Representing individual properties throughout development

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Originality statement

I declare that this submission is the product of my own work and thinking. It contains no previously published materials written by another person or accepted for any other degree or diploma at any educational institution, except when acknowledged in the bibliographical reference.

The present thesis includes work to appear in the following paper:

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Abstract

Humans can connect properties to entities in at least two ways. First, we might think that an entity has a property for being an exemplar of a kind: e.g., we see a basketball; therefore, we think it can bounce. Second, we might think that an entity has a property for being a particular individual: e.g., we see the basketball Michael Jordan played with; therefore, we think it has exclusive value. The fundamental difference is that one depends on distinguishing kinds of objects, while the other depends on distinguishing individuals by their past. This thesis explores infants' and children's capacity and interest to learn individual-related properties. Chapter 1 shortly discusses the representation of individual-related properties throughout development and summarizes each of the following chapters' goals. Chapter 2 makes a longer discussion on the topic, reviewing the developmental literature and reflecting on what it shows about the representation of individual-related properties. Chapter 3 reports a behavioral study that investigated how infants encode the agents' interaction with objects: i.e., an interaction with a kind of object (e.g., a *doll*) or a specific object (e.g., *the* doll). We found that infants can encode interactions with kinds and particulars; however, they more easily distinguish the objects the agent played with when they belong to different kinds. Chapter 4 reports an online study that investigated whether children index sound events directly to spatiotemporal objects or through their kinds. Our findings were inconclusive. Chapter 5 reports an online study that investigated the factors that motivate children to learn individual-related information. We found that children prioritize individual-related over kind-related information about objects they own, regardless of familiarity (familiar vs. unfamiliar kinds of objects) and item type (animal vs. artifact). Altogether, we aimed to compare infants' capacity to represent individual-related and kind-related information and understand what motivates them to learn individual information.

Acknowledgements

This thesis feels like the conclusion of a long journey that did not start with the Ph.D. but with my bachelor studies in São Paulo, Brazil. Initially, I did not plan to pursue an academic path. However, I felt passionate about the anthropological discussions in my social sciences degree, particularly Claude Lévi-Strauss's ideas on the common principles behind human cultural diversity and behavior. I did not know back then that cognitive science was the field actively investigating "principles" (or, more precisely, cognitive mechanisms) behind human behavior, but I knew I wanted to research that.

Somehow, I discovered cognitive science, and as this field was not very developed in Brazil, I wanted to move to Europe. This plan felt very unrealistic given my social background, and no one in my family had ever stepped out of the country. However, my mother gave me part of my grandfather's small inheritance to go to Spain in 2006 for study exchange. Nobody in my family pursued an academic career, and probably my goals seemed too unclear and uncertain. Despite that, my mother and siblings always valued education and my career decisions. I thank my mother, Cristina, and siblings Jerusha, Bertrand, and Ramon for their all-time support.

After my stay in Spain, I returned to Brazil and then moved back to Europe in 2010 to start a masters' degree. Since then, I've done two masters, and now I am concluding a Ph.D. in the continent! This trajectory was marvelous in many senses but also extremely hard. Financially, I needed to do unpleasant jobs that allowed me to stay in Europe —often "under the table", as countries like Spain do not allow students to work. Emotionally, I often felt alone. Making new friends is a fantastic experience, and I have met incredible people. However, moving to a new place every time and starting your social life from scratch is not easy.

Growing up in academia was also a painful process, partly because I needed to acquire the

cultural capital that academia requires, and I did not "bring from home". I did not even speak English fluently by the time of my second master's degree. "Catching up" with my peers was hard, but I am proud of having learned so much during this time. However, my academic development was also painful because I faced dismissive behavior, intellectual arrogance, and a lack of interest and pedagogical commitment from professors and peers. These problems often made me forget the curiosity and passion that brought me here and made me want to quit.

I do not think I would have stayed in academia and submitted this thesis if I did not have others' emotional, economic, and intellectual support. Kristen, now my wife, has been the most supportive person in my life for more than nine years. Even when we had known each other for no more than a month, she stayed awake with me the whole night, helping me write an assignment in English for my master's degree. She also helped me pay the fees of my master's degree that subtly increased, and I could not afford it. Finally, she was my "informal supervisor" during my Ph.D., reading and sharing her thoughts on my long (and often messy) manuscripts. I would need many pages to describe everything she did for my academic career and a book for everything else. Without her, I am not even sure I would have ever started this Ph.D. I dedicate my Ph.D. trajectory and thesis to her.

