than did the older participants. For the sake of simplicity, we report the analyses only in terms of the age groupings rather than according to both age and reading-skill groups.

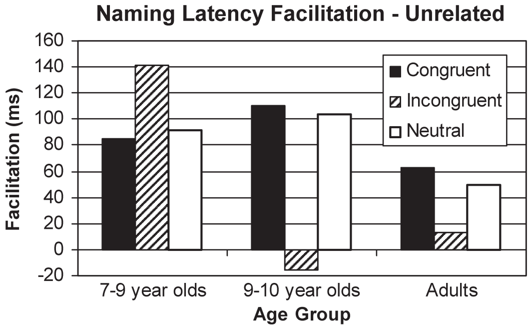

Figure 1. *Naming latency facilitation relative to the unrelated targets for congruent, incongruent, and neutral target pairs in Experiment 1.*

and neutral, $t_1(25) = 2.42$, $p < .05$; $t_2(59) = 2.21$, $p < .05$, conditions compared to the unrelated condition (85.1 ms, 141 ms, and 94.7 ms, respectively). The older children (middle panel of Figure 1) also displayed facilitation in the congruent, $t_1(23) = 2.37$, $p < .05$; $t_2(59) = 3.42$, $p < .05$, and neutral, $t_1(23) = 2.47$, $p < .05$; $t_2(59) = 2.48$, $p < .05$, conditions (110.47 and 103.33 ms, respectively), but they displayed no facilitation for the incongruent condition ($t < 0.3$; -16.1 ms). In the adults, naming latencies for both congruent and neutral targets were facilitated relative to the unrelated condition, $t_1(25) = 4.83$, $p < .05$; $t_2(57) = 4.7$, $p < .05$; $t_1(25) = 2.8$, $p < .05$; $t_2(57) = 3.85$, $p < .05$, respectively. There was no difference in naming latencies for incongruent and unrelated targets, ts < 1.15. Thus, the adult data exhibit clear evidence of top-down context use, while the older children's data also suggest the adult (top-down) pattern.

Another way to gauge the influence of the top-down mechanism is to examine the difference in naming latencies following congruent and incongruent contexts, as in Balota and Duchek (1991). Although the congruent targets were named 56 ms slower than incongruent targets by the 7–9-year-old group, this difference was not significant ($t < 1.54$). In contrast, the older children were 126.6 ms faster on congruent targets, $t_1(23) = 3.9$, $p < .05$; $t_2(59) = 3.23$, $p < .05$, and adults were 50.2 ms faster on congruent targets, $t_1(25) = 4.96$, $p < .05$, $t_2(57) = 4.87$, $p < .05$. This comparison provides more support for the hypothesis that the older children (9–10-year-olds) and adults were using the top-down mechanism more efficiently and/or more consistently than the younger group. A 3 (age group) × 2 (congruent vs. incongruent) ANOVA comparing the three age groups in the incongruent–congruent latency difference confirmed a difference in the groups' sensitivity to context, $F_1(2, 74) = 10.40$, $MSE = 10{,}137$, $p < .05$; $F_2(2, 174) = 5.66$, $MSE = 41{,}036$, $p < .05$. Finally, sensitivity to context, as measured by this difference score, was positively correlated with the overall naming accuracy for each participant, $F_1(1, 76) = 7.28$, $p < .05$, adjusted $R^2 = .076$: The greater the naming accuracy, the greater the engagement of the top-down, resource-demanding process. Because naming accuracy is loosely related to reading skill, we take this to be evidence against proposals that suggest that the use of the resource-demanding process is greatest for the poorest readers (e.g., Stanovich et al., 1985), at least within our cross-modal paradigm. Unfortunately, we did not have an independent measure of reading skill, so conclusions about the relationship of reading skill and context effects should be drawn with a strong note of caution.

Relatedness judgements

In the relatedness judgement task, participants reported whether or not the target word was

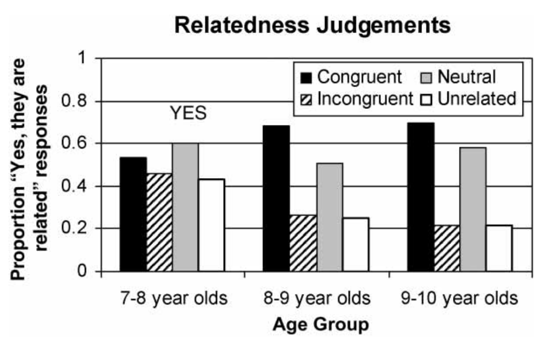

Figure 2. *Proportion of relatedness judgement responses in which the participants indicated that the target and the context sentence were related in meaning in Experiment 1.*

related in meaning to the sentence. These responses should indicate whether participants used context and comprehended the sentences after the possibly laborious process of word recognition. Proportion of "yes, they were related" responses are reported in Figure 2. If participants were sensitive to sentence context at a conscious level, the average proportion of "yes" responses should be close to 1.0 for the congruent condition and close to 0.0 for the unrelated and incongruent conditions. In contrast to the other dependent measures, where 2nd- and 3rd-graders' behaviour did not differ statistically, the responses for the 2nd-grade (7–8-year-old) and 3rd-grade (8–9-year-old) participants were quite different; thus, they were treated separately for this analysis. Before conducting statistical analyses on these responses, we performed an arcsine transformation on the proportion of "yes" responses. Hogg, Craig, and McKean (2005) have indicated that binary data that have been summarized as proportions should be submitted to an arcsine transformation in order to approximate a normal distribution of the response variable so that typical analyses of variance can be used.

A 3 (age) by 4 (context condition) ANOVA performed on these arcsine-transformed responses indicated an interaction, $F_1(6, 141) = 2.53$, $p < .05$; $F_2(6, 465) = 2.42$, $p < .05$, but no main effect of age group ($Fs < 0.6$). However, there was a main effect of context type, $F_1(1, 47) = 34.57$, $p < .05$; $F_2(1, 155) = 71.29$, $p < .05$. Subsequent ANOVAs were conducted within each age group, to explore the interaction. There was only a trend toward a difference in relatedness judgements across the context conditions for the 7–8-year-old participants in the subject analysis, $F_1(3, 30) = 2.015$, $p = .133$; however, there was a difference in the youngest children's relatedness judgements when evaluated by items, $F_2(3, 138) = 3.46$, $p < .05$. In contrast, there were strong differences in relatedness judgements across conditions for both the 8–9-year-olds and the 9–10-year-old participants in both the subject and the items analyses, $F_1(3, 42) = 15.38$, $p < .05$; $F_2(3, 171) = 21.02$, $p < .05$, and $F_1(3, 69) = 39.52$, $p < .05$; $F_2(3, 156) = 38.91$, $p < .05$, respectively, indicating that they were sensitive to the intended meaning conveyed by the sentences. In particular, all groups were more likely to state that the congruent context–target pairs were related than to say that the unrelated context–target pairs were. For 7–8-year-olds there was a trend for this by subjects, with a significant difference by items, $t_1(10) = 1.82$, $p = .10$; $t_2(55) = 3.85$, $p < .05$. The relatedness judgements for the congruent and unrelated context–target pairs were significantly different by subjects and items for the 8–9-year-olds and the 9–10-year-olds, $t_1(14) = 4.91$, $p < .05$; $t_2(59) = 8.61$, $p < .05$; and $t_1(23) = 7.71$, $p < .05$; $t_2(54) = 10.79$, $p < .05$, respectively. In addition, the two older groups were more likely to judge the congruent context–target pairs as related than the incongruent context–target pairs, $t_1(14) = 4.87$, $p < .05$; $t_2(58) = 6.34$, $p < .05$, and $t_1(23) = 6.91$, $p < .05$; $t_2(53) = 8.71$, $p < .05$, respectively for the 8–9- and the 9–10-year-olds. The younger group exhibited a similar pattern in their relatedness judgements of congruent and incongruent context–target pairs; however, this difference in relatedness judgements was only a weak trend that was not significant in the subjects analysis, but was by items, $t_1(10) = 1.11$, $p = .3$; $t_2(57) = 2.52$, $p < .05$. For the neutral condition, all groups produced average proportion of "yes, they are related" responses that were not different from 0.5, all $ts < 1.37$. Average proportions around .5 are predicted if the neutral context was really neutral, and participants activated and/or maintained each meaning for the ambiguous word about half the time.

Sentence recognition accuracy

Mean accuracy in the adults' sentence recognition task was .92 (with a range of .87 to 1.0).

Discussion

The results of Experiment 1 suggest that 9–10-year-olds are much more adult-like in their efficient use of sentence-level context than are younger children. Under a two-mechanism account, this data pattern suggests greater reliance on the top-down component by the older (9–10-year-old) children than by the younger (7–9-year-old) children. This finding supports the contextual development account and is in opposition to the predictions of the interactive–compensatory model. With these stimuli and tasks, the 7–9-year-olds' naming performance only reflected the activity of the spreading activation process, with little to no sentence-level context sensitivity. Conversely, the older (9–10-year-old) children and adult participants displayed a pattern of facilitation suggestive of both spreading activation and a top-down mechanism, with congruent targets being named faster than incongruent targets. The relatedness judgements also suggest this developmental trend of context use as can be seen in the increasing strength of the relationship between context type and relatedness responses. However, the relatedness judgements do indicate that the younger (7–9-year-old) children are able to use the top-down process some time after having named the target word. The more context-sensitive relatedness judgements of the older children suggest that the use of the top-down process increases with age and development. Furthermore, an important difference between the younger children and the older children might be the speed/efficiency with which they can utilize the top-down processing component of context use, given the other task demands.

