Constructing a Concept of Age: Age Group Categories as Placeholder Structures

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Abstract

Humans regularly use age to make predictions about other people. However, little is known about how children come to understand age. Children are sensitive to physical correlates of age already in infancy, but whether this indicates an early-emerging understanding of age as time spent alive remains an open question. We investigated the nature of children's early knowledge about age in the present study. We asked children to identify members of different age groups (e.g., "babies", "grown ups", etc.) and to order them chronologically. We found that 3- to 4-year-old children performed better on the identification task than the chronological ordering task. This suggests that children may form age group categories and map them onto labels early in development without yet understanding the chronological process of aging. These categories may initially function as placeholder structures, which children later reorganize into a chronological concept of age.

Keywords: conceptual development; conceptual change; age concepts; age groups; social categorization

Introduction

Humans routinely use age to make predictions about other people, as our bodies, minds, and behaviors change with age. However, whereas substantial research has documented how children make judgments of intelligence, social status, and social preferences on the basis of social categories like race and gender (e.g., Alton et al., 2025; Bian et al., 2017; Bian et al., 2018; Bigler et al., 2003; Diesendruck & HaLevi, 2006; Dukler & Liberman, 2022; Elenbaas & Killen, 2016; Mandalaywala et al., 2020; Martin et al., 1989; Olson et al., 2012; Shutts et al., 2016; Shutts et al., 2013; Waxman, 2010), much less is known about children's understanding of age.

Children are sensitive to physical correlates of age early in development. Seven- to 24-month-old infants respond differently to children than they do to adults, displaying more positive affect towards children than adults (Brooks and Lewis, 1976). Also, infants prefer to attend to conversations amongst children than adults (Schick et al., 2025). By three years of age, many children have learned age-related facts and labels as well, as they can state their age (Woolley & Rhoads, 2019) and identify the "grown up" in a pair of figures representing an adult and a child, even when the child figure is bigger (Boskovic & Barner, in press; Edwards, 1984).

While previous work suggests that young children differentiate people on the basis of the physical traits which correlate with age, it leaves open whether they understand age as time spent alive as adults do. Acquiring an adult-like understanding of age requires integrating knowledge across several domains of abstract content. For example, adults understand that age refers to temporal duration, how people's ages are denoted numerically (e.g., "3 years old"), and how aging correlates with biological processes such as growth. Previous studies find that children acquire an abstract understanding of time (see McCormack & Hoerl, 2017), a number system (see Carey & Barner, 2019), and an intuitive theory of biology (see Carey, 1985) gradually throughout the preschool years. These protracted developmental trajectories raise the possibility that young children's understanding of age lacks this adult-like abstract content.

Several studies suggest that children indeed do not reason about age in an adult-like manner in the preschool years despite their sensitivity to physical correlates of age. For example, 3- to 4-year-old children struggle to make relative age judgments and rank-order people by age based on who is "older" (Burke, 1982; Kogan et al, 1961; Kratochwill & Goldman, 1973; Kuczaj & Lederberg, 1977; Looft, 1971; Looft et al., 1972; Seefeldt et al 1977; Taylor et al., 1982). At this age, children also struggle to relate birth order to age and reason that somebody who is older was born first (Galper et al., 1981; Piaget, 1971). Preschoolers also affirm that people can age at different rates or cease to age and sometimes attribute causal roles to birthday parties and birthday cake, believing that children who do not have birthday parties or birthday cake may stay the same age and size (Carey, 1985; Klavir & Leiser, 2002; Woolley & Rhoads, 2019).

Given that these studies suggest that young children may not understand the chronological dimension of age, one possibility is that children's early-emerging knowledge about age, such as beliefs about age group categories and facts about people's numerical ages, serve as placeholder structures. That is, although they may lack temporal content, these beliefs may provide children with a starting point for learning the correlates of age and for constructing an intuitive theory. Previous work has argued that children form placeholder structures when they acquire understanding of domains like time and biology (Carey 1985, 2004, 2009). For example, Carey (1985) argues that to acquire an intuitive biology, children begin by learning generic facts like "animals are alive" without understanding what it means to be alive, as evidenced by the common confusion that anything that does not move (including plants) is dead. Similarly, children may also know that "healthy foods are good for you" without understanding how healthy foods contribute to the body's functioning. On Carey's view, these initial facts serve as placeholder structures that promote the organization of knowledge into

In G. Boleda, I. Dautriche, M. Maldonado, C. Saldana and T. Torrent (Eds.), *Proceedings of the 48th Annual Conference of the Cognitive Science Society*

theories, in which processes like breathing, eating, and sleeping become associated with life.

