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Authors
Styles, Suzy J.
Arias-Trejo, Natalia
Plunkett, Kim

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Priming and Lexical Interference in Infancy

Suzy J. Styles (suzy.styles@psy.ox.ac.uk)
Department of Experimental Psychology, University of Oxford
South Parks Road, Oxford, OX1 3UD, U.K.

Natalia Arias-Trejo (natalia.arias-trejo@psy.ox.ac.uk)
Department of Experimental Psychology, University of Oxford
South Parks Road, Oxford, OX1 3UD, U.K.

Kim Plunkett (kim.plunkett@psy.ox.ac.uk)
Department of Experimental Psychology, University of Oxford
South Parks Road, Oxford, OX1 3UD, U.K.

Abstract

Three experiments investigate priming effects in a looking task for infants in their second year. Infants hear two words (prime, target) in quick succession (separated by 200ms), and are presented with a picture pair (target, distracter) for 2500ms of free looking. Prime-target pairs are semantically and associatively related half of the time. Eye-movements are monitored. Infants aged 18- (Experiments 1, 2 and 3), 21- (Experiment 3) and 24- (Experiments 1 & 2) months were tested (N=328). 18-month-olds show consistent interest in named targets, but no priming effects. Experiment 1 demonstrates priming for 24-month-olds. Experiments 2 and 3 attempt to clarify whether this priming is fundamentally lexical (word-word) or visually mediated (word-picture), by varying the cue validity of the target as well as the prime. In Experiment 3, phonological competition produces a pattern of lexical interference and primed facilitation in 21-month-olds. This result supports a model of lexicon connectivity during the early stages of linguistic development.

Keywords: Priming; Lexical Development; Infancy.

Introduction

Infants acquire a vast number of words during their first two years of life (Caselli et al., 1995; Dale & Fenson, 1996; Goldfield & Reznick, 1990). To date, most research into infant vocabulary development has focused on infants' ability to generate mappings between words and their referents, leaving aside questions of when *lexical relationships* develop, and whether infants possess adult-like lexicon organization.

Adult studies investigating lexical processing have demonstrated that exposure to a related word facilitates subsequent word processing (Meyer & Schvanereveldt, 1971; Neely, 1991). These 'priming' effects reflect organization in the adult lexicon (Collins & Loftus, 1975). Such priming studies typically measure reaction times in a naming task, or a 'lexical decision' about whether a test stimulus is a real word. Clearly, neither task is appropriate for use with infants, whose metalinguistic knowledge is limited, and whose verbal skills are still developing.

Priming methodologies have been extended for use with toddlers and school-aged children, demonstrating a) that associative relationships influence accuracy in verbal memory tasks for 3- to 4-year-olds (Krackow & Gordon, 1998), b) that the speed of picture naming is primed by thematic relationships at 6 years-of-age, and additionally by taxonomic relationships at 8 years-of-age (Carr et al., 1982), c) that reaction time is primed by taxonomic, thematic and perceptual relations in an object decision task at 6 and 8 years-of-age (Hashimoto, McGregor, & Graham, 2007), and d) that both semantic and thematic relationships prime reaction time in an auditory lexical decision task for normally developing school children at 10 years-of-age (Nation & Snowling, 1999).

Researchers in the field of electrophysiology have sought to replicate adult patterns of primed brain activity in infants, using event related potentials (ERPs). While the findings from this domain are highly suggestive (Friedrich & Friederici, 2004), it is unclear whether observed infant brain activity is functionally adult-like (Torkildsen et al., 2007). It remains to be seen whether adult-like processing effects can be replicated in on-line behavioural tasks for infants. If relationships such as word association and semantic taxonomy can influence children's online language processing, it provides strong support for a model of lexical acquisition which is interconnected from a very early age (see Steyvers & Tenenbaum (2005) for a computational model of lexicon growth which relies on early network connectivity).

This paper reports three experiments investigating relationships between words in the early lexicon. The method is an adaptation of the inter-modal preferential looking (IPL) paradigm (Golinkoff et al., 1987), which shares similarities with some versions of the visual world paradigm, where systematic looking behaviour is obtained without explicit verbal instruction (e.g., Huettig & McQueen, 2007). In the current primed design, infants hear two words presented in quick succession (prime, target). Following the onset of the target word, a pair of images is presented (target, distracter), for a period of free looking (2500ms). Eye movements are recorded and looks to target and distracter are analyzed. In this paradigm, relationships between prime, target and distracter can be systematically manipulated, as can the predictive validity of each auditory cue.