Booth et al. (2006) also saw an age-based (and reading-skill-based) increase in context sensitivity for meaning selection of ambiguous words. However, despite a one-second delay between the homophone and the target, their 9- and 10-year-old participants showed a pattern similar to that of our 7–9-year-olds, while only their 12-year-old participants showed a context-sensitive pattern like the one we observed for both our older child participants (9–10 years) and adults. This provides further support for the contextual development account, but also highlights a potential trade-off between task demands and the ability of children to engage the top-down component. The task demands were higher in the Booth et al. experiment, particularly for the youngest participants and poorest readers, because the sentence contexts were presented visually, and the children were required to read the entire sentence aloud. Alternatively, the relatedness judgement task may have caused children to strategically engage the top-down mechanism more than they did in Booth et al.'s read-aloud paradigm.

In sum, we have shown that, by minimizing the task demands and encouraging attention to context, 9- to 10-year-old children are capable of engaging the top-down mechanism during meaning selection for ambiguous words in sentence context. On the other hand, even within our paradigm, which seems to encourage use of top-down context, the younger children seemed incapable of doing so in time to influence their naming latencies.

The contrasting pattern for the 7–9-year-old participants versus our 9–10-year-old participants clearly supports the contextual development account. However, one might worry that the younger participants simply were less likely to pay attention to the sentence context. It is certainly plausible that the younger children were less attentive, in general, or that they directed less effort to understanding the sentence than did their older counterparts. But the pattern of lexical priming suggests that even the youngest children were attending to the auditory stimuli, and even the youngest group's relatedness judgements show that they understood the sentences. Instead of ignoring the sentence contexts, we think that the younger children were not able to use the context efficiently to guide meaning selection due to limitations in the 7–9-year-olds' ability to manage their cognitive resources during our cross-modal task.

The contrast between our results and those of Booth et al. (2006) suggests that the failure to engage top-down processes may be related to the availability of cognitive resources that must be allocated to processing the sentence as well as the target word. Simpson and Lorsbach (1983) and Simpson and Foster (1986), as well as Coch and Holcomb (2003), suggest that younger/less skilled readers exhaust their cognitive resources (i.e., working memory, attention, and/or inhibition) while reading, leaving inadequate resources for the context integration process. This assertion is supported by the relationship we observed between target reading accuracy and context use, in which sentence-level context effects increase with reading accuracy. Clearly, the cognitive resources (e.g., working memory and inhibition) necessary to support the top-down mechanism are still under development for children in the age range we studied (e.g., Barkley, 1997; Bjorklund & Harnishfeger, 1990; Bunge, Dudukovic, Thomason, Vaidya, & Gabrieli, 2002; Casey, Galvan, & Hare, 2005a; Casey, Tottenham, Liston, & Durston, 2005b; Diamond, 2002).

Protopapas, Archonti, and Skaloumbakas (2007) recently reported a similar finding. They observed an inverse relationship between reading skill and Stroop interference, with less skilled readers showing greater Stroop interference. This was surprising, because Stroop interference is often seen as a sign of reading automaticity (Logan, 1997). Protopapas et al. accounted for the pattern in terms of a difference in attentional control: Less skilled readers have less attentional control than more skilled readers. A relatively low level of attentional control in the less skilled readers may also be a way to explain their inability to evaluate relevant sentence context when assessing the meanings of ambiguous words in our experiment.

EXPERIMENT 2: SINGLE-WORD CONTEXTS, GAUGING EXECUTIVE FUNCTIONS

Experiment 2 was designed to investigate the relationship between executive function skills, task demands, and access to the contextually appropriate meaning of a homophone. The experiment addressed two questions. First, could younger readers (7–9-year-olds) use a simpler context, consisting of a single word, efficiently to resolve a lexical ambiguity? Second, do executive functions like working memory and inhibition underlie the ability to use context for homophone resolution?

We used a paradigm similar to the one described for Experiment 1, except that the context preceding the homophone was a single-word prime that was forwardly related to one of the meanings of the homophone (i.e., commonly elicits the homophone as an associate in the Nelson et al., 1998, norms) or was unrelated to either meaning. An example stimulus item is illustrated in Table 4. Schvaneveldt, Meyer, and Becker (1976) used this technique and found that a single-word prime could constrain meaning selection to the congruent meaning of an ambiguous word in adults. For example, if given the prime *gentle* before the homophone *kind* one will respond faster to the target *nice* than to *type*. We expect this paradigm to place lower resource demands on executive functions such as working memory and inhibition than does the sentence context paradigm (Cutting et al., 2006; Simpson, 1981; Van Petten et al., 1997). Comparing the results of Experiment 2 with those of Experiment 1 will help to illuminate the role of task demands on appropriate context use. In addition, the inclusion of independent measures of working memory and inhibition will allow us to explore possible relationships between context effects and cognitive processing.

We were particularly interested in how individual differences in executive function capacity correspond to use of context. In this experiment, we were less concerned with distinguishing the spreading activation component from the top-down, resource-demanding component, but it should still be possible to distinguish the two. As in Experiment 1, spreading activation alone would predict some facilitation in all three related conditions. As in the previous experiment, the context was not associatively related to the target word. However, the context word in Experiment 2 was specifically intended to be an

Table 4. *Conditions in the word-priming experiments in Experiment 2*

Prime type	*Prime*	*Homophone*	*Target*
Congruent	laser	tag	grab
Incongruent	price	tag	grab
Neutral	ox	tag	grab
Unrelated	dump	waist	grab

associate of the intended meaning of the homophone. Thus, if spreading activation from the context to the homophone causes the contextually appropriate meaning to be more activated than the inappropriate meaning, facilitation would be greatest in the congruent condition, even without use of the top-down component. Use of the top-down component should further boost the contextually congruent condition, while inhibiting the incongruent condition relative to the neutral and unrelated conditions. Furthermore, we expected the resource-demanding component to be dependent upon executive function abilities, whereas automatic spreading activation should not be correlated with executive function ability.

Method

Participants

Participants for Experiment 2 were drawn from the same child and adult populations as were the participants in Experiment 1. Children were in academic after-school programmes and were tested in the middle of the school year. There were 9 second-graders (average age: 7.7 years), 9 third-graders (average age: 9.1 years), 14 fourth-graders (average age: 10.2 years), and 26 young adult participants. Although there were slight differences in the mean ages of the children in Experiments 1 and 2, there were no significant differences in the ages of these three groups across the two experiments, all $ts < 1.56$, $ps > .23$. As in Experiment 1, the second- and third-grade children comprise a single group for most of the analyses.

Stimuli

A total of 60 ambiguous words (homophones) were used, along with two associates (i.e., a prime and a target) for each homophone meaning. The homophones and targets were the same as those used in Experiment 1. Context words (primes) were selected using the Nelson et al. (1998) norms to ensure that each prime produced the homophone as an associate and also to ensure that the prime would not produce the to-be-named target word as an associate.[4] The prime–homophone–target sets were constructed to be congruent, incongruent, neutral, or unrelated in meaning. See the example in Table 4. A complete list of the prime–homophone–target sets appears in Appendix B. Each prime–homophone context was presented within one audio file.

Design and procedure—one-word context

Participants heard a prime word and then a homophone 1,000 ms after the offset of the prime. At the offset of the homophone, a visually presented target word appeared on the monitor. The participants read the target word aloud as quickly and accurately as possible.

The four critical conditions used in Experiment 1 were used again here, but there was no need for the neutral–unrelated distractor trials, because there were no repeated sentence contexts in Experiment 2. By eliminating these trials, we were able to redistribute the 60 items across the four conditions, allowing 15 observations per condition. The targets and primes were distributed across lists so that each participant saw each target and heard each prime–homophone context once. In addition, each target was counterbalanced across lists so that the target appeared in each context condition equally often across participants. This design created four lists.

Executive functions—measures of working memory and inhibition

We included independent measures of working-memory capacity and inhibition to investigate

[4] In Experiment 2, primes and targets related (or unrelated) to one of the meanings of the homophone were used. However, we ensured that each target was not an associate of the original prime (see Balota & Duchek, 1991, for further discussion). To ensure that the primes and targets were not associates of one another but were associates of the homophones, we used the norms produced by the children in the Experiment 1a norming study described above along with the University of South Florida Free Association Norms (Nelson et al., 1998). This ensured that facilitation observed in target naming latencies was a result of priming from the homophone and not from the original prime.

the role of each of these executive functions in context use. We selected three measures of working memory from Wechsler's Intelligence Scale for Children–Fourth Edition (WISC IV): Forward Digit Span, Backward Digit Span, and Letter/Number Sequencing (Wechsler, 2003). Each of these measures was used to calculate a child's working-memory capacity and skill. These measures are all designed to gauge a processing component of working memory. Specifically, all three tasks measure both the phonological store and articulatory rehearsal processes that make up the phonological loop (Leffard et al., 2006). However, the Letter/Number Sequencing and the Backward Digit Span tasks also measure a transformational process in which the child must use mental manipulation to accurately report the items. Wechsler (2003) argues that this mental manipulation is a higher order process and requires more executive functional demands than do processes that require only phonological storage and rehearsal, as is the case in the Forward Digit Span task. Thus, we included these measures in order to formulate a composite working-memory measure that included the storage, rehearsal, and mental manipulation aspects of working memory. Each of these measures was administered verbally, with the experimenter and participant sitting face to face.

Forward Digit Span. Participants were given an auditory list of digits to be reported back to the experimenter in the order presented. Participants progressed through increasingly longer lists with two lists at a given list length. When the participant incorrectly recalled the items from two lists of the same length, the task ended. Forward digit span equalled the number of lists recalled correctly.

Backward Digit Span. This was similar to the Forward Digit Span task except that participants recalled the list items in the reverse order of presentation.