On analogy to this, children may first form categories of age groups on the basis of physical and behavioral characteristics that are shared within groups, and map them onto commonly used labels such as “grown up”. At this time, children may not understand that these age groups are defined chronologically, such that members of some groups have been alive longer than members of others. These categories may initially serve as placeholder structures, which children later reinterpret and assign temporal content to as they acquire intuitive theories of time and biology and acquire a number system through the preschool years.

It is unclear, though, whether children’s performance in previous studies indeed suggests that they do not understand that age denotes the amount of time one has been alive, or whether the use of the word “older” in studies asking children to make relative age judgments failed to capture chronological understanding. For example, in a recent study (Boskovic & Barner, in press), 3- to 4-year-old children failed to judge who was “older” between figures representing a child and an adult, although they could identify the “grown up”. This finding is consistent with two explanations of children’s early representations of age. First, it is possible that children represent social groups like “grown up” and “child” without recognizing how these groups differ chronologically. However, it is also possible that children represent the chronological difference between groups, but are delayed in acquiring the word “older”. Studies which used the word “older” to assess children’s understanding of age may thus have masked children’s understanding.

The current study investigated the nature of children’s early knowledge about age. We asked whether children who have learned labels for age group categories understand how these groups differ chronologically, or whether these early representations function as social categories based on physical and behavioral characteristics alone, without chronological content, possibly serving as placeholder structures for the child’s construction of a concept of age. That is, we asked whether a 3-year-old who has learned to label age groups such as “grown ups” and “babies” understands that people develop from being babies to grown ups over time.

In our experiment, we asked 3- to 4-year-old children to complete two tasks testing their understanding of age. First, children completed a Label Comprehension Task to test their understanding of commonly used age group labels. In this task, children were shown pairs of figures representing babies, children, or grown ups, and asked to point to the “baby”, “child”, “boy”, “girl”, “grown up”, “man”, and “lady.” Then, children completed a Chronological Ordering Task to assess their understanding of how these groups relate chronologically. In this task, children were shown a baby, child, or grown up, then shown a pair of figures from the other two groups and asked which one the first figure will become next (e.g., “Look, it’s a child. What will they be next, a grown up or a baby?”). To screen for children’s understanding of the word “next”, which was included in the test question in the Chronological Ordering Task, we also asked children to complete a Next Number Task, in which they were asked which number comes next after a given number (e.g., “The number is 1, what comes next?”). We reasoned that if children’s early age representations are supported by a chronological understanding of age, they should perform similarly on the Chronological Ordering Task and the Label Comprehension Task. Conversely, if children’s early age representations function as placeholder social categories which lack chronological content, they should perform better on the Label Comprehension Task than on the Chronological Ordering Task.

Method

Participants

A preregistration for this experiment is available at: https://osf.io/trnjy/. Participants were 107 3- to 4-year-old children (M_{age} = 4.06 [3.04, 4.94]; SD_{age} = 0.46; 48 female, 59 male) who were able to count to four in a Count-to-Ten pre-test. Fifty-two 3-year-olds and 55 4-year-olds participated in the study. In each age group, we tested 26 children who exhibited knowledge of the word “next” in the Next Number Task (answering all three trials correctly) and 26 who did not. In addition, three 4-year-olds (two “next” knowers and one non “next” knower) were inadvertently tested in addition to the 52 children per age group that we pre-registered. Six additional children also participated in the study but were excluded from analyses for the following reasons: failure to finish the experiment (n = 5) and experimenter error (n = 1). Another two children were recruited but did not participate in the study because they did not count to four in a Count-to-Ten pre-test. All participants spoke English as a primary language.

Materials & Procedure

All materials, data, and analysis code are available at: https://osf.io/trnjy/. All participants completed a Count-to-Ten Task, a Next Number Task, a Label Comprehension Task, and a Chronological Ordering Task in that order. Participants were randomly assigned to one of two experimental lists. The two lists varied in trial order for the Label Comprehension and Chronological Ordering Tasks, such that the trial order of one list was the inverse of the other.

Count-to-Ten Task This task served as a pre-test to verify whether children were familiar with the number words in the Next Number Task. Children were asked to count to ten, and were only included in the study if they counted to at least four.

Next Number Task This task screened for children’s understanding of the word “Next”, which was included in the Chronological Ordering Task. Following Schneider et al.

