Research Article

When Do Children Understand “Opposite”?

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Purpose: The aims of the present research were to determine (a) the age at which children with typical development understand the concept of opposite, (b) whether this is related to other cognitive abilities or experiences, and (c) whether there is early implicit understanding of the concept.

Method: Children (N = 204) between 3 and 5 years of age were randomly assigned to 1 of 3 experimental conditions in a novel opposite task. Children’s language and working memory skills were assessed, and parents provided information about children’s access to learning materials about opposites.

Results: In the opposite task, 4- and 5-year-olds, but not 3-year-olds, demonstrated acquisition of the concept of opposite. Children demonstrated this understanding only when asked for the “opposite” one, suggesting that antonymy was not made salient by stimulus properties alone. Children’s accuracy was not significantly related to their language or working memory skills, to their child care experience, or to whether parents reported having books or games about opposites or playing opposite word games with children. Eye gaze analyses provided no evidence for early implicit understanding of the concept of opposite.

Conclusion: Children with typical development have a concept of opposite by 4 years of age.

Having a concept of “opposite” is considered to be a marker of typical lexical and conceptual development (e.g., American Academy of Child and Adolescent Psychiatry, 2008). This concept involves the lexical semantic relation of antonymy, and acquisition of this knowledge is a developmental achievement that likely supports, and is itself supported by, the acquisition of other linguistic skills. Antonyms are pairs of words that are both minimally and maximally different. They typically differ maximally but only on a single dimension (e.g., length or age); therefore, their meanings are simultaneously similar and different (Clark, 1970; Jones, 2002; Murphy, 2003; Owens, 2008). There is surprisingly little data on when children actually understand that these words are opposite. The purpose of the present study was to address this issue.

In order to understand the concept of opposite, a child must learn that the meanings of some words are related, that two words that form an antonymic pair have a binary relationship with each other (Murphy, 2003), and the specific relationship that the words have with each other in order to distinguish antonymy from other lexical semantic relations, such as synonymy. The challenge of abstracting similarities across exemplars of opposite is illustrated in recent computational modeling described by Chen, Lu, and Holyoak (2010). The antonym relation was particularly hard for Chen et al.’s model to learn, and they attributed this to the fact that the dimensions of meaning on which antonyms differ vary across antonym pairs; they stated, “The shifting relevance of features makes learning a good representation for antonyms challenging” (p. 876).

In the present work we focused on antonymous adjectives. Though antonymous nouns (e.g., life–death) and verbs (e.g., increase–decrease) also exist, we focused this investigation on adjectives because adjectives lend themselves to manipulation and have been the focus of previous studies on this topic. Our approach in the current work is consistent with Murphy’s (2003) view of lexical relations as metalinguistic concepts. Lexical semantic relations such as antonymy constitute metalinguistic knowledge—conceptual knowledge about words and the ways word meanings are related. As such, acquisition of the concept of an opposite can be demonstrated by correct identification of word pairs that are opposites—that is, identification of word pairs that share the semantic relation of antonymy. In the following sections we review the literature and explain how our research builds on what has been done by addressing limitations in the metalinguistic studies of children’s understanding of opposite that have so far been conducted.
Approaches to the Study of Antonym Acquisition

Empirical research assessing the development of the concept of opposite generally concludes that appreciation begins to develop around the age of 4 years (Clark, 1972; Heidenheimer, 1975; Morris, 2003). However, there is also some evidence of later (Kreezer & Dallenbach, 1929) and earlier (Jones, 2007; Jones & Murphy, 2005; Murphy & Jones, 2008) ages of acquisition and usage. These studies fall into one of two categories: metalinguistic studies and discourse studies.

Metalinguistic Studies

Metalinguistic studies evaluate children’s understanding of antonym relations and their ability to work with the metalinguistic vocabulary of opposition. To date, these studies primarily have involved verbal games wherein the child responds to a question along the lines of “What is the opposite of X?” The present research adopts a related approach. The first study to investigate children’s appreciation for the concept of opposite utilized a verbal response task and was conducted by Kreezer and Dallenbach (1929). A child was considered to know the concept of opposite if he or she produced the corresponding antonym (e.g., fast in response to slow) or if he or she utilized the strategy of negation (e.g., not fast). Kreezer and Dallenbach concluded that 50% of children could be taught the concept of opposite between the ages of 5:3 and 5:9 (years;months) and that a child could learn the concept without instruction between the ages of 8 and 9 years.

Further research revealed that the age of acquisition of the concept of opposite is probably younger than was initially found (Clark, 1972; Heidenheimer, 1975; Morris, 2003). With a similar verbal task, Clark (1972) found that children as young as 4 years could provide a correct opposite response to some of the stimulus words and that 5-year-olds provided more correct responses than 4-year-olds. Morris (2003) also found that children between the ages of 4 and 5 years were able to consistently generate opposites. However, no effect of age was found; 4- and 5-year-olds appeared to understand the concept of opposite equally well.

Also in contrast with the learning found by Kreezer and Dallenbach (1929), Clark (1972) reported a distinct order of acquisition: When making a semantically appropriate substitution, children always replaced a difficult word with an easier word but never the reverse. For example, a child might replace tall with big in the tall–short word pair but never the reverse (i.e., replacing big with tall in the big–small pair). There was a correlation between age and the number of semantically appropriate responses, which Clark (1972) suggested was the result of children in the younger age groups knowing the easier, less complex word pairs and none of the more difficult word pairs. These results suggest that the younger children tested knew the concept of opposite but did not have a sufficiently developed vocabulary to successfully perform the task with all word pairs.