Additionally, I am incredibly grateful to many beautiful comrades from Szabad Egyetem, a student movement that many students and I created to protest against the expulsion of CEU from Hungary. I found in this group what I missed in my academic trajectory: a supportive community where members try to have fun developing projects together (here, activist projects). We did not bring a revolution to Hungary or even avoid CEU's move to Vienna. However, we did organize massive protests and activities in defense of education and against the government. I felt very valued and respected by this community, and I am proud of everything we did. Thank you, Giorgia, Viktor, Milan, Alberto, Charlotte, Theresa, Mátyás, Adrien, Shwetha, and many others, for your friendship and comradeship.

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Chapter 1

General introduction

Humans are born in a world inhabited by countless living and non-living entities —people, artifacts, animals, plants, etc. The conceptualization of these entities as exemplars of kinds, such as cats, rottweilers, and pens, is fundamental to navigating this world. For example, by identifying an object as a pen, we expect it to be an artifact for writing, even if this is the first time we see the specific pen. In sum, the object is expected to have properties associated with its kind. The representation of kinds and kind-related properties gives us some understanding of countless entities without us having to meet them all.

However, we might see some entities as carriers of individual properties, value, and relations (for simplicity, "properties") rather than just kind-related properties. A particular pen might not be "just a pen" for someone, but his great-grandfather's pen, which makes it singularly valuable for him. In the same vein, someone might see an animal not just as "a cat" but Pepper, the cat she loves, and attaches exclusive personality traits, memories, etc., to him. Differently from kind-related properties, we do not expect individual-related properties to be shared across entities. Nevertheless, they give us a more fine-grained understanding of specific entities, which could be particularly important in the case of entities we regularly encounter.

The representation of kind and individual-related properties has a crucial difference. To see an entity as a carrier of kind-related properties, we must recognize it as having a particular *qualitative identity*: e.g., it is a *pen*, therefore, an artifact for writing. However, to see an entity as a carrier of individual-related properties, we must recognize it as having a particular *numerical identity*: e.g., it is *the* pen that belonged to grandpa (i.e., *the one* with a specific past; Gutheil & Rosegreen, 1996). Note that recognizing an entity's past is not necessary for kind-related properties: we believe that a particular pen has a writing function whether we know its past or not. Analogously, individual-related properties do not depend on the object's kind: even if the pen gets

totally melted, it is still an object that belonged to grandpa. In sum, different requirements seem to condition the representation of kind- and individual-related properties.

When discussing the representation of individual-related properties, the developmental literature often ignores the distinction between qualitative and numerical identity. Commonly, studies inappropriately reduce individual-related properties to "property restriction". We will use an illustration to explain why property restriction alone is inappropriate. Imagine that we find an object we identify as a pen —and therefore, we think it is an artifact for writing, just as countless other pens. However, God disappears with all pens but the one we found, making the (pen-like) writing function entity-exclusive. Still, our representation remains unchanged: we connect the writing function to the artifact's kind identity, "pen", not to its numerical identity. The property restriction occurs just because the pen we found is, literally, "one of a kind": if God brings back the pens she took, the kind function will not be entity-exclusive anymore.

Different developmental studies show that participants did not generalize a property from one entity to others in their experiments. However, this property restriction might be related to how they conceptualized the entities' kinds: participants could have thought that the target entity does not belong to the same kind as the others and consequently they do not share the specific property. Early in development, infants can already represent kinds and connect properties to them. For example, before their first year of life, infants can already recognize categories of objects such as "duck" and "car" (Parise & Csibra, 2012) and learn about new kinds of artifacts and their function (Welder & Graham, 2001). Therefore, at least in principle, they could have used their capacity to associate properties with qualitative identities in experiments where they supposedly associate properties with individuals (e.g., Hamlin, Wynn, & Bloom, 2007). In sum, unless experiments show that participants connected properties to the entity's numerical identity, we cannot rule out that they see these properties as kind-related.

The developmental literature might give the impression that representing individual-related properties is a given. Consequently, researchers do not ask about the age and circumstances in which the representation of individual-related properties happens. They investigate whether infants attribute different kinds of properties, such as prosocial traits (e.g., Hamlin, Wynn, & Bloom, 2007) and social relations (e.g., Tatone, Geraci, & Csibra, 2015; Mascaro & Csibra, 2012). However, the authors *assume* that participants associate these properties with individuals rather than testing this claim.

Representing mothers, pets, childhood toys, etc., are as essential for our daily lives as kinds of objects, and, we suggest, is not "a given". The main goal of this thesis is to reflect on the development of the representation of individual-related properties and the entities that carry them. We divided this thesis into four chapters whose content we summarize as follows:

• Chapter 2: A theoretical discussion on what is needed to represent entities as carriers of individual-related properties (for short, "unique entities"). We suggest that the representation of unique entities depends on the capacity to (1) represent episodic events with exclusive implications for event participants, as well as (2) recognize event participants throughout time. We reviewed the literature with infants and children of different ages, reflecting on whether the presented evidence indicates the attribution of individual-related properties. We will argue that, especially in early development, infants might have associated properties with the entities' qualitative identities instead —simply put, with their kinds.