(2021), the experimenter told the child, “Now we’re going to play a game called ‘What Comes Next’. In this game, I am going to say a number and you tell me what comes next.” For every trial, the experimenter then asked, “*N*, what comes next?” Children were tested with 1, 3, and 2, in that order once each. If a child gave a response that was less than the initial prompt the experimenter reminded the child that the game was called, ‘What Comes *Next*,’ and allowed them to change their response. Children only received one such reminder.

Label Comprehension Task Stimuli for the Label Comprehension Task consisted of 14 images intended to resemble a baby, child, or adult. Half of the figures were male and half were female. To control for variables such as facial expression, body positioning, and posture, stimuli were created using ChatGPT’s image generator DALL-E 3 (OpenAI, 2024). The following is an example of a prompt provided to ChatGPT to generate a stimulus: “Generate an image of a boy.” The 14 stimuli were organized into 7 pairs. Every pair consisted of a child figure and an adult figure, except one pair of a baby figure and a child figure. Sex of the figures was controlled such that male-appearing images were only paired with male-appearing images and female-appearing images were only paired with female-appearing images. The figure meant to be older was presented on the left of the pair for half the trials and on the right of the pair for half the trials. The images were presented in one of three heights in a computer slideshow presentation, corresponding to each age group: 4.7 inches for adult figures, 4 inches for child figures, and 2.4 inches for the baby figure. These heights were chosen to roughly approximate the height differences between these age groups in real life. When modifying the height of each image, the original height-to-width ratio was retained.

Seven trials were included in the Label Comprehension task. On each trial, children were told: “One of these is an X and one of these is a Y. Which one of these is an X?”, where X and Y are age group labels (see Figure 1). Knowledge of the following labels was assessed: “baby”, “child”, “boy”, “girl”, “grown up”, “lady”[1], and “man”. Each trial paired the prompted label with a contrasting age label: “boy” vs. “man”, “girl” vs. “lady”, “child” vs. “grown up”, and “baby” vs. “child”. The label denoting the older age group was said first for half of the trials and second for the other half of the trials.

[1] We included “lady” rather than “woman” as an initial pilot stage revealed children were more familiar with the term “lady”.

Figure 1. Sample trial in the Label Comprehension Task. The experimenter asked the child, “One of these is a child and one of these is a grown up. Can you point to the grown up?”

Chronological Ordering Task Stimuli for the Chronological Ordering Task consisted of 18 images intended to resemble a baby, child, or adult. Half of the figures were male and half of the figures were female. The image generation and modification process for the Chronological Ordering Task was identical to the Label Comprehension Task. The 18 stimuli were organized into six groups of three figures, which each consisted of a baby figure, a child figure, and an adult figure.

Six trials were included. On each trial, the experimenter first introduced a figure and labeled it (e.g., “Look, it’s a baby.”), pointing to the figure while producing the label. The child was then shown two additional figures of the two other age groups. Then, the experimenter asked the child, “What will they be next, an X or a Y?”, where X and Y were the other two figures’ age group labels. There were two trial types. On half of the trials, children were first shown a baby figure and then asked to choose between a child figure and an adult figure (e.g., “What will they be next, a child or a grown-up?”). On the remaining trials, children were first shown a child figure and then asked to choose between a baby figure and an adult figure (Figure 2). The order of the two response options was counterbalanced across trials. The following label trios were used across trials: “baby”-“child”-“grown up”, “girl”-“lady”-“baby”, “boy”-“man”-“baby”, and “child”-“grown up”-“baby”.

Figure 2. Sample trial in the Chronological Ordering Task. The experimenter first showed the child the figure at left and said, “Look, it’s a girl”. Then, the two figures at right appeared on the screen and the experimenter asked the child, “What will they be next, a lady or a baby?”, pointing to each figure as the label was produced.

Results

The primary aim of this study was to understand if young children initially form age group categories without understanding how they relate chronologically. To test this question, we asked how performance differed between the Label Comprehension Task and the Chronological Ordering Task. We constructed several generalized linear mixed models predicting children’s accuracy on the Label Comprehension and Chronological Ordering Tasks according to our preregistered plan. Model comparisons were performed using likelihood ratio tests and the best-fitting models were selected on the basis of a significant chi-square statistic and reduced AIC value. Where the previous model to be compared differed in random effect structure, random effects were added to render the random effect structure identical to the augmented model for the likelihood ratio test, such that the only difference between models was the addition of the fixed effect (see Winter, 2013). In an effort to reduce Type I error (see Barr, 2013; Brauer & Curtin, 2018; Schielzeth & Forstmeier, 2009), we reported models which demonstrated singular fit as is, rather than pruning random effects. All *post hoc* pairwise comparisons were adjusted for multiple comparisons using a Bonferroni correction.