Of consequence for all metalinguistic studies of opposite, Kreezer and Dallenbach (1929) found that some children who stated that they did not know the concept of opposite actually did know the relation but did not know the concept label, and vice versa. This suggests that studies that rely extensively on children’s verbal responses to reflect understanding of the word opposite, especially those that do not provide any feedback during the course of the study (as in Clark, 1972, and Morris, 2003), may be unnecessarily difficult for children.

Other relevant metalinguistic studies have examined development of semantic relations with free association tasks. These have shown that younger children tend to respond with a word that is likely to follow the stimulus word in a sentence (e.g., dark–night), whereas older children tend to respond with a word that could replace the stimulus word (e.g., dark–light; Entwisle, Forsyth, & Muuss, 1964). This is referred to as the syntactic–paradigmatic shift, is thought to occur between the ages of 5 and 9 years, and is found mainly for high-frequency adjectives (Nelson, 1977). Free association responses involving antonym relations are among the paradigmatic responses produced. The age of the shift may depend on the response task used (Jarman, 1980). Further, although it has been tempting to infer that the free association task reveals the structure of semantic memory, Nelson (1977) noted that the shift may also be attributable to the child’s changing interpretation of the task, in particular “the child’s changing ability to deal with nonmeaningful verbal tasks” (p. 113).

The notion that antonym relations might be salient for children only after 5 years of age could also be derived from findings reported by Montgomery, Anderson, and Uhl (2008). Montgomery et al. explored the mechanisms of interference in the day–night task and found that semantic competition for opposites was not strong in their sample of 3- to 5-year-olds. Instead, children’s difficulty with the day–night task was attributed to response set.

Discourse Studies

There is also evidence that children may produce antonyms in their own speech before the age of 4 years. This suggestion is supported by several studies that identify the ways antonyms are used in discourse by children and adults. Whereas the research reviewed thus far used elicitation techniques, these studies used corpus-based approaches and examined the co-occurrence of antonym pairs in turns of speech.

Spontaneous usage of antonyms was found in children as young as 2 years of age (Jones & Murphy, 2005; Tribushinina et al., 2013). Results of discourse studies suggest that children of all ages use most of the discourse functions that have been identified in adult corpora. Overall, the discourse functions used by children were found to be simultaneously similar to and different from those used by adults when speaking to children. Antonym use was always proportionally greater in child-produced speech than in child-directed speech and was found to increase significantly with age in child-produced speech; this change was not paralleled in child-directed speech (Jones, 2007; Jones & Murphy, 2005; Murphy & Jones, 2008). On the basis of these differences in the patterns of discourse function usage,
the authors tentatively concluded that children are not merely reproducing the discourse functions that they hear most often.

Discourse studies also show variability between individual children in their ages and rates of antonym usage (Jones, Murphy, Paradis, & Willners, 2012; Tribushinina et al., 2013). Jones et al. (2012) noted that this variability could be associated with parents’ usage and, possibly, children’s access to books, organized child care, and other learning opportunities. Further, young children who use more explicit contrast in their own speech (e.g., “Give me a big piece, not a small piece”) show stronger growth in adjectival production (Tribushinina et al., 2013). This use of contrast is linked to parents’ tendencies to use the same strategy in their own speech. Contrastive contexts are thought to be important to adjectival learning because they facilitate attention to the specific dimensions on which adjectives differ (Murphy & Jones, 2008; Tribushinina, 2013).

If children’s usage can be taken as a measure of their understanding, or at least the initial stages of their development of the concept of opposite, it is possible that children may display an understanding of the concept of opposite in a metalinguistic task before the age of 4 years if the task demands are either changed or decreased (Jones, 2007; Murphy & Jones, 2008). On the other hand, young children’s use of antonymy in discourse simply may reflect learned associations between words and be a developmental precursor to children’s metalinguistic understanding of opposite. Last, it is also possible that young children may understand the lexical semantic relation of antonymy but not in a way that is accessible at a conceptual level, which may be required for correct responding in metalinguistic studies.

Murphy and Jones (2008) suggested that the metalinguistic studies conducted thus far may have failed to find evidence that young children have the concept of opposite because the response tasks used have been too difficult. Although children may be able to use opposite words at a young age (as revealed in discourse studies), their usage does not indicate that they have the metalinguistic awareness of opposite and the appreciation that words are objects, separate from their concrete and immediate context, which are required for success in word association and other metalinguistic tasks (Jones et al., 2012).

In addition, children’s performance in previous metalinguistic studies could have been hindered by the requirement of a verbal response to a prompt (Vilette, 2002). Children’s verbal recall of an event can lag behind nonverbal measures of memory for the same event and can lag behind general verbal skill (Simcock & Hayne, 2003). Thus, there is the possibility that a more engaging and less verbally demanding task would reveal more accurately the development of children’s understanding of opposite. This possibility was tested in the present study.

**Present Research**

The primary goal of the present study was to determine the extent to which young children have a concept of opposite when it is evaluated with a task that does not require that children produce a verbal response and that assesses children’s understanding of the meaning of the word opposite across several antonym pair exemplars. In addition, we assessed the possibility that children might show emerging sensitivity to the antonym relation before they show this understanding in their overt behavior and investigated whether other cognitive developments or learning experiences are related to the development of the concept of opposite.

