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The extended development of mapping spatial demonstratives onto space

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Abstract:	Spatial demonstratives (this and that in English) convey distance relative to speaker (within reach vs out of reach) and object characteristics, such as ownership. Previous studies indicate that object characteristics affect adult demonstrative choice, e.g., greater use of this for owned objects (Coventry et al., 2014). Here, production of spatial demonstratives was studied developmentally to identify when demonstrative production is sensitive to both distance and ownership. In two experiments, 7-year-olds, 11-year-olds, and adults completed an object-location memory task, and a language task eliciting this or that to indicate an object. Results indicate that adult-like demonstrative production starts around 7 years and continues to develop beyond the age of 11. Non-linguistic spatial memory did not vary significantly across age-groups. Spatial demonstratives encode both semantic and spatial object characteristics throughout development, revealing the fundamental importance of semantic factors for demonstrative production.
Suggested Reviewers:	
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The extended development of mapping spatial demonstratives onto space

Highlights

- Spatial demonstratives (*this, that*) do not only indicate object distance from speaker but reflect meaningful conceptual distinctions.
- Object characteristics (e.g. ownership) are at least as important as distance for demonstrative production throughout development.
- The use of demonstratives is not mature until after the age of seven.
- Children carve up space in the same fashion as adults, as revealed by a memory-for-locations task.

The Extended Development of Mapping Spatial Demonstratives onto Space

Abstract

Spatial demonstratives (*this* and *that* in English) convey distance relative to speaker (within reach vs out of reach) and object characteristics, such as ownership. Previous studies indicate that object characteristics affect adult demonstrative choice, e.g., greater use of *this* for owned objects (Coventry et al., 2014). Here, production of spatial demonstratives was studied developmentally to identify when demonstrative production is sensitive to both distance and ownership. In two experiments, 7-year-olds, 11-year-olds, and adults completed an object-location memory task, and a language task eliciting this or that to indicate an object. Results indicate that adult-like demonstrative production starts around 7 years and continues to develop beyond the age of 11. Non-linguistic spatial memory did not vary significantly across age-groups. Spatial demonstratives encode both semantic and spatial object characteristics throughout development, revealing the fundamental importance of semantic factors for demonstrative production.

The extended development of mapping spatial demonstratives onto space

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The Extended Development of Mapping Spatial Demonstratives onto Space

Spatial demonstratives (e.g. *this* and *that* in English) are among the most important and highest frequency terms in all languages (Diessel, 1999). They appear early in development, perhaps in the first 50 words produced (Clark, 1978; but see González-Peña et al., 2020), and with deictic pointing establish joint attention (Diessel, 2006). Their use is complex, reflecting not only object proximity, but object properties such as visibility, familiarity and ownership (e.g., Coventry et al., 2014). Despite demonstratives' relevance for interaction with the physical and social world, little is known about children's demonstrative use. The present work examines when in development sensitivity to spatial and semantic characteristics emerges in demonstrative production.

Abundant evidence shows that space is perceptually divided into peripersonal (reachable) and extrapersonal (non-reachable) space, reflected in both non-linguistic spatial categorisation and demonstrative use. *This* and *that* mark the distinction between peripersonal and extrapersonal space (Coventry et al., 2014; Gudde et al., 2016). Speakers use *this* more often for reachable objects (Caldano & Coventry, 2019) even when their reach is extended by a tool (Coventry et al., 2008). The boundary between peripersonal and extrapersonal space is flexible and can be modified through body movement or locomotion (Longo & Lourenco, 2006), thus a gradual decrease in frequency of use of *this* in extrapersonal space is observed as distance increases. In memory tasks, objects in extrapersonal space (Coventry et al., 2014) or ones that are referred to by *that* (Gudde et al., 2016) are remembered as further than objects in peripersonal space or referred to by *this*. These findings suggest that the

conceptualization of space in terms of reachability is expressed in our use of spatial language (Gudde et al., 2016).