- Chapter 3: An empirical study on whether infants associate agents with kinds of objects or particular objects. Previous studies found that, upon ambiguous requests, infants are more likely to give objects the requester had not played with yet (Moll & Tomasello, 2007; Moll, Carpenter, & Tomasello, 2007, Tomasello & Haberl, 2003). However, these studies only used different kinds of objects, which leaves the following question unanswered: did infants connect the requester with the *kinds of* objects they played together or with the *specific* objects? In our study, the objects belonged to the same or different categories (e.g., two different-looking cats versus a cat and a doll). If infants associate the requester with the specific toys they played with, they should give the new object regardless of manipulation. However, if infants associate the requester with the objects' kind, they should hand the new toy when it belongs to a novel, but not to the same category.
- Chapter 4: An empirical study on how children encode events involving objects specifically whether the encoded events include the objects' kinds or just their spatiotemporal representation (based on Kirkham, Richardson, Wu, & Johnson, 2012; Richardson & Kirkham, 2004). In each trial, children watched a video where two objects alternately produced different musical sounds and "danced" to the rhythm. Then, two boxes covered the objects and, while covered, they changed their alignment on the screen (i.e., moving from their top-bottom alignment to a left-right alignment). Children heard again one of the musical sounds that had played before and were asked to indicate the box containing the toy that produced it. Critically, part of the videos showed different kinds of objects (e.g., duck and apple), and the other showed identical-looking objects (e.g., two identical bunnies). If the encoded event includes the object's qualitative identity (e.g., "duck", "apple", "bunny"), children should show better performance (lower number of

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mistakes) with different kinds of objects. Here, they just have to remember which box has the "duck" or the "apple", depending on the sound —an heuristic that will not help them if the objects are identical. However, if the encoded event ignores the objects' identities, they should perform equivalently regardless of manipulation.

Chapter 5: An empirical study on the role of ownership, familiarity (familiar versus novel kinds), and object type (animal versus artifact) on children's preference to learn individual versus kinds-based information (based on Cimpian & Park, 2014; Gelman et al., 2014; Gelman et al., 2012). We presented children trios of identical objects (e.g., three identical cats). The experimenter told the child to whom each item belongs: one cat belongs to the experimenter, one to the child, and the third one belongs to nobody. After that, children were asked whether they (i) "want to find out something new and cool 'about cats" or whether they (ii) "want to find out something cool about [my, your or nobody's] cat?". Across trials, we counterbalanced whether we asked children about the experimenter's, the child's, or nobody's object. Prior research (Cimpian & Park, 2014) found that children are generally more likely to request kind-based than individual information. However, we expected them to switch their preference regarding objects they own and, consequently, are more likely to see again. Also, we expected them to prefer individual information if they believe to "know enough" about the objects' kinds (which, we will argue, is more probable with familiar artifacts).

In summary, first, we aim to reflect on what infants and children need to represent individual-related properties. Based on that, we wish to determine what the developmental literature tells (or not) about it. We also aim to compare their capacity to represent associations with specific individuals and their kinds. Finally, we wish to understand the situations in which learning about individuals is relevant —or at least, more relevant than kinds. Altogether, we hope to bring new perspectives and lay the groundwork for future research on the representation of entities as carriers of unique properties.

Chapter 2

Representing individual properties throughout development

1. Introduction: seeing entities as carriers of "uniqueness"



"Last month my cat disappeared. A week ago, I found him and I brought him home. Today, my cat came back. Now I have two identical cats." — From cat owner Stanislav Zak to the Facebook group "Purrtacular.".

Zak's quest for a tuxedo cat illustrates something fundamental about how we think about entities. Often, entities matter for us because of their kinds: for example, we could imagine Zak trying to find a tuxedo cat for adoption in different shelters —and in this case, at least in principle, any tuxedo cat would do. Similarly, we can look for a ring because we want to propose to someone, a dog because we think dogs are great companies, and a doctor because doctors can treat our health issues. However, sometimes, entities matter for us as particulars. As in Zak's story, sometimes an entity might even have identical-looking alternatives, but we do not believe they are equivalent.

Our capacity to represent entities as carriers of unique value seems central to our daily lives. As Paul Bloom pointed out:

A central question in cognitive psychology is how humans and other animals determine the category or kind a novel entity belongs to. (...) But we also think about and name individuals. (...) Our emotions are tied to specific people and things. Original artwork and autographs can be worth fortunes, while perfect duplicates might be worthless.