Letter/Number Sequencing. Participants were told that they would hear a list of numbers and letters (e.g., 5–J–3–C). They were to report the numbers first, in numerical order starting with the lowest number (e.g., 3–5), and then the letters in alphabetical order (e.g., C–J). Participants were given three lists at each list length before progressing on to a longer list. When participants were unable to accurately report any of the entire lists from a set of three lists, the task ended. Letter/number sequencing span was the number of lists that were reported correctly.

Measure of inhibition. To measure each participant's inhibition capabilities, we used a go/no-go paradigm (e.g., Brocki & Bohlin, 2004, 2006). Participants were instructed to press the spacebar on a laptop as quickly as possible when they saw a row of Xs (XXXXX) and to not press any key when they saw a row of Xs with a Y in the middle (XXYXX). The program contained 75 go trials and 25 no-go trials. This ratio ensured that the go response was the prepotent response, and that the inhibition system would be engaged during the no-go response. Two measures from this task were used. Inhibition accuracy reflects how many times participants made a commission error (pressing the "go" key after the "no-go" stimuli presentation). Average reaction time for "go" responses reflects engagement of the inhibition process, with longer times reflecting greater engagement (Bellgrove, Hester, & Garavan, 2004; Kleinsorge & Gajewski, 2004; Luce, 1986; Ulrich, Mattes, & Miller, 1999).

Procedure

Adults completed all tasks in one 25-minute session. The child participants completed two 20-minute sessions separated by at least one day and not more than one week. In Session 1, children completed the primary experiment, followed by the go/no-go task. The primary experiment followed the same procedures as those used in Experiment 1 except that two words (the prime and the homophone) served as the auditory stimuli. The children completed the three measures of working memory in Session 2. Participants first completed the Forward Digit Span task, then the Backward Digit Span task, and finally the

Letter/Number Sequencing task. This order of tasks was the same for each participant.

Results and discussion

Target accuracy and naming latencies

We trimmed the data as in Experiment 1, resulting in the elimination of 3.7% of the responses. Table 5 summarizes the naming latency data.

A 3 (age group) by 4 (context type) ANOVA on target naming accuracy revealed no interaction between age and context. However, there was a main effect of age ($F_1 = 7.03$, $MSE = 0.021$, $p < .05$; $F_2 = 19.79$, $MSE = 0.018$, $p < .05$). The effect of age was due to the adults being more accurate than the 7–9-year-old and the 9–10-year-old participant groups (.992, .910, .945, respectively). The adults were more accurate than both of the child participant groups across all context types by subjects and items (all ts > 2.06). There was no difference in naming accuracy across the child participant groups in the subjects' analysis ($t_1 < 1.1$), but there was a difference in the items analysis, $t_2(118) = 2.19$, $p < .05$, with the older children being more accurate than the younger children. There was also a main effect of context ($F_1 = 5.39$, $MSE = 0.004$, $p < .05$, $F_2 = 6.76$, $MSE = 0.009$, $p < .05$). This effect of context was due to a difference in naming accuracy between the congruent (.97) and unrelated targets (.94), $t_1(56) = 2.041$, $p < .05$; $t_2(179) = 2.52$, $p < .05$. There was also a difference in the naming accuracy between the congruent and neutral targets, but this was only significant by items, $t_1(56) = 1.58$, $t_2(179) = 2.06$, $p < .05$, all other ts < 1.45.

A 3 (age group) by 4 (context condition) ANOVA on naming latencies revealed a main effect of context, $F_1(3, 162) = 8.25$, $MSE = 69{,}181$, $p < .05$; $F_2(3, 531) = 8.4$, $MSE = 29{,}060$, $p < .05$, and a main effect of age, $F_1(2, 54) = 12.45$, $MSE = 382, 121$, $p < .05$; $F_2(2, 177) = 267.36$, $MSE = 51{,}241$, $p < .05$. There was also an interaction by participants but not by items, $F_1(6, 162) = 2.16$, $MSE = 8{,}383$; $F_2 < 1$. Post hoc paired-samples t tests, collapsing across age group, revealed faster responses in the congruent condition than in the unrelated, incongruent, and neutral conditions, $t_1(56) = 4.29$, $p < .05$, $t_2(179) = 3.90$, $p < .05$; $t_1(56) = 4.76$, $p < .05$, $t_2(179) = 5.19$, $p < .05$; $t_1(56) = 3.31$, $p < .05$, $t_2(179) = 3.58$, $p < .05$, respectively.

Because there was a large difference in the mean naming latencies and standard errors between the children and adults, we also compared just the two child participant groups in a 2 (child age group) by 4 (context condition) ANOVA. There was a main effect of context, $F_1(3, 90) = 4.60$, $MSE = 13{,}723$, $p < .05$; $F_2(3, 354) = 5.79$, $MSE = 41{,}659$, $p < .05$, but no main effect of age, nor an interaction. There was a slight numerical tendency for the younger children to be more sensitive to context than the older children—opposite to the pattern found in Experiment 1. Unfortunately, we lacked sufficient power to detect an interaction this small—a power analysis indicated that 93 children would be required in each age group to detect an interaction of this size.

Post hoc paired-samples t tests, collapsing across the two age groups, revealed faster responses in the congruent condition than in the unrelated condition, $t_1(31) = 3.45$, $p < .05$; $t_2(119) = 3.30$, $p < .05$. As can be seen in the left two panels of Figure 3, there was no difference between the neutral and unrelated conditions, ts < 0.5, nor

Table 5. *Naming latencies for each prime–target type in each age group for Experiment 2*

Group	*Congruent*	*Incongruent*	*Neutral*	*Unrelated*
7–9-year-olds	993 (81)	1,108 (105)	1,115 (104)	1,079 (95)
9–10-year-olds	999 (94)	1,084 (106)	1,071(91)	1,091 (108)
Young adults	619 (32)	654 (36)	670 (40)	657 (37)

Note: Naming latencies in ms. Standard errors in parentheses.

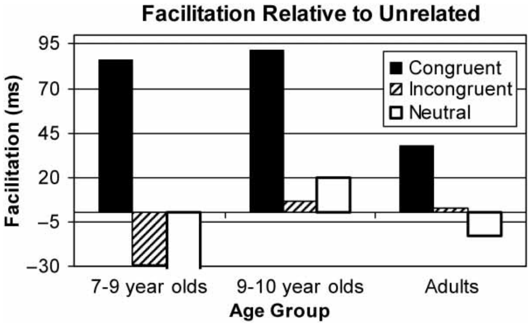

Figure 3. *Naming latency facilitation relative to the unrelated targets for congruent, incongruent, and neutral target pairs in Experiment 2.*

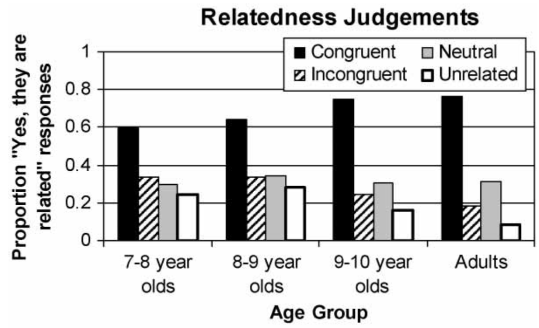

Figure 4. *Proportion of relatedness judgement responses in which the participants indicated that the target and the context word were related in meaning in Experiment 2.*

between the incongruent and unrelated conditions, *t*s < 1.0. Thus, there was no indication that the incongruent meaning was inhibited by the top-down mechanism in time to influence the naming response.

As in Experiment 1, we also examined the difference in naming latencies between the congruent and incongruent conditions. A 3 (age groups) by 2 (congruent vs. incongruent contexts) ANOVA indicated a marginally significant interaction by participants only, $F_1(2,\ 54) = 2.84$, $MSE = 6{,}193$, $p = .067$; $F_2(2,\ 177) = 2.26$, $MSE = 18{,}130$, $p = .11$. Congruent targets were named faster than the incongruent targets, $F_1(1,\ 54) = 26.67$, $MSE = 6{,}193$, $p < .05$; $F_2(1,\ 177) = 27.27$, $p < .05$. The same pattern was seen in each age group, but the size of the congruency effect grew smaller with age (and shorter naming latencies). The 7–9-year-olds named congruent targets 115 ms faster than incongruent targets. The 9–10-year-olds named congruent targets 85 ms faster than incongruent targets, while the adults named congruent targets 35 ms faster than incongruent targets (all *t*s > 2.97). Thus, in contrast to Experiment 1, all age groups appear to have selectively accessed the contextually appropriate meaning of the homophone.

Relatedness judgements

Next, we examined the relatedness judgements, which are illustrated in Figure 4. As we did in Experiment 1, we applied an arcsine transform to the relatedness responses before submitting them to our data analyses. Specifically, we calculated the proportion of "yes, they are related" responses in each context condition and then subjected these proportions to an arcsine transform in order to create relatively normal distributions of data. Based on analyses on these transformed proportions, all age groups showed a similar pattern (more "yes, they are related" judgements for congruent prime–target pairs and more "no, they are not related" for incongruent, neutral, and unrelated conditions), but the difference in relatedness judgements between conditions was the most pronounced for the older groups. First, we performed a 4 (age group) × 4 (context type) ANOVA, which shows an interaction between age and context type, $F_1(9,\ 159) = 2.90$, $p < .05$; $F_2(9,\ 693) = 2.38$, $p < .05$. There was no main effect of age (*F*s < 0.9), but there was a strong effect of context type on related judgements, $F_1(1,\ 53) = 220.57$, $p < .05$; $F_2(1,\ 231) = 269.00$, $p < .05$. Additional ANOVAs performed across the four conditions at each age level revealed a main effect of context condition on relatedness judgement for each age group: $F_1(3,\ 24) = 6.48$, $p < .05$; $F_2(3,\ 162) = 10.83$, $p < .05$, for the 7–8-year-olds; $F_1(3,\ 24) = 9.86$, $p < .05$; $F_2(3,\ 177) = 14.03$, $p < .05$, for the 8–9-year-olds; $F_1(3,\ 39) = 57.06$, $p < .05$; $F_2(3,\ 177) = 41.30$, $p < .05$, for the 9–10-year-olds; and $F_1(3,\ 72) = 133.20$, $p < .05$; $F_2(3,\ 177) = 82.63$,

$p < .05$, for the adult group. Post hoc analyses indicate that every group produced a difference in the relatedness judgements between the congruent prime–target pairs when compared to the neutral, unrelated, or incongruent prime–target pairs. All ts > 3.2 and ps < .05.