Spatial memory and demonstratives are also affected by semantic factors. Object ownership, visibility, and familiarity affect demonstrative use: owned, visible, and familiar objects are more often named using the proximal demonstrative (Coventry et al., 2014). These properties also affect memory for object location: owned, visible, and familiar objects were remembered as closer in a non-linguistic memory task (Coventry et al., 2014). These studies indicate that demonstratives encode not only distance from the speaker but also semantic properties of objects. In English this is implicit, revealed by demonstrative use. However, some languages explicitly encode the semantic properties discussed above. For example in Supyire, spoken in Mali and the Ivory Coast, demonstratives explicitly encode ownership, and in some native American languages demonstratives encode visibility (Diessel, 1999).

In summary, demonstrative production and non-linguistic spatial processing are affected by distance and object characteristics. One explanation of how these factors are related is that of 'manual affordances' - an object's potential or ease of manipulation based on physical characteristics such as size – are responsible for these effects (Rocca et al., 2019). However, it is not clear how an affordance model alone could explain the observed effects of ownership and familiarity since action-affordances of an object are constant whoever owns it. Instead, Coventry et al. (2014) propose that semantic effects on demonstrative use are mediated by the expectation of finding owned, familiar or visible objects closer to oneself (*Expectation Model*, Coventry et al., 2014).

There are at least two ways in which object semantics could integrate into the English demonstrative system. One is that physical reaching distance is the core feature, and semantic effects on demonstrative production are purely associative or expectation

effects, perhaps resulting from repeatedly encountering owned objects in peripersonal space or dangerous objects in extrapersonal space. A second possibility is that physical and semantic factors contribute equally to demonstrative production, and thus the core conceptualisation of demonstratives is based not on physical distance, but on meaningful relations with objects and space. Examining the emergence of semantic and spatial effects in development may help distinguish between these possibilities.

Little is known about children's demonstrative production. Children use the words *this* and *that* early on, but not to establish a distance contrast (Clark, 1978). Children may begin to distinguish between demonstratives in comprehension in preschool (de Villiers & de Villiers, 1974) or slightly later (Webb & Abrahamson, 1976). Sensitivity to distance in demonstrative production might emerge before age four (de Villiers & de Villiers, 1974) although other studies place mature use at some point beyond seven years (Webb & Abrahamson, 1976). All these studies tested contrastive use of demonstratives, disambiguating between two referents, thus a specific limited use of demonstratives. Küntay and Özyürek (2006), using a more ecological approach, found that four- and six-year-old Turkish-speaking children encoded some distance distinctions in demonstrative production, but less consistently than adults. This suggests a protracted development towards mature demonstrative production.

Here we examine children's spontaneous use of demonstratives in non-contrastive communicative situations and how they map onto space. We used the *memory game* paradigm (Coventry et al., 2014). Participants saw real objects at varying distances and named them using a demonstrative word while naïve to the purpose of the study. A non-linguistic memory-for-object-locations task measured spatial mapping using the same objects and locations. This paradigm is comprehensible to children and not susceptible to response bias towards experimenter's expectations in adults. Coventry

et al. (2014) examined the effects of object ownership, visibility, familiarity, and distance on demonstrative production and memory for location. Participants tended to name familiar, visible, and objects they owned using *this*. These factors also resulted in objects being remembered as closer in non-linguistic memory-for-location tasks. For developmental research we elected to study ownership, a familiar and relevant concept to which young children verbally and behaviourally express sensitivity (Nancekivell et al., 2019; Kritikos et al., 2020). The memory task allowed comparison on a spatial-only task across groups, ensuring that differences in demonstrative production are not attributable to a different conceptualization of space.

This work investigates the emergence of spatial and semantic distinctions in demonstrative production. If demonstrative distinctions are based upon an elementary notion of reachability, one should find that they emerge in development first, with semantic effects emerging later. If on the contrary demonstratives' semantics are complex, with reachability and semantic factors both core to the concept of demonstratives, we predict that age of full acquisition will be later, and protracted. We additionally expect the effects of ownership and distance to emerge together in development.