You might love your own newborn baby and be indifferent toward somebody else's — even if you are unable to tell them apart. (...) Although the understanding of individuals is much less studied than the understanding of kinds, it is every bit as central to our mental life. (Bloom, 2002, p.121)

In developmental cognitive science, the representation of individual-related value and properties still seems much less studied than kinds and kind-related properties (see Gutheil et al., 2008, for a similar point). Maybe developmental psychologists believe that kinds are more abstract and challenging than particulars, which in turn are more "perceptually-based and concrete" (Cimpian & Erickson, 2012). However, our newborn baby is not merely a "concrete individual": we believe that she is unique in a way that no other "concrete" newborn baby is. The field lacks theories that explain why some living and nonliving things are seen as carriers of individual value and properties while others are not. We do not know what exactly cognition needs to represent this "uniqueness", and, finally, how such a capacity develops.

This chapter aims to discuss what is needed to represent entities as carriers of unique value or properties. In line with other authors (Gelman & Echelbarger, 2019; Gutheil et al., 2008; Gutheil & Rosengren, 1996), we will propose that representation of events and history is fundamental for an entity's "uniqueness". We will highlight core components of such representations, which will guide our review of the developmental literature on "unique entities".

2. Representing particulars: numerical and qualitative identity in developmental cognitive science

First of all, we must clarify different notions of "particular". Philosophers have long been reflecting on this concept, going back at least to Heraclitus and Plato's discussion of the "Ship of Theseus" paradox between 500 and 400 years BC (Cohen, 2004). In a modern version of this story,

while the ship was at sea, the planks gradually rotted and were replaced by new ones. The whole ship was renovated at some point, raising the question: can we still say that this ship is the ship that left the harbor? Also, what if another ship is reconstructed elsewhere with the original planks —which one is Theseus' ship? In sum, the issue is whether the ship's identity is determined by the *object's continuous existence in time and space* (i.e., the renovated ship) or the *object's properties* (the reconstructed ship).

When cognitive scientists use terms such as "particular", "object", or "individual", they essentially mean one of the two interpretations that come out from the Ship of Theseus (Starmans & Bloom, 2018). On the one hand, a particular might be represented as a *numerical identity*: objects seen at Time 1 and at Time 2 are the same *unit* if they are spatiotemporally continuous, regardless of property changes. On the other hand, a particular might be represented as a *qualitative identity*: two spatiotemporally disconnected units might be the same, in a qualitative sense, if they share the same properties.¹

The developmental literature shows that infants can represent both numerical and qualitative identities. Regarding numerical identity, different studies show that human infants can represent and track "spatiotemporal units" —i.e., objects that are distinct from each other in space and continuous in time (see Brody, 2020, and Stavans et al., 2019, for a review). Infants are surprised to see just a single object behind a panel if before they observed two objects hiding behind it simultaneously (Xu & Carey, 1996. See also Xu & Baker, 2005, and Van de Walle et al., 2000, for similar results with a manual search paradigm). Also, the representation of this numerical identity does not depend on the encoding of the objects' material properties like shape or color. Kibbe and Leslie (2011) found that 6-month-olds remember the existence of an object behind a

¹ Numerical identity can be also thought of as "thisness", i.e., the property of something being itself (being "this (one)"), while qualitative identity can be thought of as "whatness", or the properties of a thing (Hood, 2014).

panel even if they forget the object's qualitative features (i.e., they were surprised if they saw no object behind the panel but unsurprised if a different-looking object was revealed). Additionally, infants seem to be able to infer the existence of a spatiotemporal unit even without seeing it, just based on pointing or gaze (Pätzold & Liszkowski, 2019; Csibra & Volein, 2008; Behne et al., 2005; Moll & Tomasello, 2004). In sum, infants seem equipped with mechanisms that allow them to represent and track spatiotemporal units regardless of their qualitative properties.

Regarding qualitative identity, infant studies mostly explored whether infants can distinguish spatiotemporal units based on kinds and other properties. For example, 12-month-olds expected to find two units behind a panel (or inside a box) if they previously observed that different kinds of objects (e.g., duck and truck) appeared from behind it one at a time (Van de Walle et al., 2000; Xu & Carey, 1996). Interestingly, when different-looking objects belonged to the same kind, they did not expect to find two objects behind the panel: they were seen as a single unit (Xu et al., 2004). In a less demanding paradigm, infants could distinguish units based only on shape contrast (Wilcox & Baillargeon, 1998). Therefore, even if they are particularly "sensitive" to kind contrast, they might also distinguish objects based on properties such as shape. In sum, these studies show that infants from very early use property contrast to distinguish spatiotemporal units.