The present study evaluated the development of the concept of opposite in 3-, 4-, and 5-year-olds using adjectives and a novel opposite task that assessed metalinguistic understanding but did not require the child to make a verbal response. By eliminating the need for a verbal response, we addressed one limitation of previous metalinguistic studies of children’s understanding of the concept of opposite. On each trial of the opposite task the child was presented with three images. The experimenter labeled the images for the child, selected one image, and then, using different wording in each of three conditions, asked the child to make a selection. In the “opposite-label” condition, the images were labeled with an adjective (e.g., big dog, small dog, happy dog), and the child was asked to choose “the opposite one.” The two remaining conditions were both control conditions in that we included them to assess alternative explanations for children’s behavior in the opposite-label condition. In the “another-one-label” condition, the images were similarly labeled, but the word opposite was not mentioned; the child was simply asked to choose “another one.” This condition assessed the possibility that provision of the adjectives alone (without instruction to provide the opposite) might be sufficient for children to perform above chance in the task. Last, in the “no-label” condition, the images were labeled using basic-level category information only (e.g., dog, dog, dog), and the child was again asked to choose “another one.” This condition assessed the possibility that provision of the images alone (without adjectives or instructions to provide the opposite) might be sufficient for children to perform above chance in the task.

On the basis of prior research (Clark, 1972; Heidenheimer, 1975; Morris, 2003), and the arguably reduced task demands in this task relative to the tasks used in previous metalinguistic studies, it was hypothesized that 5- and 4-year-olds, and perhaps 3-year-olds, would demonstrate a concept of opposite with above-chance performance in the opposite-label condition of the opposite task and that accuracy would improve with age. In contrast, it was hypothesized that children in all age groups would show chance performance in both control conditions unless the adjectives and images (in the another-one-label condition) or images alone (in the no-label condition) were sufficient to prompt correct responding.

We included eye gaze and latency measures so that we could examine the process of understanding as well as the product. There are numerous examples of research findings showing dissociations between implicit or processing measures (e.g., looking duration and response latencies).
and explicit judgments (e.g., Nicholson, Whalen, & Pexman, 2013). For instance, research evaluating preschoolers’ understanding of linguistic ambiguity has demonstrated that measures of implicit awareness can reveal sensitivity to linguistic ambiguity before children are able to demonstrate this awareness explicitly (Nilsen, Graham, Smith, & Chambers, 2008). We investigated whether early sensitivity to the concept of opposite might be revealed with implicit measures. Sensitivity to the concept of opposite might be different compared with sensitivity to linguistic ambiguity. The challenge of the concept of opposite for young children may be separating or abstracting from the stimuli the single relevant dimension on which the meaning of each antonym pair differs (Chen et al., 2010). Further, as proposed by Jones et al. (2012), young children may understand the semantic relation of antonymy but not in the conceptual way required for successful task performance. As such, if young children have some sensitivity to the relationship between antonym pairs but struggle with the task demands of selecting the opposite from among the two options, this might be evident in their eye gaze and response latencies. We adopted the assumption made by many language processing researchers that “the mind is going where the eye is going” (Trueswell & Gleitman, 2004, p. 320). As such, younger children may be just as likely as older children to look first to the target image (drawn to it by their sensitivity to the antonym relation) but struggle to turn this sensitivity into a correct task response and thus may be slower to respond than older children. In addition, younger children may have more total looks at the target image than older children, reflecting more frequent looks back and forth between images as they struggle to reconcile their understanding of the antonym relationship with the metalinguistic task demands of choosing the opposite one.

There has, to our knowledge, been no previous examination of how understanding of the concept of opposite is related to children’s cognitive and language skills or learning experiences. As such, our examination of these relationships was necessarily exploratory. Nonetheless, we expected that children’s working memory and language skills might be positively correlated with accuracy on the opposite task. We expected that working memory might be important to understanding the concept of opposite because one needs to hold in mind the target word and its meaning while retrieving the opposite word. There is also evidence that preschool children’s listening comprehension is related to their working memory skills and their receptive vocabulary (Florit, Roch, Altoè, & Levorato, 2009). It seems plausible that listening comprehension skills are important to children’s ability to attend to and learn from parental speech and to track speakers’ use of contrast. Indeed, there is evidence that children’s antonym usage is related to parents’ usage (Jones et al., 2012) as well as parents’ use of contrast (Tribushinina et al., 2013). As such, children with stronger working memory and receptive vocabulary skills might have a more advanced concept of opposite and thus be relatively more successful on our opposite task.

In addition, if one of the mechanisms by which children learn the concept of opposite is through the word pairs co-occurring in sentence frames, as suggested by the discourse analysis research, then children’s overall communicative ability, use of context, or knowledge of syntax might be positively correlated with their performance on the opposite task. As such, we measured these skills using overall scores and subscale (Syntax, Context) scores on the Children’s Communication Checklist–2 (CCC-2; Bishop, 2006)

Last, children’s understanding of the concept of opposite may be related to their learning experiences. In particular, Jones et al. (2012) suggested that children’s access to books and organized child care could be important learning opportunities. We tested this by asking parents to report via a Parent Questionnaire (see full description in the Method section) whether their children had had such experiences. The questionnaire included questions on child care experience, access to books and games about opposites, and experience playing word games about opposites. We expected that there may be positive associations between these opportunities and children’s accuracy on the opposite task.

**Method**

**Participants**

Participants were sixty 3-year-olds (M = 39.07 months, SD = 2.07; 30 girls, 30 boys), eighty-four 4-year-olds (M = 50.45 months, SD = 2.02; 30 girls, 30 boys), and sixty 5-year-olds (M = 62.07 months, SD = 3.25; 30 girls, 30 boys) recruited from the University of Calgary Child database. Across ages, 68 children completed each condition of the opposite task (twenty 3-year-olds, twenty-eight 4-year-olds, and twenty 5-year-olds in each condition, with equal numbers of boys and girls). An additional eight children participated but were excluded due to experimenter error (n = 3), placing two images in the box on four or more trials (n = 3), unwillingness to participate (n = 1), or a parent-reported speech delay (n = 1). All children were from English-speaking homes, and in all but three homes English was the children’s first language.