Our base model included only age (years, continuous, z-scored) as a fixed effect, with participant and item as random intercepts. This model revealed that children’s performance on the two tasks did not differ according to age ($\beta = 0.21$, $p = .05$).

Next, we asked whether children’s performance differed between the two tasks. We added a term for task (Label Comprehension or Chronological Ordering) to our base model, as well as a by-participant slope for task. Relative to the simpler model with only age as a fixed factor, this model significantly improved fit to the data ($\chi^2(1) = 24.5$, $p < .001$), suggesting that children’s performance differed between the two tasks. *Post hoc* pairwise comparisons showed that children were more accurate on the Label Comprehension Task ($M = 0.92$, $SD = 0.13$) than the Chronological Ordering Task ($M = 0.58$, $SD = 0.27$), $OR = 15.7$, $SE = 6.64$, $z = 6.5$, $p < .001$ (Figure 3), suggesting children may learn age group labels based on the groups of people they refer to before understanding how they relate chronologically.

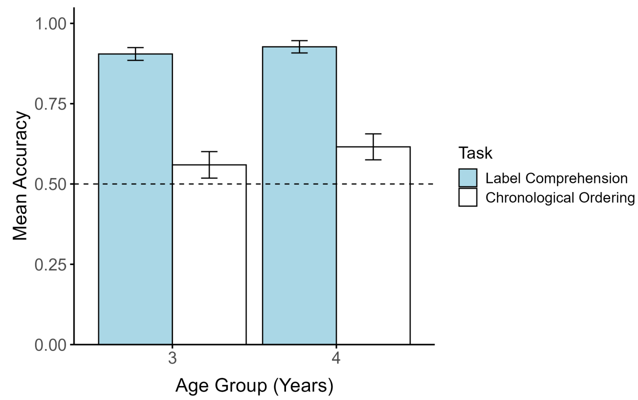

Figure 3. Children’s performance on the Label Comprehension Task and the Chronological Ordering Task as a function of age group. Error bars represent SEM and the dotted line represents chance accuracy.

Following these analyses, we asked whether children’s performance was influenced by their knowledge of the word “next” as demonstrated on the Next Number Task. We coded children as Next Knowers (1) if they responded correctly to all three trials of the Next Number Task and as Non-Next Knowers (0) if they responded incorrectly to at least one of the three trials. We added a term for Next Knowledge to the previous model, which contained age and task as fixed effects, as well as a by-item random slope for Next knowledge. We found that this augmented model did not significantly improve fit to the data ($\chi^2(1) = 0.19$, $p = .67$), suggesting that children’s comprehension of “next” did not influence their performance. However, their “next” knowledge may have been more related to their performance on the Chronological Ordering Task than the Label Comprehension Task, as the word “next” was used in the test question in the former but not the latter. To test this possibility, we asked how “next” knowledge interacted with task. We found that a Task * Next Knowledge interaction model did not improve model fit ($\chi^2(1) = 2.95$, $p = .09$) relative to a simpler model containing just Task and Next Knowledge as fixed effects. This suggests that the influence of comprehension of “next” on performance did not differ between the two tasks. Children’s comprehension of “next” does not appear to explain variability in performance on the Chronological Ordering Task.

Finally, we explored the influence of trial type on children’s accuracy on the Chronological Ordering Task. Recall that on half of the trials on this task, children were shown a figure of a baby and asked which of a figure of a child and a grown up they would be next, while on the remaining trials, children were shown a figure of a child and asked which of a figure of a baby and a grown up they would be next. We constructed a model of children’s accuracy on the Chronological Ordering Task which included children’s age, “next” knowledge, and trial type (baby shown first or child shown first) as fixed effects, with participant and item as random intercepts, as well as a by-participant random slope for trial type and a by-item random slope for "next" knowledge. Compared to a simpler model which did not include trial type as a fixed effect, we found that this augmented model improved fit to the data ($\chi^2(1) = 7.33$, $p = .008$). *Post hoc* pairwise comparisons showed that children were more accurate on the baby first ($M = 0.66$, $SD = 0.29$) than the child first ($M = 0.5$, $SD = 0.36$) trials, $OR = 2.09$, $SE = 0.43$, $z = 3.56$, $p < .001$ (Figure 4). Children's poor performance on the child first trials suggests that the ability to reason chronologically about aging may remain limited even at 4 years old.