Numerical and qualitative identities are fundamental dimensions of how we represent objects. For example, Zak's story involves both: he wants a cat with a specific numerical identity (i.e., a specific unit), and tries to find it relying on the cat's qualitative identity (i.e., a tuxedo cat, or perhaps a tuxedo cat with "such and such" traits). However, the representation of the cat as "unit" and "tuxedo cat" does not explain why Zak wants it back. What seems to happen is that Zak attributes an exclusive value to his cat unit, making it qualitatively singular and desirable. Therefore, more than showing that infants can distinguish spatiotemporal units and kinds, the question is whether they can attribute exclusive value or properties to units.

However, what is needed to connect exclusive value and properties to units? Before we review the developmental literature, we will start delineating the following proposal: the representation of episodic events is needed for this connection. Units have different histories: they have different spatiotemporal trajectories and participate in various events. Events, in turn, might have consequences for the units involved, depending on how we represent them.

3. Why are some objects unique to us? Episodic events and their implications for specific units

Often, we care about spatiotemporal units because of their kinds. We might want to adopt *a cat* because we love cats, buy *an engagement ring* because that is what we buy when we want to propose to someone, or pick *a fork* because that is what we use when we eat solid meals. Kinds inform our behavior towards units, and what to expect from them. However, sometimes we care about specific units in and of themselves —say, we want a particular cat, a particular engagement ring, and potentially even a particular fork. This section will discuss how representations of episodic events can make units unique and why representations of kinds cannot do that. For this purpose, let us imagine two different scenarios:

- 1. You saw an "S.T. Dupont Fifth Avenue" rollerball pen being sold for 2.400 dollars. This is not only a high-quality pen but also rare: only 2.000 pens of this kind were fabricated and probably it is the only pen of this kind in your town. Pen lover as you are, you find that pen special.
- 2. The person you love the most left you an envelope containing a sheet with a heart. You did not know that they also loved you, and this is the best day of your life. Right beside the

envelope, you found the BIC pen that was used to draw the heart. Romantic as you are, you find that pen special.

Both situations involve a special pen. However, the reason these pens are special are fundamentally different. The pen in situation (1) is special because of how you conceive its kind. Crucially, its "uniqueness" is just circumstantial: it just happens that the town just has one of those expensive pens —but any further pen delivered to the town will share the same value. However, the pen in situation (2) is special not because of its kind (it is an ordinary BIC pen), but because of a representation exclusively connected to it: the event the pen took part in. Only the BIC unit in (2) participated in the event where your loved one used it to write their first love message to you. Therefore, no other pen shares the value produced by the event.

Analogously to our representation of objects, event representations also have a numerical and a qualitative identity (Zacks & Tversky, 2001). On the one hand, the numerical identity of events corresponds to the representation of "episodes", i.e., segments of time at a given location that observers represent as having beginning and end (Zacks & Tversky, 2001; Ünal & Papafragou, 2019). This "episodicity" is crucial to restrict the event to event participants: no other pen will ever participate in (2) because this event already happened. On the other hand, the qualitative identity of events corresponds to how the episodic event is described or interpreted. In (2), the event is seen as a "love demonstration" from someone "you love". Arguably, the BIC pen in (2) is only special for you because of how the event it took part in was interpreted. Had the event been seen as a "demonstration of hate", or a message of love from someone you do not like, the BIC would still have a unique history. However, this history would not make it valuable and potentially you could even end up forgetting the event.

Let us make an analogy with object representations to clarify the roles of the numerical and qualitative dimensions of event representations. Imagine that a person initially represents an object unit (numerical identity) as a piece of gold (qualitative identity), and then discovers that the object is not gold, but a piece of painted metal. This discovery does not change the object's numerical identity: it is the same spatiotemporal unit. However, the unit ceased to be valuable because its value depended on having a specific qualitative identity: gold. Likewise, an episodic event is represented as an "event unit", i.e., an episode with spatiotemporal constraints. The episodic event "attaches" to event participants as their history, regardless of how the event is interpreted. Simply put, the BIC unit took part in the event (2) whether the event was interpreted as a demonstration of love or not. However, the event's qualitative identity determines whether and what kind of implications it has on participants, potentially yielding value to them.

Crucially, regardless of what happens to the properties of an object, its history remains connected to it. The history of a deceased loved one remains connected to them even after cremation. History is, simply put, (a) stable across time, (b) non-obvious, and (c) unique to the unit (Gutheil and Rosegreen, 1996). However, history is not always valuable. Any object, even ordinary ones, has a unique history. The forks in our kitchen were used on different days and times, and by different people. Still, we see them just as forks because their history is trivial for us. In short, they are just exemplars of their kind.²

To summarize, we proposed in this section that object units might become uniquely valuable depending on the kinds of events they take part in. Episodic events "attach" to event participants as their history. The qualitative identity of events might have implications for the

 $^{^{2}}$ History might also have a short-term relevance. At the dinner table, no one is supposed to use the fork I am using: it is associated with me and no one else. However, everyone including myself might forget this association after dinner: it ceases to be relevant. The fork just has relevance as "a fork", i.e. as an exemplar.

participant units, such as increasing their value and making them non-equivalent to other units, including replicas. Next, we will search for potential evidence of "uniqueness" in the developmental literature, first with children and then with infants. Additionally, we will further define what children and infants need to represent in events to become "sources of uniqueness" for units.