Based on previous research showing that infants reliably look at named images more than at unnamed images

(Reznick, 1990), the underlying hypothesis is this: if infants' degree of interest in a named image varies with the relationship between target and prime, then the relationship is encoded in infants' knowledge structure.

Experiment 1 is the first reported attempt to bias infants' looking behaviour with the use of bare auditory primes. 18-month-olds and 24-month-olds saw 12 trials in which all targets were named, and the relationship between prime and target varied. As a further experimental manipulation, infants were separated into two groups who were tested with the same stimuli at different timing intervals.

Experiments 2 & 3 attempt to tease apart two distinct processing routes which might cause primed looking behaviour. If *lexical facilitation* occurs, activation from the prime word would flow to the target word enhancing normal processing of the target, thus enhancing image interest. This account can also be termed word-word priming. Alternatively, if *visual mediation* occurs, hearing the prime would trigger conceptual activation of the prime, including information about its visual form. When the target picture appears, infants show interest according to a partial visual match or an overextension of the prime word to the target image. This account can also be termed word-picture priming. As visual mediation may occur independently of target word processing, the ultimate test of these accounts is whether the target word is *necessary* to induce primed picture looking.

If word-word priming is evident in the looking behaviour of infants in their second year, this new methodology will provide a valuable tool for investigating the precise nature of early relationships in the developing lexicon.

Experiment 1

Participants were recruited from a database of parents who had previously expressed an interest in participating in developmental studies. In the week before visiting the laboratory, primary caregivers were asked to fill out a vocabulary inventory, the Oxford CDI (Hamilton, Plunkett, & Schafer, 2000), which they brought with them to the testing session.

Seventy two 18-month-olds (mean age: 18.2 months, range: 17.1 to 18.8; 40 males) and 72 24-month-olds (24.1 months, range: 23.4 to 25.0; 34 males) were tested. 25 additional infants were excluded for failure to complete, parental failure to return CDI, fussiness during test, or experimenter error. Two subjects were later excluded due to data loss and to parental interference during test.

Method

Two stimuli lists were created for a cross-modal priming task, using words likely to be comprehended by the majority of 18-month-olds. Twelve words acted as auditory 'targets', depicted on screen. Twelve words acted as auditory 'primes', presented shortly before the onset of the target word. Twelve images acted as distracters, depicted on screen alongside the target image, but remained unnamed. Relationships between primes, targets and distracters were systematically manipulated so that in each list, half of the targets were preceded by primes which were related by word-association and semantics (basic-level taxonomic sisters), and half, by unrelated primes. Across lists, each target was preceded by a related prime, and an unrelated prime. Unrelated primes shared no phonological onset or rhyme, no association and no taxonomic relationship. Distracters were similarly unrelated to both the target and the prime. Associations were based on adult norms for British English (Moss & Older, 1996). No word was repeated within a stimulus list, and each subject saw each item in the list only once.

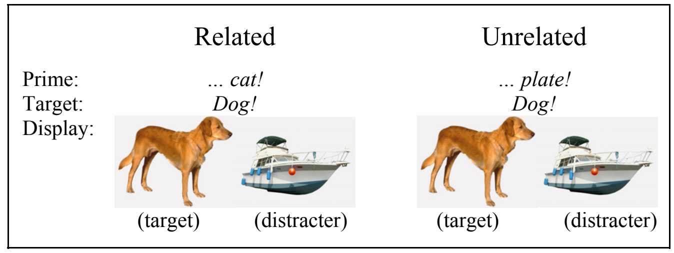

Figure 1: Related and unrelated prime conditions

The inter-stimulus interval (ISI) between prime and target was fixed at 200ms. The stimulus onset asynchrony (SOA) between the onset of the target word and onset of the image pair (target and distracter) was either 200ms or 400ms, according to subject group.