**Materials and Procedure**

Participants were tested individually in a quiet room at the University of Calgary. Each child completed the opposite task (randomly assigned to one of three conditions) followed by the Test of Early Language Development–Third Edition (TELD-3; Hresko, Reid, & Hammill, 1999), which is a measure of receptive vocabulary, and the Memory for Objects task (Nilsen & Graham, 2009), which is a measure of working memory. Parents completed a brief demographic questionnaire and the CCC-2. U.S. Edition (Bishop, 2006), while their child participated.

**Opposite Task**

The visual stimuli for the opposite task were color images of familiar animals (e.g., cat, dog, dinosaur; see...
online supplemental materials, Supplemental Appendix A). The images were presented in sets of three (e.g., dirty pig, clean pig, small pig), and within a set all images were the same type of animal. Because preschool-aged children may use visual similarity (e.g., shape, texture, color) to guide categorization of objects (Baldwin, 1992; Bonthoux & Kalenine, 2007; Morgan & Greene, 1994), care was taken to minimize the visual similarity (e.g., color, posture, size) of the images within sets so that no one image looked particularly similar to the other two (e.g., black cat, white cat, orange cat).

The images depicted eight pairs (16 words) of antonyms (see online supplemental materials, Supplemental Appendix B). Two of the eight word pairs were used for training, and the remaining six pairs were used for the test trials; each word pair was presented once. Given our procedure, we needed to select pairs that could be depicted in animal images (rendering pairs such as hard–soft or alive–dead less suitable). We selected candidate pairs from previous discourse and metalinguistic studies on antonymy (Bracken, 1988; Clark, 1972; Heidenheimer, 1975; Jones & Murphy, 2005). The only pair we used that had not been used in a previous study was awake–asleep, but because the words awake and asleep are both listed in the MacArthur–Bates Communicative Development Inventory (Words and Sentences; Fenson et al., 2007) for 30-month-olds, we felt reasonably confident that children in the present study would know the meanings of those words. In addition, we used the pair fat–thin, but in previous studies this was thick–thin (Bracken, 1988; Clark, 1972; Heidenheimer, 1975). We replaced thick with fat because many children in Clark’s (1972) study made this substitution and because fat was a more appropriate adjective to use with animal names.

In each set of images presented to the child, two of the images depicted animals in opposite states and thus were used to represent the antonymous adjectives (e.g., dirty–clean). The third image was used to represent an unrelated distractor (e.g., small). The distractors were generated from the eight pairs of adjectives. One member of each antonym pair was used once as a distractor, with the limitation that the words short and tall were not used as the distractor for the big–small word pair and vice versa. The distractor was never part of the word pair used in the set of images immediately preceding or following it.

On each of the eight trials in the opposite task, a child was presented with a set of three images (e.g., dirty pig, clean pig, small pig). On the table was a shallow open box positioned directly in front of the child (see Figure 1). All sessions were recorded as digital video with the camera angled to record the child’s eye gaze.

The experimenter introduced the task to the child through two training trials. The experimenter placed a set of images (e.g., dirty pig, clean pig, small pig) on the table in front of the child and labeled each image while pointing to it. The experimenter always placed the first image directly in front of the child. The placement of the second and third images was counterbalanced, such that on half of the trials the second image was placed to the left of the first image. This balancing ensured that children who always chose the image placed last (or second) performed at chance. The location of the other two images was counterbalanced, such that in half of the trials the target was placed on the right side of the child. This balancing ensured that children who always chose the image on the right (or on the left) performed at chance. Following the labeling of the images, the experimenter put the middle image (e.g., clean pig) into the box and labeled the image again while doing so. The shallowness of the box ensured that children could see the selected image throughout the trial.

For some word pairs the target and distractor images were quite similar. For example, the small pig did not have any dirt on it and could, therefore, also be considered a clean pig. If the experimenter placed the image of the dirty pig in the box, the child would have had to select between two images that depicted pigs with no dirt on them (i.e., the clean pig and the small pig). To help mitigate this problem, the experimenter always placed the image that was fusible with the distractor image (in this example, the clean pig) into the box.

Each child saw two training trials (presented in a fixed order), which were followed by one of four possible orders of presentation of the six test trials. In the opposite-label condition, the experimenter then asked the child to place “the opposite one in the box” (e.g., dirty pig). This was the signal to the child that it was his or her turn to
place an image into the box. In the another-one-label and no-label conditions, children were asked to place “another one in the box.” The no-label condition further differed from the opposite-label and another-one-label conditions in that the images were described simply with nouns and without adjectives (e.g., pig, pig, pig). In the two training trials presented in the opposite-label condition (but not in the another-one-label or no-label conditions), the child received feedback about his or her image selection. If the child selected the distractor image, the experimenter presented the correct image with the instruction that the experimenter had selected and verbally told the child the correct response. If the child selected the target image, the experimenter provided positive feedback. No feedback was provided on the six test trials. On training trials in the another-one-label and no-label conditions, the child was provided with positive feedback if he or she put either image in the box and was provided with corrective feedback if he or she did not.

Participant responses in the opposite task were coded as either a correct target selection (image depicting opposite adjective) or an incorrect distractor selection (image depicting unrelated adjective). Measures coded from the video included response latency, the proportion of first fixations on the target, and the durations of looks to the target (proportion of looking time relative to total looking time).