4. Representing uniqueness throughout development

Representations of uniqueness can take very different forms, from the singular value children connect to their teddy bears to the attribution of exclusive properties, such as individual knowledge and preferences to agents. Despite these differences, our goal in this section is to discuss how the representation of history overall grounds uniqueness. Also, we want to question multiple studies where children and infants seemingly attribute uniqueness. We will highlight that a common problem to these studies is that we do not know whether the property was associated with a unit or its kind.

4.1. Attribution of unique value to artifacts in childhood

The industrial production of artifacts is insightful for thinking about the roots of uniquely significant objects. This is because industrialized products can be perfectly identical in a material sense. The kinds and amount of materials used, the design, and so on: a company often suppresses all forms of variability among items of the same kind and buyers do not expect to find variation among them either. However, even though artifacts can be identical to each other in a material sense, this does not impede some of them from becoming singularly significant to us. One's engagement ring, the teddy bear from our childhood, and so on —some artifacts have singular value and are not exchangeable by replicas.

Different studies have explored attribution of unique significance to artifacts in childhood (see Gelman & Echelbarger, 2019, for a review). For example, Gelman and Davidson (2016) have shown that 3-year-olds prefer old-looking objects over identical, but new-looking ones when the old objects were "attachment toys" (i.e., toys that parents believed that "the[ir] child actively played with, that were clearly used and well-loved"; Gelman & Davidson, 2016, p. 148). In contrast, children tended to select the new-looking items when they were not attached to their object. Also, previously to Gelman and Davidson (2016), Hood and Bloom (2008) had similar findings. In their study, 3- to 6-year-olds first learned about a machine that magically duplicates objects and then observed their toys being copied. When asked to select the toy they wanted to keep, children tended to select originals over duplicates when the originals were their attachment toys, but not when they were just toys they owned. Both studies show that children's attachment is not reducible to the toys' material properties. Children are attached to specific toy *units*.

The question then is what makes them attached to specific units. History is a good candidate: we have argued that it connects to units and not to qualitative identities. However, what in their history is relevant? In principle, it could be ownership, which is a historically based concept (you have to refer to history if you want to justify that you own something; Mahr & Csibra, 2020). Evidence shows that children might value more object units that they possess or own over replicas (Hartley & Fisher, 2018; Hood et al., 2016; McEwan et al., 2016; Gelman et al., 2012). However, in Hood and Bloom (2008) and Gelman and Davidson (2016), they did not prefer all the objects they owned, making their attachment unlikely based on ownership. Analogously, children's attachment cannot be reduced to having a shared history with the toys *per se*, as they share a history with all the toys they own but are attached to just some of them. Nevertheless, what is critical is

that children's shared history with different objects is not the same —and some histories might contain events that are believed to be relevant, while others not.

Gelman and Davidson (2016) found that children tended to be more attached to toys they sleep with. However, we cannot know whether they feel attached to these toys because they sleep with them or whether they sleep with them because of their attachment. The directionality is unclear. Nevertheless, other studies have shown how the past can influence children's preference for a unit. For example, around 5 years of age, children prefer objects that they created over replicas (a phenomenon usually referred to as the "IKEA effect"; Marsh et al., 2018). Importantly, children also find the past of some objects valuable even if they were not part of it. Pesowski and Friedman (2019) found that 4- to 7-year-olds prefer an object over a newer replica if the object was "made by a robot" or "created in a castle". However, they did not prefer items with a mundane past, such as being purchased from a shop. Children also prefer originals over replicas when originals were previously owned or possessed by relevant individuals, such as Harry Potter or Queen Elizabeth II (Gelman et al., 2015; Hood & Bloom, 2008). In sum, these studies show how different qualitative attributes of the units' past can make them more valuable than material replicas.

Current evidence seems enough to show, first, that children at least as young as 3 years of age prefer some object units over replicas —indicating that their preference is not reducible to the objects' material properties or kinds. Second, children seem to attribute a unique value to units because they believe their past is qualitatively relevant, i.e., it contains kinds of events and event participants that matter. Future discussions on unique value could try to determine whether common principles can be found behind different "events that matter", explaining why they yield significance to units. For now, it is enough to say that (1) children attribute unique value to entities,

and (2) this unique value depends on the kinds of events that are part of the entities' past, and not simply on representing their past.