Materials Auditory recordings were made in a single session by a female native speaker of British English, using high-affect child directed speech. A 16-bit signal was recorded at 44.1 Hz in a sound dampening room, directly onto a computer. Stimuli were selected from multiple recorded tokens for clarity, typicality and affect, and were digitally edited to remove head and tail clicks. Visual stimuli were high-quality digital photographs of animals and objects, presented on a 10% grey background.

Procedure After a few minutes of 'settling in', infants sat on their caregiver's lap facing a rear-projection screen in a purpose-built IPL booth. Parents were asked to wear headphones and to close their eyes during the procedure, which lasted approximately one and a half minutes. The experimenter moved to an adjacent control booth, where each trial was manually initiated when the infant's attention was centered on the screen.

While the screen was blank, the priming phrase began (e.g., *Yesterday, I saw a cat*). 200ms after the offset of the prime, the target word began. At a fixed stimulus onset asynchrony (SOA) from the onset of the target (200ms or 400ms), the test phase began with the onset of images, which remained on screen for 2,500ms. Target side was counterbalanced. Trial order was randomized on presentation. Infants sat approximately 90cm from the 790mm wide screen. Images were 320mm wide, together occupying a visual angle of approximately 48º, and separated by a gap of 155mm (10º).

Infants' eye movements were monitored by two small cameras located above the image presentation areas of the screen. The camera feeds were combined online into a single split-screen image and digitally captured during test. Blind manual coding was conducted offline frame-by-frame at a temporal accuracy of 40ms. All coding was conducted by an experienced coder (previously assessed inter-coder reliability above 95%). Looks to left and right were automatically re-combined with trial information. Looks to the target and distracter were analyzed from the onset of image presentation.

Results

Only trials in which both the prime and target words were reported as "understood" in the vocabulary survey were included in analyses (18-month-olds: 67%; 24-month-olds: 91%), and infants were excluded if they contributed trials to only one priming condition. Trials were excluded from analysis if infants did not fixate the screen area for more than a few frames, which constituted less than 5% of trials in all groups. The dependent measure of interest is the proportion of target looking (PTL), which is calculated as the total amount of time spent looking at the target as a proportion of the total amount of time spent looking at both images.

18-month-olds Subject means were calculated for each priming condition. In a 2x2 univariate ANOVA comparing the effects of SOA (400ms, 200ms) and priming condition (related, unrelated) on PTL, no effects or interactions were found. With an overall mean PTL of 0.59 ($SD = 0.17$), 18-month-olds systematically looked at the target more than the distracter ($t(122) = 6.02$, $p < 0.001$, $d = 0.54$).

24-month-olds Simple comparisons were conducted due to unequal variance across subsets of the data. Older infants looked more at targets in the related priming condition than in the unrelated priming condition ($t(139) = 3.80$, $p < 0.001$, $d = 0.63$). There was no reliable difference between SOA conditions, either at the overall level or within priming conditions. Due to this lack of difference, data were pooled across SOA conditions. In both priming conditions, infants systematically looked to the target, with a mean PTL of 0.61 ($SD = 0.12$) in the related priming condition ($t(70) = 8.24$, $p < 0.001$, $d = 0.98$), and 0.54 ($SD = 0.11$) in the unrelated condition ($t(69) = 3.04$, $p < 0.005$, $d = 0.36$).

Discussion

At 24 months-of-age, where two words (prime, target) are presented in quick succession prior to dual image presentation (target, distracter), the looking pattern varies according to the relationship between prime and target: When the prime and the target are related by association and taxonomy (e.g., *cat* and *dog*), older infants direct more visual attention to the target than they do when the prime and target are unrelated (e.g., *plate* and *dog*). Overall, they look more at named targets than unnamed distracters, and this visual preference is *modulated* by the prime.

18-month-olds show a preference for named targets over unnamed distracters, but no effect of prime. These differences between age groups may be due to increasing strength or density of lexical relationships, but changes in memory span may also be critically involved.