The video recording was examined on a frame-by-frame basis (frame = 33 ms) using Final Cut Pro 5.0.4 (Apple Inc., Cupertino, CA), with audio and video signals synchronized. Eye gaze measures were coded from when the experimenter began voicing “Can you put the opposite [or another one] in the box?” to when the child placed the image in the box. Eye gaze measures were coded from the initiation of movement when it preceded the voicing of the response request because although the children were instructed to keep their hands in their laps, they were not instructed regarding where to look. Thus, a child might look at the images on the table as soon as the experimenter finished labeling the images. Individual trials were considered invalid and were excluded from the eye gaze analysis if the child (a) was not facing in the direction of the camera (or if their gaze was otherwise obscured), (b) knocked an image off the table, (c) asked a question of the experimenter, (d) needed to be encouraged to respond, or (e) moved from seated after the trial had started. A total of 79 trials (6.45%) were excluded from the eye gaze analyses for these reasons.

A second coder coded data for 50 of the participants (25% of the data). Neither coder was fully blind to the experimental condition to which a child was assigned because audio information about the condition was linked to audio information that was essential to the coding process. Interrater reliability was assessed using a two-way mixed-model absolute agreement single-measures intraclass correlation coefficient (ICC; Hallgren, 2012; McGraw & Wong, 1996). The resulting ICC was in the excellent range for all variables evaluated (Cicchetti, 1994): response latency, ICC = .981; correct first fixations on the target, ICC = .945; proportion of time looking at the target image, ICC = .996.

TELD-3

The TELD-3 is a standardized test designed to measure the language skills of children aged 2;0 to 7;11. The examiner’s manual reports good test reliability (Cronbach’s coefficient alpha, all rs > .91; Hresko et al., 1999). The TELD-3 consists of two subtests: Receptive Language and Expressive Language. Only receptive vocabulary was of interest in the present study, so only the Receptive Language subtest was administered. This subtest consists of items that assess semantic, morphological, and syntactic skills. Raw scores on the Receptive Language subtest were used in the present analyses. The TELD-3 contains two forms; Form A was used in the present research.

Memory for Objects

The Memory for Objects task evaluates children’s working memory capacity (Nilsen & Graham, 2009). In this task, the child is shown between one and three sets of three pictures, is asked to name the pictures (from left to right), and is asked to remember the last picture (item) in each row. Pictures are viewed such that only one row is visible at a time, and the final row of pictures is covered before the child makes a response.

Increasing the number of rows presented within a trial increases the task difficulty by increasing the number of items to recall. In the present experiment each child was presented with two practice trials (1 single-row trial and 1 two-row trial) and up to 18 test trials (4 single-row trials, 10 two-row trials, and 4 three-row trials). Testing continued until the child failed to recall a single item from four consecutive trials. The measure of interest was the number of items correctly recalled regardless of order (scored out of 36).

Alternate versions of this test using colored dots (Case, Kurland, & Goldberg, 1982; Gathercole & Pickering, 2000), numbers (Ruffman, Rustin, Garnham, & Parkin, 2001), and sentences (Daneman & Carpenter, 1980; Gathercole & Pickering, 2000) have been used with older children and adults. Using factor analysis, these measures, as well as classic measures of working memory such as backward digit span, have been found to load onto a measure of central executive working memory (Gathercole, Pickering, Ambridge, & Wearing, 2004).

CCC-2

The CCC-2 is a standardized test designed to discriminate children with communication impairments from children with typical development and to screen receptive and expressive language skills. The CCC-2 assesses children’s communication behaviors across 10 subscales and is intended for use with children aged 4;0 to 16;11. It is a 70-item questionnaire that is to be completed by someone (i.e., parent, teacher, or therapist) who knows the child well. Scores on the Context and Syntax subscales were of interest in the present study, as was one of the two composite scores: the general communication composite.

The U.S. version of the CCC-2 was normed on 950 children with typical development with a sample that
was representative of the U.S. population as reported in the 2002 Current Population Survey (as cited in Bishop, 2006). The examiner’s manual reports good test reliability (Cronbach’s coefficient alpha, all rs > .75; Bishop, 2006).

**Parent Questionnaire**

Parents were asked to complete a brief demographic questionnaire comprising nine questions about the child’s age, siblings, birth order, languages spoken in the household, child care experience, and access to games and books about the concept of opposite. Five of the questions were designed to help us describe the sample, and four of the questions were designed to assess characteristics or experiences (i.e., type of child care attended, age starting child care, availability of books or games on opposites, and experience playing word games about opposites) that might be related to understanding the concept of opposite.

**Results**

**Opposite Task Accuracy**

Children’s proportions of target selections (i.e., number of times the target image was selected divided by the number of valid trials; hereafter referred to as accuracy) in each of the conditions, as a function of age, are presented in Table 1. Accuracy was evaluated with a 3 (age: 3, 4, and 5 years) × 3 (condition: opposite-label, another-one-label, and no-label) between-subjects analysis of variance (ANOVA). There was a main effect of age, \( F(2, 195) = 8.87, p < .001 \), and a main effect of condition, \( F(2, 195) = 13.15, p < .001 \). Of most importance, there was a marginally significant Age × Condition interaction, \( F(4, 195) = 2.27, p = .063 \). Follow-up simple main-effect tests for each condition revealed the nature of this interaction. In the opposite-label condition, there was a significant main effect of age, \( F(2, 68) = 9.88, p < .001 \). Five-year-olds were more accurate than 4-year-olds, \( t(65) = 2.47, p = .016 \), and 3-year-olds, \( t(65) = 4.45, p < .001 \). Four-year-olds also were more accurate than 3-year-olds, \( t(65) = 2.33, p = .023 \). Fisher’s least significant difference correction was applied to these \( t \) tests and to all subsequent follow-up \( t \) tests unless otherwise noted. There was no significant main effect of age in the another-one-label or no-label conditions (all \( ps > .141 \)).