Executive function and reading-skill analyses

We examined whether each participant's performance on the working-memory measures was related to his or her difference in naming latencies between the congruent and incongruent conditions. For the adult participants, we found that there was no relationship between any of the working-memory measures or inhibition measures and context sensitivity (i.e., latency difference between incongruent and congruent conditions), all coefficient ts < 1. Thus, we withheld the adult sample from additional working-memory and inhibition measure analyses. For the child sample, we found that our working-memory measures were significantly correlated to one another; these correlations were weak to moderate in strength (.38–.496). Thus, we created a composite working-memory score for each participant by adding his/her span scores from the three working-memory measures (see Table 6). We did this to capture both the storage (via forward digit span) and processing components (via backward digit span and letter–number sequencing) of working memory. When this composite working-memory measure was loaded as a predictor it accounted for a large proportion of variance in the latency differences for child participants, $F_1(1, 29) = 13.06$, $MSE = 14{,}618$, $p < .05$, adjusted $R^2 = .29$, but not for adults ($F_1 < 1$). Thus, children who showed the most selective activation for the contextually appropriate meaning tended to have greater working-memory resources.

We also evaluated the relationship between inhibition skills and context sensitivity. The proportion of commission errors in the go/no-go task did not account for a significant proportion of variance in context sensitivity (i.e., the difference between context-congruent and context-incongruent target naming latencies) for either children or adults. However, most participants were very accurate (average error rate was 0.11 for the children). Therefore, we used response time on go trials (GoRT) as an approximation of inhibition activity (Bellgrove et al., 2004; Kleinsorge & Gajewski, 2004; Luce, 1986; Ulrich et al., 1999). Long reaction times for GoRT indicate the engagement of the stimulus discrimination mechanism, whereas shorter GoRTs indicate that the response is being executed without full stimulus discrimination (Bellgrove et al., 2004; Donders, 1868/1969; Kleinsorge & Gajewski, 2004; Luce, 1986; Ulrich et al., 1999). In fact, GoRT was a reliable predictor of naming latency facilitation for context-congruent targets as compared to context-incongruent targets for children, $F_1(1, 30) = 4.36$, $p < .05$, adjusted $R^2 = .10$, but not adults ($F_1 < 1$). For the children, the composite working-memory span and GoRT combined to account for 41% of variance in selective facilitation for targets in the congruent compared to the incongruent condition, $F(2, 29) = 11.01$, $p < .05$, adjusted $R^2 = .41$.

We calculated the average target word reading accuracy for each participant. Mean accuracy for

Table 6. *Composite working-memory span and inhibition reaction time averages and ranges for each age group in Experiment 2*

	Composite WM Span		*Go/No-Go RT (ms)*		*Target Naming Accuracy*	
Age group	*Average*	*Range*	*Average*	*Range*	*Average*	*Range*
7–9-year-olds	28.90	16–39	648.17	433–850	.90	.63–1.00
9–10-year-olds	30.69	21–33	610.71	474–775	.95	.74–1.00
Young adults	39.56	28–50	460.03	368–645	.99	.95–1.00

Note: WM = working memory. RT = reaction time.

each group is in Table 6. Target naming accuracy was a predictor of context sensitivity for children only, accounting for 26% of the variance in children's context sensitivity, $F(1, 31) = 12.06$, $p < .05$, adjusted $R^2 = .26$. A regression model of the children's data, in which the composite working-memory span, GoRT, and reading accuracy were entered simultaneously, yielded an adjusted $R^2 = .53$, $F_1(3, 26) = 11.95$, $MSE = 9{,}702$, $p < .05$, with all *t*s > 2.76. Note, however, that when grade level or age was added as an additional predictor, it accounted for no more of the unique variance above and beyond that accounted for by forward digit span, GoRT, and naming accuracy. The standard regression coefficients and the proportion of unique variance accounted for in each of the predictor variables[5] are included in Table 7.

Table 7. *Standardized regression coefficients and proportion of unique variances accounted for by composite working-memory span, go/no-go reaction time, and target naming accuracy*

Predictor variable	*Standardized beta coefficient*	*Proportion of unique variance accounted for*
Composite WM	.43	.158
RT for go/no-go	.35	.123
Target naming accuracy	.39	.130

Note: WM = working memory. RT = reaction time. Proportion of unique variance accounted for by each predictor variable was obtained from squared part correlations for each predictor.

Discussion

When the context was limited to a single word, both groups of children patterned very much like the young adults. They successfully used context to access the appropriate meaning of the homophone. Our finding that children as young as 7 were proficient at using lexical context for lexical ambiguity resolution extends the work of Booth et al. (2006), who found that lexical level facilitation decreased from age 9 to 12, while sentence level facilitation increased.

More importantly, Experiment 2 helps illuminate the processes that are related to successful context use in children. It is possible that spreading activation alone produced the selective facilitation of the contextually congruent targets for both children and adults. However, we think it likely that the top-down mechanism was also involved, because the degree of context sensitivity (the difference in naming latencies for congruent and incongruent targets) was related to the children's working-memory capacity (our composite working-memory score), inhibition engagement (as measured by GoRT), and reading skill (as measured by target naming accuracy). As working-memory capacity, inhibition engagement, and reading skill increased, so did the ability to use context during meaning selection. To the degree that spreading activation is an automatic process, it should not depend on these executive function capacities. We believe that the simpler contexts in Experiment 2 made the experimental tasks less taxing, allowing the younger children to engage the top-down mechanism as well as spreading activation.

Of course, it is also possible that the reason our measures of working-memory capacity and inhibition engagement were correlated with context sensitivity is that both performance on these tasks and the ability to use context for homophone resolution are influenced by a third predictor variable (or a set of such variables). We have already suggested that reading skill is one such possibility, and there could be others, such as the participant's motivation and attentiveness during the experiment. Attentiveness to the experimental tasks is quite difficult to rule out as an explanatory

[5] To calculate the proportion of unique variance accounted for by each predictor variable, we calculated the part correlations for each predictor (holding the other variables constant). We then squared these part correlations to find this unique variance for each predictor. The joint variance that is accounted for when all three predictor variables (composite working-memory span, go/no-go reaction time, and target naming accuracy) are loaded, calculated as the difference between the overall adjusted R^2 for the regression with all predictors and the summation of the squared part correlations for the three predictor variables, was found to be: $.53 - (.158 + .123 + .130) = .12$.

underlying predictor variable, because both the working-memory measures and the go/no-go task require a high level of attentiveness to achieve high executive function scores. Nonetheless, these tasks are commonly used to assess executive function (rather than attentiveness or motivation), under the assumption that a skilled experimenter will succeed in getting all participants to perform their best. Thus, while the finding that working-memory span and GoRT collectively account for 41% of the variance in context sensitivity is both impressive and strongly suggestive, we cannot rule out the possibility that the contextual sensitivity in Experiment 2 was due to spreading activation alone.

COMPARISONS BETWEEN EXPERIMENTS 1 AND 2

Do we have any direct evidence that reducing the cognitive load for the children increased their ability to use context efficiently to resolve the lexical ambiguity? This question can be answered by comparing the results of the two experiments. As expected, the adult pattern of behaviour remained similar across both experiments while the pattern of behaviour of the children, especially the younger children, was quite different across the experiments. Thus, we limit our cross-experiment comparisons to the performance of the two child participant groups (7–9- vs. 9–10-year-old groups).

Naming latency facilitation: Experiments 1 and 2 (children)

To examine the effect of task difficulty on context use in children, we compared the performance of each of the age groups in the sentence and word context comparisons. It has been noted that processing a sentence is more demanding of working memory and attention than processing a word (cf. Cutting et al., 2006; Simpson, 1981; Van Petten et al., 1997). Thus, using a word rather than a sentence context should lead to greater context effects for readers with limited working memory and attention capacity (e.g., children).

An overall 2 (Experiment 1 vs. 2) by 2 (child age group) by 4 (context condition) ANOVA indicated a three-way interaction, $F_1(3, 234) = 2.92$, $p < .05$; $F_2(3, 705) = 2.75$, $p < .05$. As shown by the analyses already reported for Experiments 1 and 2, above, this interaction is due to performance differences of the younger (7–9-year-old) children in the two experiments. Specifically, the 7–9-year-olds' naming latencies were similar for both congruent and incongruent targets in Experiment 1, while in Experiment 2, 7–9-year-olds had faster naming latencies for the congruent targets than for the incongruent targets. In addition to the three-way interaction, there were main effects of experiment, $F_1(1, 78) = 16.75$, $p < .05$; $F_2(1, 235) = 391.78$, $p < .05$, age, $F_1(1, 78) = 9.18$, $p < .05$; $F_2(1, 235) = 209.64$, $p < .05$, and context condition, $F_1(3, 234) = 7.87$, $p < .05$; $F_2(3, 705) = 7.86$, $p < .05$.