4.2. Attribution of unique (mental) properties to agents in childhood

Another way units could be seen as different from any other is if they acquired exclusive properties. Here we will discuss how the representation of episodic events can yield exclusive properties to units, focusing on the attribution of individual mental states. Beliefs, desires, and intentions are often thought of as individual-specific, but this is not necessarily the case: for example, 4-6 year-olds may generalize beliefs and preferences to social groups (e.g., "believe the sun is their God" or "love eating apples"; Diesendruck & Eldror, 2011). We will argue here that the restriction or not of a mental state to individuals could be determined by how children represent the agent's past.

4.2.1. Attribution of individual knowledge

Multiple studies have explored children's attribution of knowledge to others. However, Gutheil and colleagues (2008) were one of the few to show that children can restrict it to units by representing their history (see also Hood et al., 2012). In their study, 4- to 5-year-olds performed a drawing activity under the observation of a Winnie-the-Pooh toy (say, Pooh₁), and later were asked whether another identical-looking Winnie-the-Pooh (say, Pooh₂) knew what they had drawn. Potentially, children could have forgotten or ignored the different spatiotemporal histories of those toys, basing the knowledge attribution on the qualitative identity of "pooh" —and therefore, extending the epistemic state to both toys. However, the authors found that children successfully distinguished Pooh₁ from Pooh₂, believing that Pooh₁ is the unit that knows about the drawing. Gutheil and colleagues (2008) emphasized the crucial role of children's representation of the spatiotemporal aspect of Pooh₁'s history for knowledge restriction. However, we want to use their experiment to highlight the necessity of other representational elements for that to happen. First, children represented Pooh₁ as the participant of a kind of episodic event with epistemic implications: a "watching" event. Had Pooh₁ been just there but "not watched", then no attribution of knowledge would have happened. Király and colleagues (2018) found that 3-year-olds conclude that an observer "actually" does not know the correct location of an object if they find out that the sunglasses the observer wore during object hiding are opaque. In other words, children changed their *interpretation* of the episodic event and its implications, while the spatiotemporal components remained the same.

Second, aside from "Pooh₁ watched X", another representational component is needed for knowledge restriction. Specifically, children interpreted the event ("X") as a causal event with consequences to *a particular unit* (a specific piece of paper). Given that Pooh₂ did not watch the event, Pooh₂ could not know about the drawing —the reason children restricted it to Pooh₁. However, events do not always transform the units' properties: a function demonstration with, say, a xylophone unit could reveal a property shared by xylophones in general (Shamsudheen, 2020). Therefore, children could think that Pooh₂ independently learned the xylophone function through other xylophone units, extending the epistemic state to Pooh₂. Cimpian and Scott (2012) have shown that 4- to 7-year-old children believe that the kind-related information they learned is also known by others, while individual information is not. Consequently, whether the epistemic state is about a unit's specific properties or kind should matter for knowledge restriction.

In summary, we argue that the restriction of an epistemic state to an agent depends on the representation of different aspects of the agent's history, namely:

- The identification of the event as a kind of event with psychological implications (e.g., an agent who "watches X" learns about "X").
- (2) The psychological state is about an event-caused property (e.g., the agent observed a causal event whose implications others cannot, in principle, assess).
- (3) The recognition of the agent who was involved in the event (in Gutheil et al., 2008, children tracked it in the here and now).

Beyond the attribution of knowledge, we will argue that these three representational requirements have also to be in place for the individual-exclusive attribution of preferences. We will focus on preference because some researchers assume that preference is, in principle, an individual matter unless evidence indicates otherwise. However, we will suggest that children will not necessarily restrict a preference unless children's representation of the agent's past restricts a particular preference to an agent unit.

4.2.2. Attribution of individual preference

Consider Diesendruck and colleagues (2015), whose study explored 3-to-4-year-olds' beliefs about the scope of an object preference. They found that, by default, children do not extend a frog's object preference to another frog puppet —specifically, they do not expect the second frog to reach for the object that the previous frog repeatedly selected. However, when children are exposed to two different frog puppets making the same object choices, they extend the object preference to a third frog puppet (but not to a new bird puppet). According to the authors, their findings indicate that distributional evidence made children change their initial belief that a particular agent has a preference, thinking, instead, that the preference is frogs (i.e., generic to the kind).

In this study, children seem to represent the frog's choices as a kind of event with psychological implications: i.e., (object) choices indicate preferences (requirement "1" above). Additionally, they distinguished the original frog from others, expecting only the original frog to have a preference (requirement "3" above). However, we do not know why children initially restricted their preference to an agent unit. After all, not rarely, preferences for kinds of objects are shared —e.g., frogs like eating mosquitoes.