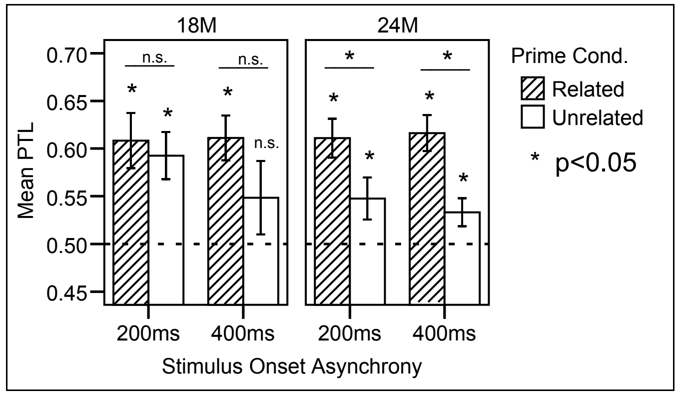

Figure 2: Mean Proportion of Target Looking in Experiment 1. Two ages, separated by timing condition (SOA) and prime type. +/- one standard error.

Experiment 2

The priming effect in Experiment 1 could have been either word-word (lexical facilitation) or word-picture (visual mediation) priming. In order to clarify the type of priming, Experiment 2 manipulates target naming as well as prime type, with half of all targets remaining unnamed. In this 2x2 design, if 'priming' is primarily mediated by word-picture matching, then target naming should have no effect on the degree of target interest. If priming is primarily lexical (word-word), then interest in the target would only be greater in the condition where the target is *both* named and primed. If both types of priming (word-word and word-picture) are present, then more complex interactions between naming and priming would be evident.

For Experiment 2, the longer SOA condition was selected, as priming effects were more reliable in this timing condition. As an additional control, all images in Experiment 2 behaved as both targets and distracters to reduce any effects of visual preference within an image pair.

Participants were recruited as in Experiment 1, and parents filled out CDIs prior to their visit. Thirty six 18-month-olds (mean age: 18.2 months, range: 17.0 to 19.3; 21 males) and 40 24-month-olds (24.1 months, range: 22.9 to 24.9; 25 males) were tested. Nine additional infants were excluded for parental failure to return the vocabulary questionnaire and for experimenter error. One further infant from each age group was later removed due to data corruption.

Method

Four stimuli lists were created in which target-distracter picture pairs were yoked across lists. Across lists, all images occurred equally often as targets and as distracters. As in

Experiment 1, within each list, half of the targets were preceded by primes which were related by word-association and semantics (basic-level taxonomic sisters), and half, by unrelated primes. Across lists, each target was preceded by a related prime, and an unrelated prime. Unrelated primes shared no phonological onset or rhyme, no association and no taxonomic relationship. Distracters were unrelated to both the target and the prime. Novel to this design, in half of the trials, the target was named, and in half, it was replaced by a place-holder such as '*Look*!' Thus each list contained 12 trials, of which three were related-primes with named-targets, three were unrelated-primes with named-targets, three were related-primes with unnamed-targets, and three were unrelated-primes with unnamed targets (see Figure 3). No word was repeated within a list. Infants encountered each trial only once during test.

As in Experiment 1, the inter-stimulus interval (ISI) between prime and target was fixed at 200ms. The stimulus onset asynchrony (SOA) between the onset of the target word and the image pair (target-distracter) was fixed at 400ms.

Materials Visual and auditory stimuli were prepared and edited as in Experiment 1, although this time, digital recordings were made in a quiet room with a Marantz PMD670 solid state recorder, sampling a 16 bit signal, at 44.1Hz. A single recording session provided all of the tokens for Experiments 2 and 3, and a single set of images was collated for both experiments.

Procedure The testing procedure was identical to Experiment 1, with three minor exceptions: First, during the priming phase a small abstract shape rotated on screen for 500ms as a visual attention-holder. This shape left the screen before prime or target word were heard; Second, testing was carried out in a booth adjacent to the one used in Experiment 1, which differed only in stereo output and a flat-screen monitor (Images were 25cm x 34cm, together subtending an approximate visual angle of 52°, separated by a gap of 12°); Third, carrier phrases for primes were slightly shorter than in Experiment 1 (e.g., *I saw a cat!*).

Results

As in Experiment 1, only trials in which both prime and target words were reported as "understood" were included in analyses. Trials were also excluded from analysis if infants did not fixate the screen area for more than a few frames. Exclusion rates were comparable to Experiment 1.