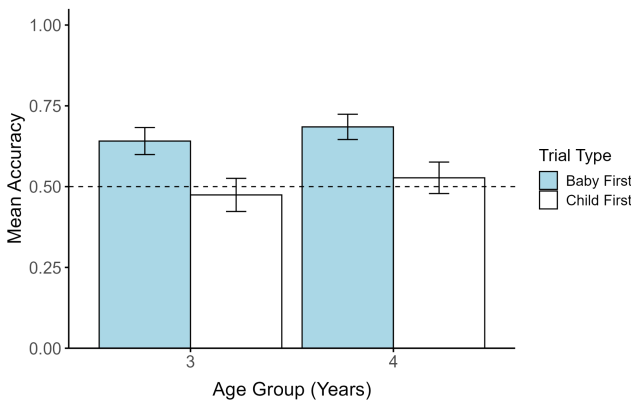

Figure 4. Children's performance on the Chronological Ordering Task as a function of age group and trial type. Error bars represent SEM and the dotted line represents chance accuracy.

Discussion

We investigated the nature of children's early representations of age. We found two main results. First, children were better at identifying members of different age groups than at ordering them chronologically. In fact, even at 4 years old, children struggled to order the age groups chronologically, especially when shown a figure of a child first and asked whether they will be a baby or a grown up next. This suggests that by three years of age, many children are able to categorize people by age and map these age groups onto labels but do not yet understand that these groups relate chronologically. That is, a preschooler may know how to identify "babies", "children", and "grown ups", but may not know that people go from being babies to children to grown ups with time. At this stage, these categories may function as placeholders in the child's developing understanding of age.

These results are consistent with other work on children's reasoning about age. While children can report their own age by three years old (Woolley & Rhoads, 2019), this may reflect knowledge of a rote fact, and children may not understand numerical expressions of age until a year later (Boskovic & Barner, in press; Kuczaj & Lederberg, 1977). Consistent with a shallow understanding of numerical age, some young children claim that a child who is about to turn three will stay two if they do not celebrate a birthday party, but that they can catch up in age if they have two birthday parties the next year. This suggests that some children do not understand that a person's age corresponds to the amount of time they have been alive (Klavir & Leiser, 2002; Woolley & Rhoads, 2019). Three- to 4-year-old children also err in making judgments of who is "older" (Burke, 1982; Kogan et al, 1961; Kratochwill & Goldman, 1973; Kuczaj & Lederberg, 1977; Looft, 1971; Looft et al., 1972; Seefeldt et al 1977; Taylor et al., 1982) and in relating birth order to age (Galper et al., 1981; Piaget, 1971), further suggesting that they do not yet understand the chronological process of aging.

The present study suggests that preschool-aged children may represent age group categories without understanding the temporal dimension of age. Our suggestion is that these categories may serve as placeholder structures, as do facts such as people's numerical expressions of age, which are not yet understood at three years old either. This is analogous to how young children learn facts about what things are "alive" or "dead" prior to possessing a concept of life and are familiar with activities such as eating and sleeping without understanding how they relate to maintaining life (Carey, 1985). In the case of intuitive biology, young children explain these facts and activities in terms of what they already understand, ascribing them psychological explanations (e.g., defining "alive" or "dead" based on movement and viewing desires as the cause of eating and sleeping). Similarly, young children may recognize that groups of people look and act differently and are referred to with different labels and numerical ages, but explain these observations by appealing to social categorization and physical causation, phenomena that they are more equipped to reason about than the abstract notion of time (see McCormack & Hoerl, 2017; Hoerl & McCormack, 2019 for discussion of children's development of temporal reasoning).

How might children use placeholder structures to acquire a chronological understanding of age? A recent study points to a potential source of children's understanding that age groups relate chronologically. Boskovic & Barner (in press) found that 3- to 5-year-old children's ability to judge which of two people is older was predicted by whether numerical ages were provided to the child. Further, children's performance was predicted by their understanding of the number words included in the study, even when numerical ages were not provided. This suggests that acquiring a number system may be important to developing a chronological understanding of age, at least in Western cultures in which people's ages are quantified numerically (see Sinha et al., 2011, for discussion of an Amazonian culture in which this is not the case).