To summarize, in this study we investigated for the first time the influence of egocentric distance and ownership on demonstrative production cross-sectionally in children and adults. A non-linguistic memory task using the same objects and locations served as a baseline measure of spatial development. We tested 7- and 11-year-old children and adults. Seven-year-olds were selected because they are the oldest age-group featured in previous literature (Webb & Abrahamson, 1976). Eleven-year-olds were the oldest age-group within the same schools as younger participants. Across two

experiments we find that, while memory for object location is relatively stable over the age range, demonstrative production development is protracted.

Experiment 1

Method

Participants. Participants were 21 7-year-olds (M_{age}=7:0, range 6:6–7:6, 22 11-year-olds (M_{age}=11;3, range 10;9 to 11;9), and 24 adults. Fifteen additional participants were excluded, 13 for systematic response patterns (e.g., only saying *that* or consistently alternating *this* and *that*), one for not recalling which was their object, and one for poor depth perception. Children attended a school in _____. Adults were Psychology undergraduates participating for course credit. All were native English speakers with normal or corrected-to-normal vision and no known neurological or developmental disorders.

Apparatus & Materials. The *Memory Game* involves a 120cm-wide table either 120cm, 150cm, or 180cm long (to accommodate reach of each age group), covered in black cloth. A wooden bar was positioned at the long midline with four coloured dots equidistant from one another (25cm, 30cm and 35cm for each table, respectively). Only the first two dots were within the participant's reach (confirmed at debrief). Black curtains surrounded the three sides of the apparatus (Figure 1). Two plastic dinosaur figures (3x5x1.5cm) were used, identical except for an identifying sticker (orange/purple). These were 'realistic' rather than anthropomorphic, and were not named, nor touched by children before the end of the procedure. Opaque glasses and an indication stick were used. Experimenter-A operated a hand puppet in the demonstrative production task.

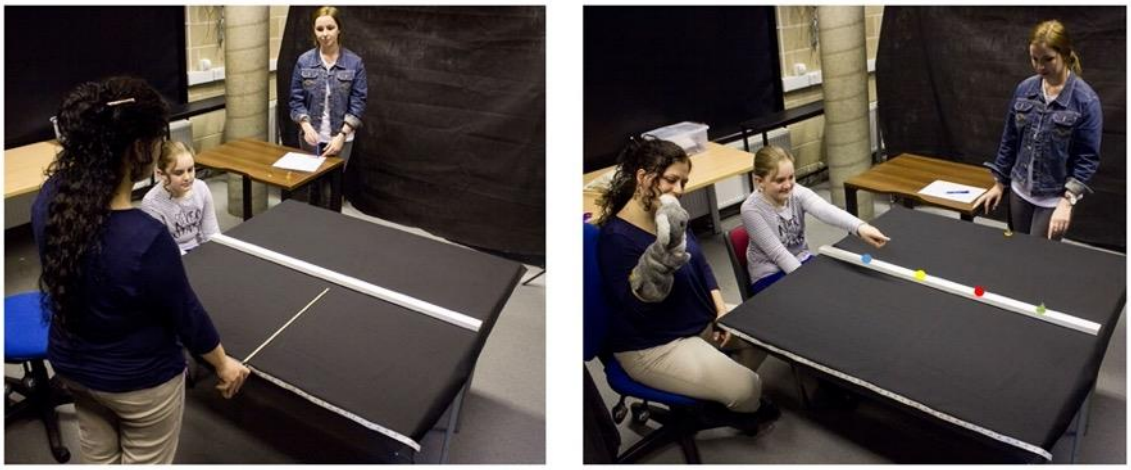

Figure 1: Photographs of experimental setup. Experimenter-A (left), participant (middle) and Experimenter-B (right). The left panel shows the recall stage of the Memory Task. Following object removal, Experimenter-A places the indication stick at the edge of the table and the participant indicates which direction to move the stick to match the location of the previous object. The right panel shows the Demonstrative Production Task. The target object (the dinosaur that jumped) is at the furthest location in this case, whereas the other dinosaur is stationary at the edge of the table. The dots present were easily visible to participants but here are enhanced for illustration purposes.