18-month-olds In a 2x2 univariate ANOVA comparing the effect of prime condition (related, unrelated) and target condition (named, unnamed) on PTL, there was a main effect of target ($F(1,110) = 4.18$, $p < 0.05$, $\eta^2 = 0.038$), with no further effects or interactions. Data were thus pooled across priming conditions, confirming that PTL was greater in the target named conditions ($t(109) = 2.09$, $p < 0.05$, $d = 0.40$). 18-month-olds showed systematic preference for the target in named conditions, ($t(52) = 4.10$, $p < 0.001$, $d = 0.52$), with a mean PTL of 0.61 ($SD = 0.21$). In unnamed trials, mean PTL was 0.53 ($SD = 0.21$), and target preference was not reliable.

24-month-olds In a 2x2 ANOVA comparing the effect of priming condition and target condition on PTL, no main effects or interactions were found. Pooled data indicated that 24-month-olds looked more at targets overall than at distracters ($M = 0.55$, $SD = 0.17$, $t(155) = 3.37$, $p = 0.001$, $d = 0.27$), demonstrating that they had extracted target-identifying information from auditory stimuli in the majority of cases. Their performance did not, however, show systematic variation according to prime or target condition.

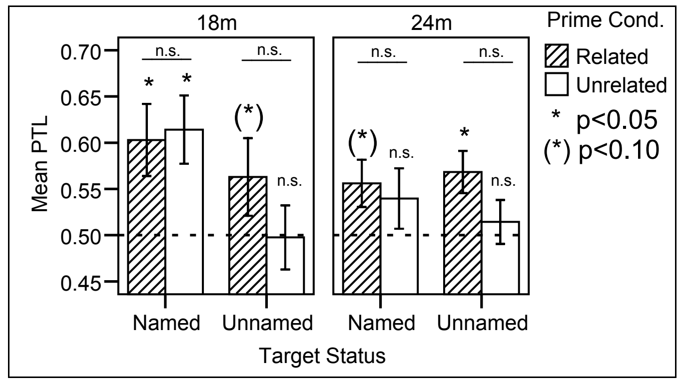

Figure 3: Mean PTL in Experiment 2. Two ages, separated by target status and prime type. SOA is 400ms. +/- one standard error.

Discussion

Younger infants in Experiment 2 replicate the pattern of Experiment 1, responding to target naming, but showing no systematic effect of prime type. The older infants in Experiment 2 respond to the majority of target images, but their preference reduced to a low average, where differences between the conditions are difficult to detect.

One consequence of the design in Experiment 2 is the variation in auditory cue validity. In Experiment 1, the target word was 100% predictive of a screen image. In addition, the prime was relevant 50% of the time. Auditory stimuli were therefore highly reliable cues. By contrast, in Experiment 2, primes and targets had cue validities of only 50% each. It is thus possible that older infants were aware of the unreliable nature of the auditory cues, and employed a form of strategic responding which may have overshadowed systematic responses to primes and targets. Post hoc review of video recordings supports this interpretation (compared to Experiment 1, more gestures and facial expressions were consistent with annoyance, e.g., shaking head at screen, looking away early, closing eyes).

Experiment 3

To circumvent possible strategic responding in 24-month-old infants, Experiment 3 introduced three changes to the methodology. First, an intermediate age group (21 months) was targeted, as strategic responding may not yet have developed in this group. Second, to increase task difficulty, and thus, the automaticity of responding, target and distracter images were selected to share phonological onsets, making them cohort-competitors. Third, to maximize the likelihood of phonological interference, a shorter SOA (200ms) was used

Participants were recruited and were sent CDI forms prior to their visit, as in Experiments 1 and 2. Fifty two 18-month-olds (mean age: 18.0 months, range: 17.2 to 18.3; 25 males) and 56 21-month-olds (20.9 months, range: 20.1 to 21.2; 22 males) were tested. Four additional infants were removed and replaced for fussiness during test. Eight 18-month-olds were later removed for failure to comprehend test items in more than six trials.

Method

Four stimuli lists were created in which target-distracter pairs were yoked across lists. Priming relationships (related, unrelated) and target naming (named, unnamed) were counterbalanced within and across lists as in Experiment 2. That is, within each list, half of the targets were preceded by primes related by word-association and semantics (basic-level taxonomic sisters), and half, by unrelated primes. Across lists, each target was preceded by both prime types. Unrelated primes shared no phonological onset or rhyme, no association and no taxonomic relationship. Both within and across lists half of all targets were replaced by the word 'Look!' The critical difference in stimuli preparation for Experiment 3 was that distracters in all four conditions shared a phonological onset with the target (e.g., target: *dog*, distracter: *door*).