Why might numerical knowledge lead children to a temporally based understanding of age? As children learn how number words denote magnitude, they might compare the magnitudes of numerical expressions of age, gleaning that "5 years old" is greater than "3 years old", suggesting ages differ somehow in magnitude, while perhaps leaving open what kind of magnitude this might be. One possibility is that children might discover that time is relevant when they hear number words combined with temporal duration words such as “years” and “months” in expressions of age. Although preschool-aged children do not yet understand the precise durations encoded by duration words, there is some evidence that they may have grouped them into a common class of words which denote duration (Grant & Suddendorf, 2011; Shatz et al., 2010; Tillman & Barner, 2015). Thus, while preschoolers may not yet understand the exact durations denoted by expressions of age such as “5 years old” and “3 years old”, they may understand that these expressions denote temporal duration and that the former is greater than the latter.

Another possibility is that children might not yet understand that “years” and “months” denote duration when they acquire an understanding of number words. In this case, their acquisition of a number system may provide them with the understanding that people’s ages differ in magnitude, but they may not be able to glean directly from numerical expressions of age that the dimension of magnitude denoted is that of time. Children may then draw on other experiences to infer this. For example, as children celebrate their own and others’ birthdays, children may notice the correlation between passing time and the increase of one’s numerical age, gleaning that time is the dimension of magnitude denoted by age. Future work should investigate this question, as well as asking whether children understand that age denotes time since birth as soon as they identify time as the dimension of magnitude denoted by age or if children proceed through an intermediate stage of understanding that age denotes temporal duration without knowing the starting point yet. Finally, while recent work finding that numerical knowledge predicts age judgment ability suggests that acquiring a number system is important in developing an understanding of age, future work should extend this finding by asking whether numerical knowledge also predicts children’s ability to order age groups chronologically, as was tested in the current study.

Children’s performance in the Chronological Ordering Task is relevant not only to understanding how children acquire an understanding of age, but also addresses their developing understanding of growth. Size cues were available to children in the task, such that the grown up figures were taller than the child figures, which were taller than the baby figures. Children therefore could have succeeded on the task by reasoning that people get bigger but not smaller, yet they failed to do so. Though previous studies have claimed that children possess an understanding of growth already at three years old, our findings cast doubt on this hypothesis. In fact, it is possible that the methods used in past studies overestimated children’s understanding of growth. For example, in a classic study, Rosengren and colleagues (1991) found that children as young as three who were shown a figure of an animal as a “baby” could identify a bigger figure as representing what it would look like as an “adult”. However, children could have succeeded on this task by deploying an understanding that “babies” are small and “adults” are big, without representing the process of growth, as supported by our finding that children form age group categories before developing an understanding of aging or growth over time. Similarly, other studies find that children as young as three are more likely to say that animals and plants “grow” than artifacts (Fouquet et al., 2017; Jipson & Callanan, 2003; Margett & Witherington, 2011), but it remains possible that young children memorize this fact without understanding it, akin to how young children memorize that animals are “alive” (Carey, 1985).

Our study features several limitations that should be addressed in future work. First, the age range sampled was not wide enough to reveal the age at which children perform similarly on the Chronological Ordering and Label Comprehension Tasks. We are currently conducting an experiment with older children in our lab to address this question. Second, the task demands in the Chronological Ordering Task may have been greater than those in the Label Comprehension Task, which may have masked children’s understanding of aging. For example, the Chronological Ordering Task requires comprehension of the word “next” and sequential ordering of age. However, that children’s knowledge of “next” did not relate to their performance on the Chronological Ordering Task, despite half of the children sampled having answered every question of the Next Number Task correctly, suggests that children’s performance was not limited by their lack of comprehension of this word. Further, we believe this difference in measures is not merely one of “task demands”, but instead reflects an actual difference in the complexity of mapping age group categories onto labels vs. representing the chronological process of aging. Supporting this possibility, while children have learned many words denoting categories by three years old (Shipley & McAfee, 2015), many studies employing a wide range of methods find that children at this age generally struggle to represent temporal order (e.g., Goulding et al., 2025; McColgan & McCormack, 2008; Tillman et al., 2022). Thus, children’s poor performance in the Chronological Ordering Task may genuinely reflect a lack of chronological representation of age, in line with young children’s limitations in temporal reasoning.

In summary, the current study suggests that children’s understanding of age begins with the acquisition of placeholder structures - like age groups - that initially lack adult-like meaning. As evidence for this, we found that children form categories for different age groups and map them onto labels by three years old, without yet understanding how they relate chronologically. We propose that categories may serve as placeholder structures, along with facts about age such as people’s numerical ages, which serve as the basis for acquiring a chronological understanding of age.

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