Design & Procedure. Children were tested in a quiet schoolroom. Experimenter-A began the session sitting beside the participant, while Experimenter-B stood occluded by another table. Participants were shown the dinosaur figures and told that one belonged to them: "Look, Lauren has a little present for you from us at the University to say thank you for coming. There are 2 dinosaurs, one is for you. Which one do you want, the one with the blue sticker or the one with the red one? Excellent! The dinosaur with the red sticker is yours, and you can keep it when we finish. The other is mine." They completed the Memory for Object Location Task, then the Demonstrative Production Task.

Task 1: Memory for Object Location. The memory task compared performance on a spatial-only task, to ensure that group differences in demonstrative production are not attributable to immaturities in spatial cognition. No age differences pertaining to current research questions were found. As our principal focus is on demonstrative production, for brevity we report the full memory task procedure and analysis in the Supplementary Materials.

Task 2: Demonstrative Production, Participants were asked to tell the puppet, 'Charlie', which dinosaur "jumped": *"Did you know that dinosaurs jump sometimes? But they only jump when Charlie is not looking. Now what you have to do is to pay attention, because sometimes Charlie will ask you if a dinosaur jumped, and you have to tell him. But Charlie is not so good at English, he doesn't understand many words. The only words he understands are 'this one' and 'that one'."* For each trial, Experimenter-B made the dinosaur 'jump' by placing it on a dot, while the other dinosaur remained on the edge of the table in the middle. Experimenter-A, using the puppet, would then ask *"Hi! Did any dinosaur jump? (...) Which dinosaur jumped?"* If the participant did not use demonstratives, they were reminded that the puppet could not understand, and the instructions were repeated.

Task 2 was also presented as a memory game. Memory questions (e.g., *"On which dot was your dinosaur last?"*) were asked periodically to create a cover story to test demonstrative production. To minimise task length, this was not done with 7-year-olds. Upon debrief, no participants indicated intuition of the hypothesis. Participants perseverating with one demonstrative were told after the fourth and eight trials *"Charlie is starting to get bored that you always say 'that'; you can also say 'this'"*. Data of participants using only *that,* systematically alternating demonstratives throughout, or

who declared using a strategy (e.g. always using *this* for one object and *that* for the other) were excluded from analysis.

Participants completed two practice trials and 16 experimental trials, two trials per object per location, randomised within two blocks with the same constraints as Task 1. To check whether the participant correctly remembered the ownership assignment, participants were asked to take their dinosaur to keep at the end of the session.

Results

Memory task. Accuracy improved with age, all age groups underestimated the distance of closer objects, and there were no other effects, including those of ownership. See Supplementary Materials.

Demonstrative production task. *Analysis:* Figure 2a represents the percentage of use of *this* by age group and location. A 4x2x3 mixed ANOVA with Location and Ownership as within-participants factors and Age Group as between-participants factors was conducted. Greenhouse-Geisser degrees of freedom adjustments were applied where sphericity was violated. A main effect of Location, $F(2.5,159)=26.73$, $MSe=4.34, p<.001, \eta p^2=.30$ showed participants used *this* more for closer locations and *that* for further ones, confirmed by a significant linear contrast, $F(1,64)=58.46, MSe=10.74, p<.001, \eta p^2=.48$. The interaction between Location x Age Group was significant, $F(6,64)=5.20, MSe=.70, p<.001, \eta p^2=.14$ because the effect of location was present in Adults, $F(2.04,47)=33.24, MSe=5.88, p<.001, \eta p^2=.59$, and 11-year-olds, $F(3,63)=5.98, MSe=1.05, p=.001, \eta p^2=.22$, but non-significant in 7-year-olds, $F(2.3,46.8)=1.77, MSe=.25, p=.18, \eta p^2=.08$. The only other main effect or interaction to approach significance was Ownership, with a trend for using *this* more often for owned objects, $F(1,64)=3.66, MSe=.47, p=.06, \eta p^2=.05$ (see Figure 2).