Children’s accuracy relative to chance performance (i.e., 50% target image selection, or three trials out of six) in each condition was evaluated with a two-tailed, single-sample \( t \) test for each of the conditions. Accuracy in the opposite-label condition was significantly above chance, \( t(67) = 5.02, p < .001 \). This effect was driven by both 5- and 4-year-olds performing above chance: \( t(19) = 5.71, p < .001 \), and \( t(27) = 3.31, p = .003 \), respectively. Three-year-olds performed at chance, \( t(19) = 0.00, p = 1.00 \). These tests remain significant even after applying a Bonferroni correction. In contrast, children’s accuracy was not significantly above chance in the another-one-label or no-label conditions (all \( ps > .452 \)).

To evaluate whether children learned about the concept of opposite in the study (across the six study trials), children’s accuracy in the first set of three trials (Block 1; \( M = 0.52, SD = 0.31 \)) was compared with their accuracy in the second set of three trials (Block 2; \( M = 0.57, SD = 0.30 \)) with a 2 (block: 1, 2) × 3 (age: 3, 4, and 5 years old) × 3 (condition: opposite-label, another-one-label, and no-label) mixed design ANOVA. Accuracy on the two blocks of trials was not significantly different, \( F(1, 195) = 2.39, p = .124 \). Furthermore, accuracy as a function of block did not interact with either condition or age (all \( ps > .903 \)). Together, this suggests that children’s accuracy did not improve over the course of the opposite task, suggesting that children did not learn about the concept of opposite from the opposite task itself.

**Correlations and Demographics**

Children’s scores on the measures of working memory, receptive vocabulary (TELD-3 raw score), and communication skills (CCC-2 scales) are presented in Table 2, Table 3, and Table 4. We evaluated relationships between children’s performance in the opposite-label condition of the opposite task and these measures with partial correlations, correcting for children’s age—that is, we tested five correlations, none of which were significant after Bonferroni correction was applied.

We next examined relationships between children’s accuracy (i.e., proportion of correct responses) in the opposite-label condition, and responses to four of the questions on the demographic questionnaire were evaluated with chi-square analyses and Pearson correlations. The one significant association that survived Bonferroni correction was between children performing above chance (four or more trials out of six) on the opposite task and parents reporting having books or games in the home that focus on opposites, \( \chi^2(1) = 6.12, p < .05 \). That is, children whose parents reported that they had books or games focused on opposites were more likely to perform above chance than those who did not have access to these materials in the home. It is important to note, however, that there was a trend for children with access to books or games on opposites (\( M = 51.66, SD = 9.29 \)) to be older than those without access (\( M = 46.09, SD = 7.96 \)). To control for this variability, we conducted a hierarchical logistic regression in which the criterion variable was whether children performed above chance on the opposite task. As predictors, we entered child’s age on the first step and access to books or games on the second step.

<p>| Table 1. Children’s mean proportions of correct target item selections in each condition. |
|-----------------------------------------------|---------------|---------------|---------------|</p>
<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Opposite-label</th>
<th>Another-one-label</th>
<th>No-label</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.50</td>
<td>0.44</td>
<td>0.15</td>
</tr>
<tr>
<td>4</td>
<td>0.64</td>
<td>0.54</td>
<td>0.19</td>
</tr>
<tr>
<td>5</td>
<td>0.79</td>
<td>0.55</td>
<td>0.22</td>
</tr>
</tbody>
</table>

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With the child’s age statistically controlled in this way, the relationship between access to games or books and children’s accuracy on the opposite task was marginal ($p = .068$) and thus should not be overinterpreted.

**Opposite Task Response Latency and Eye Gaze**

Eye gaze and latency measures were included to evaluate whether children showed evidence of an implicit understanding of opposite before they are able to perform above chance. In particular, we tested the hypothesis that young children struggle with the metalinguistic task demands of selecting the opposite one (e.g., Jones et al., 2012) and that this might be evident in their eye gaze and response latencies. In short, younger children may be slower to respond and may have more total looks at the target image than older children despite being just as likely as older children to look first to the target image.

### Table 2. Children’s mean raw scores on additional measures and demographic characteristics in the opposite-label condition.

<table>
<thead>
<tr>
<th>Variable</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Object memory</td>
<td>6.00</td>
<td>5.71</td>
<td>14.35</td>
<td>5.00</td>
</tr>
<tr>
<td>TELD-3</td>
<td>22.70</td>
<td>4.41</td>
<td>27.78</td>
<td>4.41</td>
</tr>
<tr>
<td>CCC-2 GCC</td>
<td>—</td>
<td>—</td>
<td>78.70</td>
<td>15.85</td>
</tr>
<tr>
<td>CCC-2 Syntax</td>
<td>—</td>
<td>—</td>
<td>3.41</td>
<td>3.84</td>
</tr>
<tr>
<td>CCC-2 Context</td>
<td>—</td>
<td>—</td>
<td>6.59</td>
<td>3.38</td>
</tr>
<tr>
<td>Age started preschool or day care (years)</td>
<td>1.25</td>
<td>0.62</td>
<td>2.65</td>
<td>0.81</td>
</tr>
<tr>
<td>Children in family (N)</td>
<td>2.05</td>
<td>0.52</td>
<td>2.15</td>
<td>0.78</td>
</tr>
<tr>
<td>In child care (%)</td>
<td>75</td>
<td>54</td>
<td>55</td>
<td>60</td>
</tr>
<tr>
<td>Have access to books or games about opposites (%)</td>
<td>70</td>
<td>82</td>
<td>95</td>
<td>82</td>
</tr>
<tr>
<td>Have experience playing word games with opposites (%)</td>
<td>33</td>
<td>52</td>
<td>70</td>
<td>47</td>
</tr>
</tbody>
</table>

Note. The Children’s Communication Checklist–2 (CCC-2) is not intended for use with children under the age of 4 years. Em dashes indicate data not obtained. TELD-3 = Test of Early Language Development–Third Edition; GCC = general communication composite.