To further examine differences between children's performances in Experiment 1 (sentence context) and Experiment 2 (word context), we compared naming latencies for each context condition across experiments. There was a main effect of experiment for all context conditions such that naming latencies were longer in Experiment 1 than in Experiment 2, all ts > 2.14, ps $< .05$. That is, naming a target took longer after listening to a sentence than after listening to a pair of words as context. This is not surprising given Simpson's (1981) results indicating that sentence processing is more demanding on working memory than is word processing. This result also suggests that the same limited processing capacity is dedicated to both reading aloud and context use, to some extent. If this were not the case, then naming latencies should be the same for the sentence and word contexts.

Next, within each age group, we conducted context type (4) by experiment (2) ANOVAs on naming latencies. As one might expect, the only interaction of context and experiment was for the younger participants (7–9-year-olds), $F_1(3, 126) = 4.46$, $p < .05$; $F_2(3, 351) = 4.21$, $p < .05$. The 7–9-year-old participants displayed selective facilitation, as measured by the naming latencies of congruent targets subtracted from the naming latencies of incongruent targets, in Experiment 2 but not in Experiment 1, $t_1(42) = 3.15$, $p < .05$; $t_2(117) = 2.80$, $p < .05$. These findings indicate that the younger participants were able to use the word context, but not the sentence context, to aid in meaning selection.

GENERAL DISCUSSION

The current experiments provide insight into three developmental aspects of context use. First, they detail a crucial segment of the developmental trajectory of context use during meaning selection for ambiguous words. Second, they begin to examine how executive functions (e.g., working memory and inhibition) underlie appropriate context use and lead to successful meaning selection. Finally, these studies help to distinguish between developmental theories of context use. The results support an account in which early context use is greatly impacted by task demands, and top-down context effects increase with development, reading skill, and executive functioning. We called this the *contextual development* account.

We began this paper with a puzzle, in which young children are expert users of spoken and real-world context, who are able to use context to learn new words and detect semantic anomalies. Likewise, beginning readers often use context strategically to identify printed words, and it has commonly been assumed by scholars that context influences beginning readers more than mature readers in assigning meanings to printed words (e.g., Stanovich et al., 1985). Nonetheless, some research suggested that elementary-school children did not use context in an adult-like manner (Simpson & Foster, 1986; Simpson & Lorsbach, 1983). Most recently, Booth et al. (2006) mapped out a developmental trajectory from age 9 to 12, in which lexical-level context effects decreased while sentence-level context effects increased. In an attempt to resolve this puzzle, we considered a dual-mechanism contextual development account, in which automatic spreading activation functions in an adult-like manner throughout elementary school, but the top-down mechanism for meaning selection comes online gradually. The top-down mechanism is modulated by task demands as well as the developing executive function abilities of the individual. Such an account explains prior results quite well and was further tested and supported by the current set of experiments.

Experiment 1, in which the younger participants did not display context sensitivity via their naming responses, illustrates that the top-down mechanism may not be utilized by these young readers during complex tasks that combine oral sentence comprehension and reading aloud. However, the relatedness judgements suggest that these young children may be able to use this top-down mechanism for context use some time after the reading process is complete. Furthermore, the youngest group of children was fully capable of using single-word contexts to access the appropriate homophone meaning in Experiment 2. In addition, the correlation between contextual sensitivity and executive function abilities in Experiment 2 suggests that the children were using a top-down resource-demanding mechanism in addition to automatic spreading activation. This is in line with the executive function development framework of Bjorklund and Harnishfeger (1990) in which a limited pool of resources must be spread across executive processing. Adequate working memory is necessary in order to maintain activation of context relevant to meaning selection for the ambiguous word. Inhibition may also be used to suppress the activation of the irrelevant ambiguous word meanings (Gernsbacher, 1993; Gernsbacher & Faust, 1991). When these resources are limited or unavailable (e.g., if they are strained in the reading process) then context-guided meaning selection can fail.

The results of Experiment 2 help to illuminate why context use increases with age. These results indicate that greater context use comes with greater working-memory capacity, inhibition engagement, and reading skill. Such an account is in opposition to the interactive–compensatory model. However, it is important to note that both the interactive–compensatory model of Stanovich and colleagues (Stanovich et al., 1985, 1981), and the original contextual development account based on the work of Simpson and others (Simpson & Lorsbach, 1983; Simpson & Foster, 1986), were conceived within the domain of reading. The current experiments, on the other hand, used a cross-modal paradigm in order to minimize reading demands for our younger participants. Presumably, the same cognitive mechanisms are potentially available to support context use during reading and listening, but as we have noted, children's ability to allocate cognitive resources across different aspects of an experimental task are likely to be strongly impacted by stimulus modality.

The modality difference between the earlier work (including Booth et al., 2006) and our experiments could have introduced some new potential concerns. For example, the cross-modal nature of our task meant that within each trial participants had to switch their attention from the auditory modality to the visual modality. The modality switching cost itself may have led to the different patterns of context effects in our age groups. On the other hand, children have had much more experience with using context for meaning selection in the listening modality than in the reading modality, so one could argue that the present experiments are a better test of context use during language comprehension. Furthermore, our results from Experiment 1 nicely coincide with the results of Booth et al. (2006) who found that younger (9–10-year-olds) and less skilled readers were able to use lexical level context, but were not able to use sentence-level context to the same degree as were older (12-year-olds) and more skilled readers.

To be clear, Booth and colleagues (2006) did not explain their pattern of results via the development of the automatic spreading activation process and the top-down resource-demanding process as we do. Instead, they explained their results via a single process governed by distributed attractor networks (cf. Kawamoto, 1993). It is possible that the two processes of automatic spreading activation and top-down context use could actually be implemented within a distributed attractor network as described by Booth and colleagues (2006). For example, the two processes could change the energy landscape of the attractor network on a different time course, with the automatic spreading activation processes acting more efficiently than the top-down process, especially in individuals with fewer executive function resources. Thus, our results and conclusions are not necessarily in conflict with those put forth by Booth and colleagues; like them, we found a developmental trajectory in which lexical context processing develops before sentence-level context use.

In sum, the results from the present series of studies support the Contextual Development account in which greater context sensitivity comes with age and reading skill (Simpson & Foster, 1986; Simpson & Lorsbach, 1983). These studies also expand the contextual development account to implicate increases in executive function resources such as working memory and inhibition with increased use of context. Taken together with the earlier studies by Simpson and colleagues and the recent study of Booth et al. (2006), our experiments help clarify the relationships among task demands, individual differences in executive functioning, age, and sensitivity to sentence-level and lexical-level context. In addition, the results from our studies directly oppose the interactive–compensatory model proposed by Stanovich, West, and colleagues (Stanovich et al., 1985, 1981; West & Stanovich, 1978) in which younger/less skilled readers show greater context sensitivity than do older/more skilled readers.

The two processes hypothesized to underlie context use can be characterized as an automatic spreading activation process and a top-down resource-demanding process that is dependent upon working memory and inhibition. It appears as if both of these contextual processes are present quite early in development (i.e., at least by around the age of 7 years old, the age of our youngest participants). However, if a task is sufficiently resource demanding for an individual, he or she may not have enough cognitive resources (e.g., working memory and/or inhibitory skills) remaining to dedicate to context evaluation through the top-down process. As readers mature, they display more context sensitivity because they have greater working-memory and inhibition resources that they are better able to spread across multiple processes.

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APPENDIX A

Sentence context stimuli (Experiment 1)

	Context type	*Priming sentence*	*Homophone*	*Target*
1.	Congruent	Mom called us in, then we sat down and...	ate	drank
	Incongruent	George counted the candles and found...	eight	drank
	Neutral	Melanie told her husband the word was...	ate	drank
	Unrelated	I have to ask my mom if I...	can	drank
	Neu-Unrel	Melanie told her husband the word was...	can	drank
2.	Congruent	The handyman picked up the long...	board	nail
	Incongruent	The long lesson left the students...	bored	nail
	Neutral	Melanie told her husband the word was...	board	nail
	Unrelated	Karl said the girl had a pleasant...	scent	nail
	Neu-Unrel	Melanie told her husband the word was...	scent	nail
3.	Congruent	Jill gets upset when her stereo...	breaks	crack
	Incongruent	Jim needs to replace his car's...	brakes	crack
	Neutral	Melanie told her husband the word was...	breaks	crack
	Unrelated	What my brother told me does not make...	sense	crack
	Neu-Unrel	Melanie told her husband the word was...	sense	crack
4.	Congruent	Bob smashed the little crawling...	bug	roach
	Incongruent	Nikki is glad that she has a sister to...	bug	roach
	Neutral	Melanie told her husband the word was...	bug	roach
	Unrelated	Mark asked which bike I was going to...	choose	roach
	Neu-Unrel	Melanie told her husband the word was...	choose	roach
5.	Congruent	I found something in the store I wanted to...	buy	pay
	Incongruent	When Jon's mom left, she told him...	bye	pay
	Neutral	Melanie told her husband the word was...	buy	pay
	Unrelated	The swimmer said that the water was...	chilly	pay
	Neu-Unrel	Melanie told her husband the word was...	chilly	pay
6.	Congruent	Rebecca ate the corn from the...	can	soda
	Incongruent	I have to ask my mom if I...	can	soda
	Neutral	Melanie told her husband the word was...	can	soda
	Unrelated	George counted the candles and found...	eight	soda
	Neu-Unrel	Melanie told her husband the word was...	eight	soda
7.	Congruent	Billy looked at the ground and found one...	cent	money
	Incongruent	Karl said the girl had a pleasant...	scent	money
	Neutral	Melanie told her husband the word was...	cent	money
	Unrelated	The long lesson left the students...	bored	money
	Neu-Unrel	Melanie told her husband the word was...	bored	money
8.	Congruent	The gumball cost Lynn twenty-five...	cents	dollars
	Incongruent	What my brother told me does not make...	sense	dollars
	Neutral	Melanie told her husband the word was...	cents	dollars
	Unrelated	Jim needs to replace his car's...	brakes	dollars
	Neu-Unrel	Melanie told her husband the word was...	brakes	dollars
9.	Congruent	Steve is gross because of how loudly he...	chews	gum
	Incongruent	Mark asked which bike I was going to...	choose	gum
	Neutral	Melanie told her husband the word was...	chews	gum
	Unrelated	Nikki is glad that she has a sister to...	bug	gum
	Neu-Unrel	Melanie told her husband the word was...	bug	gum