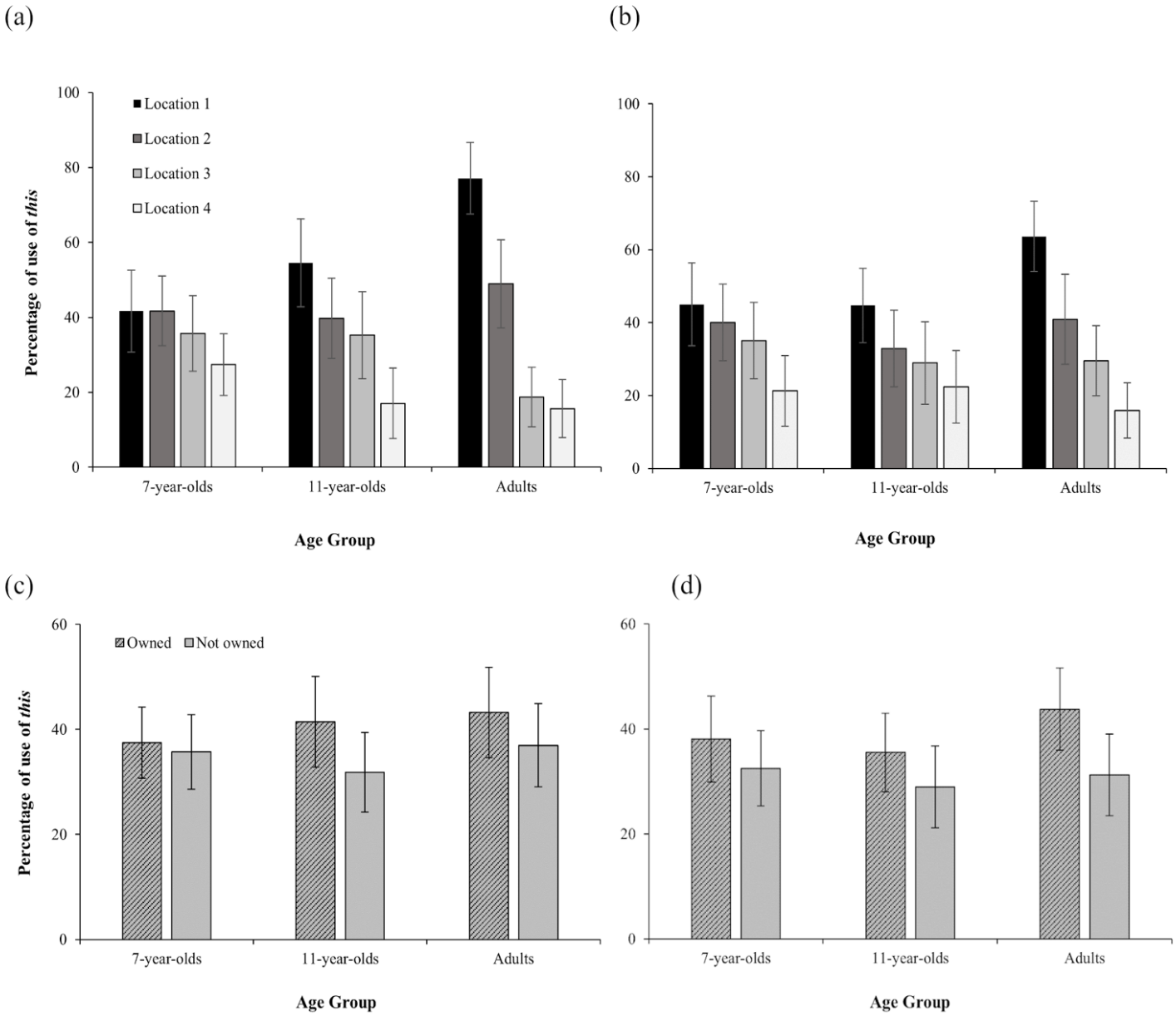

Figure 2: Percentage use of *this* by age group according to the four locations (a. Experiment 1, b. Experiment 2), and ownership condition (c. Experiment 1, d. Experiment 2).