### Table 3. Children’s mean raw scores on additional measures and demographic characteristics in the another-one-label condition.

<table>
<thead>
<tr>
<th>Variable</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Object memory</td>
<td>14.80</td>
<td>4.02</td>
<td>15.52</td>
<td>5.12</td>
</tr>
<tr>
<td>TELD-3</td>
<td>22.90</td>
<td>4.76</td>
<td>28.96</td>
<td>2.76</td>
</tr>
<tr>
<td>CCC-2 GCC</td>
<td>—</td>
<td>—</td>
<td>80.22</td>
<td>15.71</td>
</tr>
<tr>
<td>CCC-2 Syntax</td>
<td>—</td>
<td>—</td>
<td>2.85</td>
<td>2.33</td>
</tr>
<tr>
<td>CCC-2 Context</td>
<td>—</td>
<td>—</td>
<td>6.89</td>
<td>2.90</td>
</tr>
<tr>
<td>Age started preschool or day care (years)</td>
<td>1.64</td>
<td>0.74</td>
<td>2.68</td>
<td>0.72</td>
</tr>
<tr>
<td>Children in family (N)</td>
<td>1.50</td>
<td>0.63</td>
<td>2.04</td>
<td>0.74</td>
</tr>
<tr>
<td>In child care (%)</td>
<td>55</td>
<td>57</td>
<td>60</td>
<td>57</td>
</tr>
<tr>
<td>Have access to books or games about opposites (%)</td>
<td>70</td>
<td>82</td>
<td>95</td>
<td>82</td>
</tr>
<tr>
<td>Have experience playing word games with opposites (%)</td>
<td>60</td>
<td>79</td>
<td>75</td>
<td>73</td>
</tr>
</tbody>
</table>

Note. The Children’s Communication Checklist–2 (CCC-2) is not intended for use with children under the age of 4 years. Em dashes indicate data not obtained. TELD-3 = Test of Early Language Development–Third Edition; GCC = general communication composite.
that children were engaged in a different manner of processing in the opposite condition (vs. the other conditions, in which the word opposite was not used). As such, this result provides evidence that children carried out additional processing in the opposite condition; presumably, that processing is what is required to evaluate the opposite relationship. All other effects were not significant (ps > .598). The null effects of age in this analysis do not support the prediction that younger children would be slower to respond than older children due to sensitivity to the antonym relation but challenges with the metalinguistic task demands.

Eye Gaze Fixations

Children’s mean proportions of first looks to the correct image (target) were evaluated with a 3 (age: 3, 4, and 5 years old) × 3 (condition: opposite-label, another-one-label, and no-label) between-subjects ANOVA. Mean proportions of first looks to the correct image are presented in Table 5. There was a significant effect of age, F(2, 191) = 5.26, p = .006; a significant effect of condition, F(2, 191) = 6.60, p = .002; and a significant interaction between age and condition, F(4, 191) = 3.32, p = .012. Follow-up simple main-effect tests for each condition revealed the nature of this interaction. In the opposite-label condition there was a significant main effect of age, F(2, 62) = 9.95, p < .001. Five-year-olds made more correct first looks than 4-year-olds, t(62) = 3.21, p = .002, and 3-year-olds, t(62) = 4.32, p < .001. Four-year-olds did not differ from 3-year-olds, t(62) = 1.50, p = .139. As such, these results provide little evidence that younger children are drawn to the correct image in the opposite-label condition. There were no significant effects of age in the other two conditions (ps > .796).

Eye Gaze Total Looks

Eye gaze was also examined in terms of duration of time spent looking at the target as a proportion of the total
looking time. A higher proportion reflects more time spent looking at the target and less time looking at other locations. Mean proportion of time spent looking at the target image is presented in Table 5. Children’s proportions of time spent looking at the target were evaluated with a 3 (age: 3, 4, and 5 years old) × 3 (condition: opposite-label, another-one-label, and no-label) between-subjects ANOVA. There were no significant effects (all ps > .201). As such, there was no support for the prediction that younger children would have more total looks at the target than older children and thus little evidence that younger children are sensitive to the antonym relation but struggle with the conceptual demands of the metalinguistic task.

Discussion

The primary goal of the present study was to determine the age at which children develop an understanding for the concept of opposite with a task that is not overly demanding. Secondary goals were to evaluate whether there was evidence of early sensitivity to the concept of opposite and whether other cognitive developments or learning experiences are related to the development of this concept.