(*Continued overleaf*)

APPENDIX A. (*Continued*)

	Context type	*Priming sentence*	*Homophone*	*Target*
10.	Congruent	The waitress served a bowl of the...	chili	beans
	Incongruent	The swimmer said that the water was...	chilly	beans
	Neutral	Melanie told her husband the word was...	chili	beans
	Unrelated	When Jon's mom left, she told him...	bye	beans
	Neu-Unrel	Melanie told her husband the word was...	bye	beans
11.	Congruent	I thought the amount of homework was not...	fair	good
	Incongruent	Kent and Lauren met at the local...	fair	good
	Neutral	Melanie told her husband the word was...	fair	good
	Unrelated	Jake asked if I wanted to eat the fresh...	pear	good
	Neu-Unrel	Melanie told her husband the word was...	pear	good
12.	Congruent	Barbara tried to smash the little...	fly	swatter
	Incongruent	When we go to California we will...	fly	swatter
	Neutral	Melanie told her husband the word was...	fly	swatter
	Unrelated	The dogs Karen and I have are the same...	kind	swatter
	Neu-Unrel	Melanie told her husband the word was...	kind	swatter
13.	Congruent	The house is clean because we expect a...	guest	room
	Incongruent	Molly didn't know the answer, so she...	guessed	room
	Neutral	Melanie told her husband the word was...	guest	room
	Unrelated	I asked mom if I could go, she said I could...	not	room
	Neu-Unrel	Melanie told her husband the word was...	not	room
14.	Congruent	After Sean runs, he often rubs his...	heel	ankle
	Incongruent	Yvonne wondered if her cut would ever...	heal	ankle
	Neutral	Melanie told her husband the word was...	heel	ankle
	Unrelated	Henry worried that he had a big...	nose	ankle
	Neu-Unrel	Melanie told her husband the word was...	nose	ankle
15.	Congruent	Nancy hid the candy on a shelf that was...	high	low
	Incongruent	When Rachel got here, she said...	hi	low
	Neutral	Melanie told her husband the word was...	high	low
	Unrelated	The pilot got the signal that it was clear to...	land	low
	Neu-Unrel	Melanie told her husband the word was...	land	low
16.	Congruent	Tom need more than one, he needed a...	pair	socks
	Incongruent	Jake asked if I wanted to eat the fresh...	pear	socks
	Neutral	Melanie told her husband the word was...	pair	socks
	Unrelated	Kent and Lauren met at the local...	fair	socks
	Neu-Unrel	Melanie told her husband the word was...	fair	socks
17.	Congruent	I like Jane because she is so...	kind	nice
	Incongruent	The dogs Karen and I have are the same...	kind	nice
	Neutral	Melanie told her husband the word was...	kind	nice
	Unrelated	When we go to California we will...	fly	nice
	Neu-Unrel	Melanie told her husband the word was...	fly	nice
18.	Congruent	Marjorie's shoelaces are in a...	knot	rope
	Incongruent	I asked mom if I could go, she said I could...	not	rope
	Neutral	Melanie told her husband the word was...	knot	rope
	Unrelated	Molly didn't know the answer, so she...	guessed	rope
	Neu-Unrel	Melanie told her husband the word was...	guessed	rope
19.	Congruent	The teacher asked a question that no one...	knows	learns
	Incongruent	Henry worried that he had a big...	nose	learns
	Neutral	Melanie told her husband the word was...	knows	learns
	Unrelated	Yvonne wondered if her cut would ever...	heal	learns

(*Continued overleaf*)

APPENDIX A. (*Continued*)

	Context type	*Priming sentence*	*Homophone*	*Target*
	Neu-Unrel	Melanie told her husband the word was...	heal	learns
20.	Congruent	The gopher dug a deep hole in the...	land	grass
	Incongruent	The pilot got the signal that it was clear to...	land	grass
	Neutral	Melanie told her husband the word was...	land	grass
	Unrelated	When Rachel got here, she said...	hi	grass
	Neu-Unrel	Melanie told her husband the word was...	hi	grass
21.	Congruent	My mom wishes that she could get a...	maid	clean
	Incongruent	Kelly enjoyed the card that I had...	made	clean
	Neutral	Melanie told her husband the word was...	maid	clean
	Unrelated	Janet told Mike that his skin looked...	pale	clean
	Neu-Unrel	Melanie told her husband the word was...	pale	clean
22.	Congruent	The cat wanted to enjoy the serving of...	meat	beef
	Incongruent	Mike and I wanted our parents to...	meet	beef
	Neutral	Melanie told her husband the word was...	meat	beef
	Unrelated	At the stop sign, Connie needed to...	pause	beef
	Neu-Unrel	Melanie told her husband the word was...	pause	beef
23.	Congruent	To solve the problem, Sue had to use her...	mind	body
	Incongruent	Ann ate the last candy, she asked if Ed will...	mind	body
	Neutral	Melanie told her husband the word was...	mind	body
	Unrelated	The hard wind tossed around the...	plane	body
	Neu-Unrel	Melanie told her husband the word was...	plane	body
24.	Congruent	The boy with M&Ms asked if I would like...	one	two
	Incongruent	I was surprised when our team...	won	two
	Neutral	Melanie told her husband the word was...	one	two
	Unrelated	Jessie got her new pet from the...	pound	two
	Neu-Unrel	Melanie told her husband the word was...	pound	two
25.	Congruent	Tom wants to jump, but is scared he will...	miss	hit
	Incongruent	The woman is not married, so we call her...	miss	hit
	Neutral	Melanie told her husband the word was...	miss	hit
	Unrelated	I covered the food with the...	wrap	hit
	Neu-Unrel	Melanie told her husband the word was...	wrap	hit
26.	Congruent	Fran put the shells into a...	pail	shovel
	Incongruent	Janet told Mike that his skin looked...	pale	shovel
	Neutral	Melanie told her husband the word was...	pail	shovel
	Unrelated	Kelly enjoyed the card that I had...	made	shovel
	Neu-Unrel	Melanie told her husband the word was...	made	shovel
27.	Congruent	The kitty was licking its...	paws	dog
	Incongruent	At the stop sign, Connie needed to...	pause	dog
	Neutral	Melanie told her husband the word was...	paws	dog
	Unrelated	Mike and I wanted our parents to...	meet	dog
	Neu-Unrel	Melanie told her husband the word was...	meet	dog
28.	Congruent	Joe doesn't like jam on his toast, he likes it...	plain	bland
	Incongruent	The hard wind tossed around the...	plane	bland
	Neutral	Melanie told her husband the word was...	plain	bland
	Unrelated	Ann ate the last candy, she asked if Ed will...	mind	bland
	Neu-Unrel	Melanie told her husband the word was...	mind	bland
29.	Congruent	Luke liked chocolate so much that he ate a...	pound	fat
	Incongruent	Jessie got her new pet from the...	pound	fat
	Neutral	Melanie told her husband the word was...	pound	fat

(*Continued overleaf*)

APPENDIX A. (*Continued*)

	Context type	*Priming sentence*	*Homophone*	*Target*
	Unrelated	I was surprised when our team...	won	fat
	Neu-Unrel	Melanie told her husband the word was...	won	fat
30.	Congruent	The singer wrote a new...	rap	sing
	Incongruent	I covered the food with the...	wrap	sing
	Neutral	Melanie told her husband the word was...	rap	sing
	Unrelated	The woman is not married, so we call her...	miss	sing
	Neu-Unrel	Melanie told her husband the word was...	miss	sing
31.	Congruent	The man knew that his son would be the...	prince	charming
	Incongruent	Wherever he walked, the wolf left his...	prints	charming
	Neutral	Melanie told her husband the word was...	prince	charming
	Unrelated	June saw that the pants were on...	sale	charming
	Neu-Unrel	Melanie told her husband the word was...	sale	charming
32.	Congruent	The doctor asked if he could get his head to...	raise	hand
	Incongruent	Jill was hot from the sun's...	rays	hand
	Neutral	Melanie told her husband the word was...	raise	hand
	Unrelated	Megan could not believe what she...	saw	hand
	Neu-Unrel	Melanie told her husband the word was...	saw	hand
33.	Congruent	Jenny likes it when she is given...	praise	honor
	Incongruent	Before they eat dinner, the family...	prays	honor
	Neutral	Melanie told her husband the word was	praise	honor
	Unrelated	Mary needs her glasses in order to...	see	honor
	Neu-Unrel	Melanie told her husband the word was...	see	honor
34.	Congruent	Jenny asked me about the list I had...	read	wrote
	Incongruent	Kurt stumped his toe, now it looks really...	red	wrote
	Neutral	Melanie told her husband the word was...	read	wrote
	Unrelated	Her sister was irritating, so Maria told her to...	shoo	wrote
	Neu-Unrel	Melanie told her husband the word was...	shoo	wrote
35.	Congruent	My teacher said that Donna was...	right	correct
	Incongruent	Joe said the pain in his back was on his...	right	correct
	Neutral	Melanie told her husband the word was...	right	correct
	Unrelated	The warrior protected himself with his...	soared	correct
	Neu-Unrel	Melanie told her husband the word was...	soared	correct
36.	Congruent	The wind blew in the yacht's...	sail	breeze
	Incongruent	June saw that the pants were on...	sale	breeze
	Neutral	Melanie told her husband the word was...	sail	breeze
	Unrelated	Wherever he walked, the wolf left his...	prints	breeze
	Neu-Unrel	Melanie told her husband the word was...	prints	breeze
37.	Congruent	Connie hacked through the pole with a...	saw	cut
	Incongruent	Megan could not believe what she...	saw	cut
	Neutral	Melanie told her husband the word was...	saw	cut
	Unrelated	Jill was hot from the sun's...	rays	cut
	Neu-Unrel	Melanie told her husband the word was...	rays	cut
38.	Congruent	Pat and Mark could not wait to visit the...	sea	fish
	Incongruent	Mary needs her glasses in order to...	see	fish
	Neutral	Melanie told her husband the word was...	sea	fish
	Unrelated	Before they eat dinner, the family...	prays	fish
	Neu-Unrel	Melanie told her husband the word was...	prays	fish
39.	Congruent	Kerry tied the laces on his...	shoe	lace
	Incongruent	Her sister was irritating, so Maria told her to...	shoo	lace