Discussion

For memory, all age groups misremembered objects in peripersonal space as closer than those in extrapersonal space, and there was no effect of ownership. For demonstrative production, adults used the proximal demonstrative *this* more often in the closest locations, replicating Coventry et al.'s (2008, 2014) findings. This effect was weaker in 11-year-olds, and absent in 7-year-olds. Regarding ownership, Coventry et al. (2014) found that participants used the proximal demonstrative more often for owned than not-owned objects. Here a trend congruent with this finding fell short of conventional significance. We speculate that this shortfall was due to type of stimulus. While children were keen to keep the dinosaur after the experiment, adults were not. This motivated a replication using stimuli with enhanced ownership value for all participants.

Experiment 2

We increased stimulus value to all participants by combining the dinosaur figure with a token of economic value. We predicted the same pattern of results for both tasks, with a stronger ownership effect.

Method

Participants. Participants were 20 7-year-olds (M_{age}=6;11, range 6:5–7:5, 19 11-year-olds (M_{age}=10;11, range 10;4 to 11;6) and 22 adults. Thirteen additional participants were excluded for systematic response patterns, and one for poor depth perception. Children attended three schools in _____. Adults were university students and the general public and received £4.

Apparatus & Materials. The only change was that the dinosaur figures were attached to a gold coin-shaped token worth £4. Adults were told that they could exchange the token for payment. Children were told that the coin was worth £4, and they could give it to their teacher to buy books, paints and other attractive school materials. This allowed identical stimuli for all participants while avoiding ethical issues associated with payment of children.

Design & Procedure. These remained as for Experiment 1.

Results

Memory task. As in Experiment 1, participants underestimated the distance of closer objects, and the ownership effect was non-significant. The main effect of Age group was also non-significant. See Supplementary Materials for details.

Demonstrative production task. Figure 2b represents the percentage of use of *this* by age group, location, and condition.

Analysis. The same analysis as in Experiment 1 revealed a main effect of Location, $F(3,174)=18.54, MSe=2.08, p<.001, \eta p^2=.24$; participants used *this* more for closer locations and *that* for further ones, as in Experiment 1, confirmed by a linear contrast, $F(1,63)=50.5, MSe=6.15, p<.001, \eta p^2=.47$. There was also a main effect of Ownership, $F(1,58)=7.37, MSe=.82, p=.009, \eta p^2=.11$; as in Experiment 1, participants used *this* more often for owned objects, and this time the difference is statistically significant (see Figure 2). The interaction between Location and Group was not significant, $F(6,58)=1.64, MSe=.18, p=.14, \eta p^2=.05$. No other main effects or interactions approached significance, $Fs<2, ps>.15$.

Discussion

As in Experiment 1, we found the same location memory effects across age groups and no effect of ownership. In demonstrative production, participants used the proximal demonstrative more often for closer locations than for further ones in each age groups. The age differences showed a non-significant trend in the same direction as those in Experiment 1. The modified stimuli elicited a greater use of *this* for owned objects on the demonstrative production task, consistent with previous literature.

General Discussion

Two experiments examined when in development reachable distance and ownership affect demonstrative production. This was to describe the developmental course of demonstrative production, and to understand whether spatial demonstrative mapping is articulated primarily around object reachability or if semantic object properties are of core relevance. Results show that semantic effects (ownership) on demonstrative production are uniform across age groups, but the influence of reachability on demonstrative choice may undergo protracted development, as indicated in Experiment 1. This conclusion should be made with caution because the age differences in the same direction in Experiment 2 did not reach significance.