Materials Auditory stimuli were recorded and prepared in the same session and manner as for Experiment 2, and visual stimuli were created from the same pool of images.

As in Experiments 1 and 2, the inter-stimulus interval (ISI) between prime and target was fixed at 200ms. The SOA between the onset of the target word and the image pair was fixed at 200ms, the shorter of the SOAs previously employed in Experiment 1.

Procedure The testing procedure was identical to Experiment 2, except that a different visual attention-holder was used.

Results

18-month-olds In a 2x2 univariate ANOVA comparing the effect of prime condition (related, unrelated) and target condition (named, unnamed) on PTL, a main effect of target status was found ($F(1,157) = 26.52$, $p < 0.001$, $\eta^2 = 0.144$). A one-sample t-test confirmed that 18-month-olds looked at the target more than the distracter in the named conditions ($M = 0.61$, $SD = 0.17$, $t(79) = 5.61$, $p < 0.001$, $d = 0.81$).

21-month-olds In a 2x2 univariate ANOVA comparing the effect of priming condition and target condition on PTL, there was an interaction between prime type and target status ($F(1, 217) = 5.91$, $p < 0.05$, $\eta^2 = 0.026$).

Simple effects clarified the pattern of interaction: Target looking was greater in the related-named condition than in either the related-unnamed condition ($t(54) = 2.86$, $p < 0.01$, $d = 0.52$), or in the unrelated-named condition ($t(54) = 2.84$, $p < 0.01$, $d = 0.47$). Thus, 21-month-olds looked at the target more than the distracter only in the condition where both the target was named, and the prime was related ($M = 0.57$, $SD = 0.15$, $t(55) = 3.52$, $p = 0.001$, $d = 0.95$).

Discussion

As in Experiments 1 & 2, 18-month-olds responded to target naming, but were unaffected by lexical primes presented at short latencies. In contrast to Experiment 2, older infants were affected by *both* target naming and by priming relationship. The combination of short SOA with a phonological onset-competitor meant that infants had only begun to process the target word when two equally valid images appeared. To identify the correct target, infants needed to continue processing the target word, while inhibiting response to a cohort competitor. In this case, 21-month-olds only showed target looking above chance in the related-named condition. Thus the phonological interference was only overcome with support from a related prime. Moreover, older infants do not show preference for primed, but unnamed targets, as would be predicted by a visual mediation account. This pattern of inhibition and processing facilitation is only compatible with a lexical, or word-word priming account.

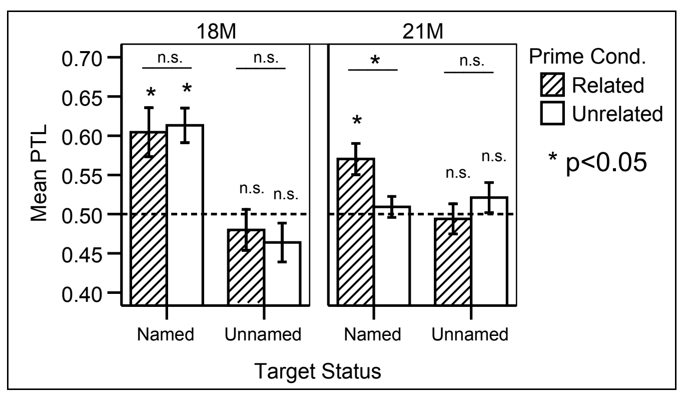

Figure 4: Mean PTL in Experiment 3. Two ages, separated by target naming and prime type. SOA is 200ms. Picture-pairs share onset. +/- one standard error.

General Discussion

In the current series of experiments, 18-month-olds showed a consistent preference for named targets over unnamed images, with no reliable sensitivity to prime-target relationships. By 24 months-of-age, lexical primes created additional target interest, but this was only the case when auditory cue validity was high, as in Experiment 1. When auditory cue validity dropped, as in Experiment 2, older infants' behaviour became un-systematic, and difficult to interpret. Phonological interference effects shown by 21-month-olds in Experiment 3 support a *lexical facilitation* interpretation of the priming effect, as both prime and target were necessary for the older infants to systematically identify the target. The visual mediation account predicted target preference even when the prime was related and the target unnamed. This was not found.