(*Continued overleaf*)

APPENDIX A. (*Continued*)

	Context type	*Priming sentence*	*Homophone*	*Target*
	Neutral	Melanie told her husband the word was...	shoe	lace
	Unrelated	Kurt stumped his toe, now it looks really...	red	lace
	Neu-Unrel	Melanie told her husband the word was...	red	lace
40.	Congruent	The cardinal jumped from his nest and...	soared	flew
	Incongruent	The warrior protected himself with his...	sword	flew
	Neutral	Melanie told her husband the word was...	soared	flew
	Unrelated	Joe said the pain in his back was on his...	right	flew
	Neu-Unrel	Melanie told her husband the word was...	right	flew
41.	Congruent	Harry enjoyed playing baseball with his...	son	boy
	Incongruent	The children on the sand played in the...	sun	boy
	Neutral	Melanie told her husband the word was...	son	boy
	Unrelated	The water was so deep that we had to...	wade	boy
	Neu-Unrel	Melanie told her husband the word was...	wade	boy
42.	Congruent	George tripped over the...	stair	case
	Incongruent	My parents told me it was not polite to...	stare	case
	Neutral	Melanie told her husband the word was...	stair	case
	Unrelated	We did not want all of the food to go to...	waste	case
	Neu-Unrel	Melanie told her husband the word was...	waste	case
43.	Congruent	At recess the children played...	tag	grab
	Incongruent	Jerry was bothered by the shirt's...	tag	grab
	Neutral	Melanie told her husband the word was...	tag	grab
	Unrelated	Kirk's clothes get tighter when he gains...	weight	grab
	Neu-Unrel	Melanie told her husband the word was	weight	grab
44.	Congruent	The children enjoyed the Bible...	tale	story
	Incongruent	The cow moved her...	tail	story
	Neutral	Melanie told her husband the word was...	tale	story
	Unrelated	When my mom leaves she makes sure to...	wave	story
	Neu-Unrel	Melanie told her husband the word was...	wave	story
45.	Congruent	Mark snatched the football that Pete...	threw	away
	Incongruent	There was a long tunnel that we had to walk...	through	away
	Neutral	Melanie told her husband the word was...	threw	away
	Unrelated	During the spring we did go to school for a...	week	away
	Neu-Unrel	Melanie told her husband the word was...	week	away
46.	Congruent	The doctor asked Eddie how much he...	weighed	ton
	Incongruent	The water was so deep that we had to...	wade	ton
	Neutral	Melanie told her husband the word was...	weighed	ton
	Unrelated	The children on the sand played in the...	sun	ton
	Neu-Unrel	Melanie told her husband the word was...	sun	ton
47.	Congruent	The skirt was tight around her...	waist	belt
	Incongruent	We did not want all of the food to go to...	waste	belt
	Neutral	Melanie told her husband the word was...	waist	belt
	Unrelated	My parents told me it was not polite to...	stare	belt
	Neu-Unrel	Melanie told her husband the word was...	stare	belt
48.	Congruent	The bus wasn't on time, so we had to...	wait	line
	Incongruent	Kirk's clothes get tighter when he gains...	weight	line
	Neutral	Melanie told her husband the word was...	wait	line
	Unrelated	Jerry was bothered by the shirt's...	tag	line
	Neu-Unrel	Melanie told her husband the word was...	tag	line
49.	Congruent	The surfer rode into shore on the...	wave	beach

(*Continued overleaf*)

APPENDIX A. (*Continued*)

	Context type	*Priming sentence*	*Homophone*	*Target*
	Incongruent	When my mom leaves she makes sure to...	wave	beach
	Neutral	Melanie told her husband the word was...	wave	beach
	Unrelated	The cow moved its...	tail	beach
	Neu-Unrel	Melanie told her husband the word was...	tail	beach
50.	Congruent	Lara hasn't eaten, so she is feeling very...	weak	tired
	Incongruent	During the spring we did go to school for a...	week	tired
	Neutral	Melanie told her husband the word was...	weak	tired
	Unrelated	There was a long tunnel that we had to walk...	through	tired
	Neu-Unrel	Melanie told her husband the word was...	through	tired
51.	Congruent	The child couldn't reach the toy, so he...	whined	begged
	Incongruent	In the mountains, the roads began to...	wind	begged
	Neutral	Melanie told her husband the word was...	whined	begged
	Unrelated	After a loud concert, Neil's ears will...	ring	begged
	Neu-Unrel	Melanie told her husband the word was...	ring	begged
52.	Congruent	The house was old and made of...	wood	fire
	Incongruent	Jill wanted me to go with her; I said that I...	would	fire
	Neutral	Melanie told her husband the word was...	wood	fire
	Unrelated	Burt hates it when his mother call him...	dear	fire
	Neu-Unrel	Melanie told her husband the word was...	dear	fire
53.	Congruent	Paul saw that he was bitten on the arm by the...	ant	hill
	Incongruent	Nell liked to go to Columbia to visit her...	aunt	hill
	Neutral	Melanie told her husband the word was...	ant	hill
	Unrelated	The doctor said that the baby was...	male	hill
	Neu-Unrel	Melanie told her husband the word was...	male	hill
54.	Congruent	Tanya though the coat's cloth had a nice...	feel	soft
	Incongruent	When I am sick, I hate the way I...	feel	soft
	Neutral	Melanie told her husband the word was...	feel	soft
	Unrelated	At the party, Doug had a large glass of...	punch	soft
	Neu-Unrel	Melanie told her husband the word was...	punch	soft
55.	Congruent	The game was so great, we wanted to...	watch	listen
	Incongruent	Sally gave look a shiny new...	watch	listen
	Neutral	Melanie told her husband the word was...	watch	listen
	Unrelated	Don wondered which assistant he should...	hire	listen
	Neu-Unrel	Melanie told her husband the word was...	hire	listen
56.	Congruent	Bobby asked Sue if she would wear his...	ring	finger
	Incongruent	After a loud concert, Neil's ears will...	ring	finger
	Neutral	Melanie told her husband the word was...	ring	finger
	Unrelated	In the mountains, the roads began to...	wind	finger
	Neu-Unrel	Melanie told her husband the word was...	wind	finger
57.	Congruent	Hugo looked into the forest and saw a...	deer	bambi
	Incongruent	Burt hates it when his mother call him...	dear	bambi
	Neutral	Melanie told her husband the word was...	deer	bambi
	Unrelated	Jill wanted me to go with her; I said that I...	would	bambi
	Neu-Unrel	Melanie told her husband the word was...	would	bambi
58.	Congruent	Hank wanted to work by delivering the...	mail	box
	Incongruent	The doctor said that the baby was...	male	box
	Neutral	Melanie told her husband the word was...	mail	box
	Unrelated	Nell liked to go to Columbia to visit her...	aunt	box
	Neu-Unrel	Melanie told her husband the word was...	aunt	box

(*Continued overleaf*)

APPENDIX A. (*Continued*)

	Context type	*Priming sentence*	*Homophone*	*Target*
59.	Congruent	Mike was really hurt by George's. . .	punch	kick
	Incongruent	At the party, Doug had a large glass of. . .	punch	kick
	Neutral	Melanie told her husband the word was. . .	punch	kick
	Unrelated	When I am sick, I hate the way I. . .	feel	kick
	Neu-Unrel	Melanie told her husband the word was. . .	feel	kick
60.	Congruent	Sam was surprised that Jaime could jump. . .	higher	lower
	Incongruent	Don wondered which assistant he should. . .	hire	lower
	Neutral	Melanie told her husband the word was. . .	higher	lower
	Unrelated	Sally gave look a shiny new. . .	watch	lower
	Neu-Unrel	Melanie told her husband the word was. . .	watch	lower

Note: Neu-Unrel = neutral−unrelated.