This is the first developmental work to systematically test non-contrastive demonstrative production across graded distances and shows that sensitivity to distance of demonstrative production continues to develop after the age of seven. In 7-year-olds, the effect was absent in Experiment 1 and present in Experiment 2, but the pattern of data was similar between studies. This late emergence contrasts with some early research suggesting possible contrastive use of *this* and *that* before age four (de Villiers & Villiers, 1974), but is consistent with Küntay and Özyürek's (2006) findings in Turkish that demonstratives are not used in an

adult fashion by the age of six. Our study is the first to examine later development to confirm that this process extends beyond the age of seven, even in a language with a relatively simple demonstrative system. The fact that the effect of distance was absent in the youngest group in Experiment 1 and weak in Experiment 2 may suggest that distinctions in demonstrative production emerge around age seven, with sampling differences accounting for the variation between experiments. It is also possible that the higher value of the object in Experiment 2 made distance distinctions more salient. However, there were no statistically significant interactions between distance and ownership.

This late development may reflect the complexity of demonstrative words. Relative proximity or nearbyness influences demonstrative choice even when both objects are in reach; the nearer is more likely to be labelled as this (Bonfigioli et al., 2009). Additionally, employing appropriate demonstratives plausibly demands fast on-line integration of spatial and semantic information, that may still be developing over this age range. Indeed, Rocca et al. (2020) have shown activation in brain regions responsible for multimodal integration during spatial demonstrative comprehension tasks, which are some of the last brain regions to completely mature, after age 10 (Markant & Thomas, 2013). Sensitivity to distance in demonstrative production may start with very far distances, as there was a measurable decrease in the use of *this* beyond one-meter distance in the youngest group in both experiments.

In contrast, no age effects were found in demonstrative use to mark object ownership. Thus, the variety of effects of ownership in young children (e.g., Cleroux & Friedman, 2021; Kanngiesser et al., 2014 Nancekivell et al., 2019) includes demonstrative choice, from at least seven years. These data suggest that semantic factors affecting demonstrative choice are robust even in the youngest age group, supporting the view that reachability is not necessarily the primary factor in the acquisition of demonstratives in development.

Memory for object location was stable across age groups, allowing us to attribute the changes in demonstrative production to extra-spatial maturation. We found no reliable effect of ownership on object-location memory. The ownership effect may best be detected in designs with more trials per condition (e.g., Coventry et al., 2014 had 24 trials across 6 locations, while the current study was adapted for developmental research to have 12 trials across 2 regions). Regardless, the distinctive developmentally stable pattern of memory errors across the four locations provided a spatial-cognition baseline from which to study demonstrative production.

The present study suggests that the mapping between perceptual space and demonstratives develops over a protracted period, years after children incorporate

demonstratives into their lexicon and after they develop a mature spatial mapping. Semantic factors, rather than being add-ons to an initial distinction between reachable and non-reachable space, may be equally fundamental drivers for the acquisition of demonstratives, and thus demonstratives reflect higher order conceptual distinctions. The sensitivity to ownership throughout development contrasts with Rocca et al.'s (2019) claim that demonstratives encode object manual affordance. Ownership does not impact on the object's physical potential to be grasped, but does indicate whether the speaker is permitted to interact with it. This suggests that semantic effects in demonstrative production operate at a conceptual level, rather than the physical-mechanical level described by Rocca et al. (2019). The focus on demonstratives referring to spatial regions has neglected the importance of semantic factors which merit more careful consideration from a developmental perspective.

In summary, this study is the first to simultaneously examine spatial memory and spatial demonstratives through development. We find that spatial demonstrative use develops over an extended period. Sensitivity to object properties and object distance undergo protracted and parallel development. Demonstratives are not simply labels for near and far space; they indicate meaningful conceptual distinctions that reflect the way we interact with objects in space.

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