The developmental trajectory presented here could be taken to indicate that lexicon connectivity begins between 18- and 21-months of age. This suggests that the onset of lexicon inter-connectivity is timed to a critical mass of vocabulary items, or to the onset of an individual's 'word spurt'. Alternatively, it is also possible that experimental features of the current task make it inappropriate for 18-month-olds. For example, prime-to-target activation may take longer for younger infants (thus younger infants may require longer ISIs), or memory capacity may limit younger infants processing of phonological information to only the most recent item (hence, their performing as though no prime was presented). It remains to be seen whether early lexical relationships, such as those demonstrated here, are primarily associative or taxonomic in nature, as the two were intertwined in the current design.

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References

Carr, T., H, McCauley, C., Sperber, R. D., & Parmelee, C. M. (1982). Words, pictures, and priming: On semantic activation, conscious identification, and the automaticity of information processing. *Journal of Experimental Psychology: Human Perception and Performance, 8*, 757-758.

Caselli, M. C., Bates, E., Casadio, P., Fenson, J., Fenson, L., Sanderl, L., et al. (1995). A cross-linguistic study of early lexical development. *Cognitive Development, 10*, 159-199.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review, 82*, 407-428.

Dale, P. S., & Fenson, L. (1996). Lexical development norms for young children. *Behavior Research Methods, Instruments, & Computers, 28*, 125-127.

Friedrich, M., & Friederici, A. D. (2004). N400-like semantic incongruity effect in 19-month-olds: processing known words in picture contexts. *Journal of Cognitive Neuroscience, 16*, 1465-1477.

Goldfield, B. A., & Reznick, J. S. (1990). Early lexical acquisition: Rate, content, and the vocabulary spurt. *Journal of Child Language, 17*, 171-183.

Golinkoff, R. M., Hirsh-Pasek, K., Cauley, K. M., & Gordon, L. (1987). The eyes have it: Lexical and syntactic comprehension in a new paradigm. *Journal of Child Language, 14*, 23-45.

Hamilton, A., Plunkett, K., & Schafer, G. (2000). Infant vocabulary development assessed with a British communicative development inventory. *Journal of Child Language, 27*, 689-705.

Hashimoto, N., McGregor, K. K., & Graham, A. (2007). Conceptual organization at 6 and 8 years of age: evidence from the semantic priming of object decisions. *Journal of Speech, Language, and Hearing Research, 50*, 161-176.

Huettig, F., & McQueen, J. M. (2007). The tug of war between phonological, semantic and shape information in language-mediated visual search. *Journal of Memory and Language, 57*, 460-482.

Krackow, E., & Gordon, P. (1998). Are Lions and Tigers Substitutes or Associates? Evidence against Slot Filler Accounts of Children's Early Categorization. *Child Development, 69*, 347-354.

Meyer, D. E., & Schvanereveldt, R. W. (1971). Facilitation in recognising pairs of words: Evidence of a dependence between retrieval operations. *Journal of Experimental Psychology, 90*, 227-234.

Moss, H. E., & Older, L. (1996). *Birkbeck Word Association Norms*. Hove, UK: Psychology Press.

Nation, K., & Snowling, M. J. (1999). Developmental differences in sensitivity to semantic relations among good and poor comprehenders: evidence from semantic priming. *Cognition, 70*, B1-B13.

Neely, J. H. (1991). Semantic priming effects in visual word recognition: A selective review of current findings and theories. In D. Besner & G. W. Humphreys (Eds.), *Basic processes in reading: Visual word recognition*. Hillsdale NJ: Earlbaum.

Reznick, J. S. (1990). Visual preference as a test of infant word comprehension. *Applied Psycholinguistics, 11*, 145-166.

Steyvers, M., & Tenenbaum, J. B. (2005). The large-scale structure of semantic networks: Statistical analyses and a model of semantic growth. *Cognitive Science, 29*, 41-78.

Torkildsen, J. v. K., Syversen, G., Simonsen, H. G., Moen, I., & Lindgren, M. (2007). Electrophysiological correlates of auditory semantic priming in 24-month-olds. *Journal of Neurolinguistics, 20*, 332-351.