APPENDIX B

One-word context stimuli (Experiment 2)

	Context type	*Prime*	*Homophone*	*Target*
1.	Congruent	food	ate	drank
	Incongruent	seven	eight	drank
	Neutral	pin	ate	drank
	Unrelated	leave	bye	drank
2.	Congruent	splinter	board	nail
	Incongruent	lonely	bored	nail
	Neutral	water	board	nail
	Unrelated	able	can	nail
3.	Congruent	glass	breaks	crack
	Incongruent	pedal	brakes	crack
	Neutral	gel	breaks	crack
	Unrelated	aroma	scent	crack
4.	Congruent	insect	bug	roach
	Incongruent	annoy	bug	roach
	Neutral	grape	bug	roach
	Unrelated	logic	sense	roach
5.	Congruent	sell	buy	pay
	Incongruent	leave	bye	pay
	Neutral	talk	buy	pay
	Unrelated	seven	eight	pay
6.	Congruent	aluminum	can	soda
	Incongruent	able	can	soda
	Neutral	girl	can	soda
	Unrelated	lonely	bored	soda
7.	Congruent	penny	cent	money
	Incongruent	aroma	scent	money
	Neutral	live	cent	money
	Unrelated	pedal	brakes	money
8.	Congruent	fifty	cents	dollars

APPENDIX B. (*Continued*)

	Context type	*Prime*	*Homophone*	*Target*
	Incongruent	logic	sense	dollars
	Neutral	lane	cents	dollars
	Unrelated	annoy	bug	dollars
9.	Congruent	eat	chews	gum
	Incongruent	pick	choose	gum
	Neutral	slam	chews	gum
	Unrelated	supposed	guessed	gum
10.	Congruent	hotdog	chili	beans
	Incongruent	cold	chilly	beans
	Neutral	year	chili	beans
	Unrelated	cure	heal	beans
11.	Congruent	even	fair	good
	Incongruent	carnival	fair	good
	Neutral	loose	fair	good
	Unrelated	hello	hi	good
12.	Congruent	moth	fly	swatter
	Incongruent	bird	fly	swatter
	Neutral	milk	fly	swatter
	Unrelated	peach	pear	swatter
13.	Congruent	visitor	guest	room
	Incongruent	supposed	guessed	room
	Neutral	chunk	guest	room
	Unrelated	pick	choose	room
14.	Congruent	foot	heel	ankle
	Incongruent	cure	heal	ankle
	Neutral	porch	heel	ankle
	Unrelated	cold	chilly	ankle
15.	Congruent	sky	high	low
	Incongruent	hello	hi	low
	Neutral	bloom	high	low

(*Continued overleaf*)

APPENDIX B. (*Continued*)

	Context type	*Prime*	*Homophone*	*Target*
	Unrelated	carnival	fair	low
16.	Congruent	couple	pair	socks
	Incongruent	peach	pear	socks
	Neutral	gem	pair	socks
	Unrelated	bird	fly	socks
17.	Congruent	gentle	kind	nice
	Incongruent	type	kind	nice
	Neutral	paper	kind	nice
	Unrelated	custom	made	nice
18.	Congruent	tie	knot	rope
	Incongruent	why	not	rope
	Neutral	buzz	knot	rope
	Unrelated	introduce	meet	rope
19.	Congruent	guess	knows	learns
	Incongruent	snot	nose	learns
	Neutral	king	knows	learns
	Unrelated	care	mind	learns
20.	Congruent	farm	land	grass
	Incongruent	plane	land	grass
	Neutral	toy	land	grass
	Unrelated	victory	won	grass
21.	Congruent	butler	maid	clean
	Incongruent	custom	made	clean
	Neutral	kite	maid	clean
	Unrelated	type	kind	clean
22.	Congruent	raw	meat	beef
	Incongruent	introduce	meet	beef
	Neutral	drape	meat	beef
	Unrelated	why	not	beef
23.	Congruent	think	mind	body
	Incongruent	care	mind	body
	Neutral	chair	mind	body
	Unrelated	snot	nose	body
24.	Congruent	single	one	two
	Incongruent	victory	won	two
	Neutral	think	one	two
	Unrelated	plane	land	two
25.	Congruent	skip	miss	hit
	Incongruent	mister	miss	hit
	Neutral	rear	miss	hit
	Unrelated	seen	saw	hit
26.	Congruent	bucket	pail	shovel
	Incongruent	light	pale	shovel
	Neutral	leave	pail	shovel
	Unrelated	foil	wrap	shovel
27.	Congruent	kitten	paws	dog
	Incongruent	delay	pause	dog

APPENDIX B. (*Continued*)

	Context type	*Prime*	*Homophone*	*Target*
	Neutral	juice	paws	dog
	Unrelated	thumb	prints	dog
28.	Congruent	simple	plain	bland
	Incongruent	airport	plane	bland
	Neutral	goat	plain	bland
	Unrelated	harmful	rays	bland
29.	Congruent	ounce	pound	fat
	Incongruent	puppy	pound	fat
	Neutral	call	pound	fat
	Unrelated	mister	miss	fat
30.	Congruent	rhyme	rap	sing
	Incongruent	foil	wrap	sing
	Neutral	bench	rap	sing
	Unrelated	light	pale	sing
31.	Congruent	king	prince	charming
	Incongruent	thumb	prints	charming
	Neutral	lake	prince	charming
	Unrelated	delay	pause	charming
32.	Congruent	lift	raise	hand
	Incongruent	harmful	rays	hand
	Neutral	junk	raise	hand
	Unrelated	airport	plane	hand
33.	Congruent	compliment	praise	honor
	Incongruent	worship	prays	honor
	Neutral	rat	praise	honor
	Unrelated	puppy	pound	honor
34.	Congruent	study	read	wrote
	Incongruent	stoplight	red	wrote
	Neutral	mark	read	wrote
	Unrelated	vision	see	wrote
35.	Congruent	wrong	right	correct
	Incongruent	left	right	correct
	Neutral	soon	right	correct
	Unrelated	away	shoo	correct
36.	Congruent	boat	sail	breeze
	Incongruent	bargain	sale	breeze
	Neutral	prank	sail	breeze
	Unrelated	knife	sword	breeze
37.	Congruent	chain	saw	cut
	Incongruent	seen	saw	cut
	Neutral	lake	saw	cut
	Unrelated	worship	prays	cut
38.	Congruent	gull	sea	fish
	Incongruent	vision	see	fish
	Neutral	mop	sea	fish
	Unrelated	stoplight	red	fish
39.	Congruent	sneaker	shoe	lace

(*Continued overleaf*)

APPENDIX B. (*Continued*)

	Context type	*Prime*	*Homophone*	*Target*
	Incongruent	away	shoo	lace
	Neutral	angel	shoe	lace
	Unrelated	left	right	lace
40.	Congruent	eagle	soared	flew
	Incongruent	knife	sword	flew
	Neutral	gift	soared	flew
	Unrelated	bargain	sale	flew
41.	Congruent	father	son	boy
	Incongruent	shine	sun	boy
	Neutral	rip	son	boy
	Unrelated	drive	through	boy
42.	Congruent	step	stair	case
	Incongruent	look	stare	case
	Neutral	pond	stair	case
	Unrelated	ocean	wade	case
43.	Congruent	laser	tag	grab
	Incongruent	price	tag	grab
	Neutral	ox	tag	grab
	Unrelated	dump	waste	grab
44.	Congruent	fairy	tale	story
	Incongruent	wag	tail	story
	Neutral	pint	tale	story
	Unrelated	height	weight	story
45.	Congruent	tossed	threw	away
	Incongruent	drive	through	away
	Neutral	pill	threw	away
	Unrelated	shine	sun	away
46.	Congruent	scale	weighed	ton
	Incongruent	ocean	wade	ton
	Neutral	music	weighed	ton
	Unrelated	look	stare	ton
47.	Congruent	hip	waist	belt
	Incongruent	dump	waste	belt
	Neutral	sting	waist	belt
	Unrelated	price	tag	belt
48.	Congruent	delay	wait	line
	Incongruent	height	weight	line
	Neutral	pile	wait	line
	Unrelated	wag	tail	line
49.	Congruent	tide	wave	beach
	Incongruent	greet	wave	beach
	Neutral	flute	wave	beach
	Unrelated	niece	aunt	beach

APPENDIX B. (*Continued*)

	Context type	*Prime*	*Homophone*	*Target*
50.	Congruent	strong	weak	tired
	Incongruent	month	week	tired
	Neutral	fear	weak	tired
	Unrelated	sick	feel	tired
51.	Congruent	cried	whined	begged
	Incongruent	curve	wind	begged
	Neutral	syrup	whined	begged
	Unrelated	time	watch	begged
52.	Congruent	lumber	wood	fire
	Incongruent	should	would	fire
	Neutral	stab	wood	fire
	Unrelated	doorbell	ring	fire
53.	Congruent	aardvark	ant	hill
	Incongruent	niece	aunt	hill
	Neutral	rind	ant	hill
	Unrelated	honey	dear	hill
54.	Congruent	touch	feel	soft
	Incongruent	sick	feel	soft
	Neutral	rule	feel	soft
	Unrelated	guy	male	soft
55.	Congruent	observe	watch	listen
	Incongruent	time	watch	listen
	Neutral	jug	watch	listen
	Unrelated	Hawaiian	punch	listen
56.	Congruent	diamond	ring	finger
	Incongruent	doorbell	ring	finger
	Neutral	edge	ring	finger
	Unrelated	job	hire	finger
57.	Congruent	antlers	deer	bambi
	Incongruent	honey	dear	bambi
	Neutral	poet	deer	bambi
	Unrelated	greet	wave	bambi
58.	Congruent	stamp	mail	box
	Incongruent	guy	male	box
	Neutral	slime	mail	box
	Unrelated	month	week	box
59.	Congruent	fist	punch	kick
	Incongruent	Hawaiian	punch	kick
	Neutral	lamp	punch	kick
	Unrelated	curve	wind	kick
60.	Congruent	lift	higher	lower
	Incongruent	job	hire	lower
	Neutral	toast	higher	lower
	Unrelated	should	would	lower