Development of Opposite Understanding

The main predictions—that 4- and 5-year-olds would demonstrate an understanding of opposite in the opposite-label condition of the opposite task and that accuracy on the task would improve with age—were supported. Four- and 5-year-olds, but not 3-year-olds, performed above chance. Furthermore, 5-year-olds were more accurate than 4-year-olds, who in turn were more accurate than 3-year-olds. Although the task difficulty was minimized by eliminating the need for a verbal response and by encouraging children’s engagement with the task through the use of pictures of animals, the youngest children still did not demonstrate a metalinguistic understanding of opposite. This is consistent with the conclusions made in previous metalinguistic studies that 4-year-olds, but not 3-year-olds, understand the concept of opposite (Clark, 1972; Morris, 2003). Like these studies, we here found that the age of acquisition was considerably earlier than that suggested by the results of the initial metalinguistic study conducted by Kreezer and Dallenbach (1929). We also found that children’s accuracy improved between the ages of 4 and 5 years, which is consistent with Clark (1972) and with the general pattern of acquisition found by Kreezer and Dallenbach but is inconsistent with the findings of Morris (2003).

The design of our task enabled us to evaluate opposite understanding in children younger than 4 years, which addressed one of the major limitations of previous metalinguistic studies. Previous studies had concluded that children as young as 4 years had at least a nascent understanding of opposite but had not evaluated younger children and thus were unable to conclude whether younger children might also understand the concept. The design of our task allowed for the participation of even the youngest children we tested and therefore allowed us to establish with more confidence a baseline age at which most children did not understand the concept of opposite.

We also included the another-one-label and no-label conditions to help rule out alternative explanations for children’s performance in the opposite-label condition. Results showed that children of all ages performed at chance in both of these control conditions. As such, we inferred that provision of the images and adjectives was not sufficient to prompt nonrandom performance in the opposite task. There was nothing in the stimulus materials themselves that made the opposite relationship salient. Children needed to be explicitly asked for the “opposite one” in order to select the image depicting the antonym. Furthermore, longer response latencies for all children in the opposite-label condition suggested that this condition required processing beyond that required for the other two conditions. We presume that this additional processing involves consideration of the opposite relationship.

A related goal of the current study was to explore whether there were other cognitive achievements and learning experiences related to knowledge of opposite. It was predicted that children’s accuracy on the opposite task would be positively correlated with their working memory, receptive vocabulary, and communicative skills. None of these hypotheses were supported, perhaps due to the restricted range of scores observed in the sample, particularly with the receptive vocabulary task. It may also be the case that our use of picture stimuli attenuated the working memory demands of the task and thus eliminated any relationship that might exist between working memory and knowledge of opposite. It is also possible that other measures that were not included in the present study might be more strongly related to children’s knowledge of opposite. For instance, cognitive flexibility and other executive functions besides working memory could support children’s ability to reason about word meaning and show success in the opposite task. Those relationships could be assessed in future research.

Demographic data provided by parents revealed that children who had access to books or games about opposites in the home tended to have above-chance performance in the opposite-label condition of the opposite task, but this relationship was only marginally significant once child’s age was controlled. Thus, there was little support in our findings for the hypothesis that children’s learning experiences might be related to their understanding of opposite. This relationship could be explored more systematically in future research via a training or longitudinal study involving shared book reading.

Implicit Awareness

Several measures of implicit awareness, specifically the eye gaze measures, were included in order to evaluate whether children would show sensitivity to the concept of opposite. We found no evidence of early sensitivity in any
of the eye gaze measures: The older children were more likely to look first at the correct image, and the youngest children in our sample did not take longer to respond or look more often at the correct target image. Thus, it appears that only the older children demonstrated understanding of opposite, through overt means (correct target selections) and in processing (more correct first looks to targets). In speculating about why we did not find evidence of implicit appreciation in young children’s processing, at least two explanations seem possible. One interpretation is that understanding of opposite, unlike other cognitive skills, does not develop implicitly first. Of course, it is also possible that implicit awareness is present in younger children but that our measures were simply not sensitive enough to detect this awareness. We would lean toward the first interpretation because the eye gaze measures did show sensitivity to some differences in processing, but we cannot rule out the second explanation.

A limitation of the current design of the opposite task is that, in principle, a child could perform above chance simply by understanding that there is some kind of association between the words that form the antonym pair without necessarily understanding that the association is one of opposite. This is possible because the distractor is unrelated to the word pair. Although children could be simply noticing an association between the word pairs, evidence from the another-one-label condition in the present study suggests that this is not the case. When children were presented with the adjectival labels but not the concept name (opposite), they did not perform above chance; the adjectival labels themselves were not sufficient for above-chance performance. If the children in the opposite-label condition were simply noticing the relationship between the words in an antonym pair, the children in the another-one-label condition should have also performed above chance. That they did not suggests that children in the opposite-label condition were paying attention to the specific antonymic relationship mentioned in the instructions.

A further limitation of the current study was that there could have been variability in the pictures we chose in terms of their ability to convey the meaning of each label. That is, the picture of the old rabbit may have been a less fitting illustration of that label than the dirty pig was of its label. We are reassured somewhat by the fact that we presented children with multiple trials and by the fact that, across children, items were used as both targets and distracters. Nonetheless, our findings may be influenced to some degree by our choice of stimuli.

Conclusions

The results of the present study provide several novel contributions. To evaluate children’s understanding of opposite, we developed a task that allowed collection of both implicit and explicit behavioral responses. In addition, to our knowledge this study is the first metalinguistic study that includes 3-year-olds. Therefore, the assumption made by previous researchers about the lack of understanding in 3-year-olds is now supported by empirical test. The results allow us to conclude that the majority of children under the age of 4 years do not yet have a metalinguistic concept of opposite or demonstrate sensitivity to the concept in their processing. The results do not provide clear evidence that children’s cognitive skills or experiences are related to their understanding of opposite. As such, there is more to be done in future research to identify the key factors that help children learn the concept of opposite and to suggest intervention strategies for children who struggle with the concept.

Acknowledgments

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References