The authors just seem to assume that children believe that preferences are "individual by default" (based on studies such as Buresh & Woodward, 2007³). We do not share their assumption and suggest that children's initial restriction of preference might have been a byproduct of an unnoticed factor: their interpretation of the experimenter's communicative goal with the puppets. The experimenter, for example, did not merely call the puppet "a frog", but the proper name "Flowery". This decision might have given the impression that she wanted to mark the frog's relevance as an individual (see Jeshion, 2009). Consequently, Flowery's choices were initially interpreted as a demonstration of personal preference. Children then changed their minds once they were shown other frogs making the same choice.

We have no reason to assume that, for children, preferences are individual "by default". However, we suggest that a preference could be interpreted as individual-specific without communicative cues, depending on the role that historical representations play in this preference. For example, in Gelman and Davidson's (2016) study on children's preference for attachment toys, children did not think the experimenters would show the same preference. Arguably, what happened is that children's toys became valuable for them because of the history they, and only

³ Note, however, that Buresh and Woodward (2007) did not talk about individual "preferences". They concluded that infants think that object-reaching *goals* are specific to individuals. We will discuss Buresh and Woodward's findings later, when talking about infants.

they, share. The researchers did not sleep with the children's teddy bears or play with them with people they love. Therefore, just like $Pooh_2$ cannot, in principle, know the event-caused property, the researcher cannot have the event-caused preference for children's toys (requirement "2" above).

4.2.3. Concluding remarks on the attribution of unique mental properties to agents in childhood

The capacity to represent different kinds of events and the units' spatiotemporal history can make children restrict mental properties to individuals. These historical representations could increase the mental "singularity" that children attribute to some agents throughout time. Perhaps this can be illustrated by imagining one's mother. Like many mothers, she might love "disaster movies" and cats, as well as know how to drive. However, only this person's mother shares the same love for their cat, and remembers when they watched "Deep Impact" together at the cinema and also driving them to school. The child sees the mother as a carrier of "mental individuality", which informs more detailedly how to interact and what to expect from her.

Crucially, by discussing studies on mental state attribution, we were able to establish some representational requirements for the representation of individual-specific properties based on history. Based on these requirements, we will investigate current evidence that infants younger than 2 years of age restrict properties to units and see them as unique with those requirements in mind. We will question most studies suggesting that they do so and propose that children could have connected properties to the units' qualitative identities, such as their kinds. Differently from studies with 3-year-olds and older, infant studies do not resort to the use of replicas to exclude this

possibility. We will argue that attribution of individual properties and representation of uniqueness in infancy might be a bigger challenge than usually assumed.

4.3. "Non-evidence" and evidence of uniqueness in infancy

"Mom" is, perhaps, the first thing that comes to our minds when wondering about infants' representation of significant individuals. Evidence shows, for example, that even neonates seem to recognize their mother's face (Pascalis et al., 1995), and 1-month-olds also seem to recognize their mother's voice (Mehler et al., 1978). In addition, two-month-olds seem more responsive to smiles and vocalizations coming from their mothers than from strangers (Bigelow & Rochat, 2006). This kind of evidence shows that infants distinguish their mothers from strangers and respond differently to them.

Does this constitute evidence that, for 2-month-olds, mothers are important as particulars? A crucial feature of the multiple studies discussed before is that children were asked about the value of an entity in comparison to *replicas*. By doing this, these studies can show that children's preferences are not merely connected to material properties but to individuals in and of themselves. The same cannot be said about 2-month-olds and their mothers. They seem to recognize their mothers and respond to them in a particular way, but mothers also tend to be perceptually unique (Bower, 1974). Would infants think that they have multiple mothers if they were presented with replicas? If their preference is merely connected to their mother's perceptual features, they should show an equal preference. Nevertheless, if their preference is grounded on significant relations between their "mother unit" and themselves, they should prefer their mother over replicas. "Mother", in this case, would be just one: the one with whom they share a past.

Bower (1974) reported an experiment that tested just that. Twelve-week-old infants were presented to "three mothers" created through a mirror effect. According to Bower, infants of this age were "not disturbed at all" and interacted with all three mothers in turn. In contrast, when their mother was paired with strangers, they were not disturbed but preferred to interact with their mother. This behavior seemingly changed after 5 months of age, when infants started to be "very disturbed" at the sight of three mothers while showing no sign of disturbance when their mothers were paired with strangers. Bower (1974, p. 202) concludes that "this in fact shows that the young infant (less than five months) thinks that he has a multiplicity of mothers, whereas the older child knows he has one".

Unfortunately, Bower (1974) never cited the source of his findings, therefore they cannot be submitted to scrutiny. To our knowledge, no one else suggested or conducted a study that tested whether infants' preference is just connected to their mother's qualitative identity (i.e., having the "mother look") or numerical identity (i.e., the spatiotemporal unit). The lack of interest on this issue probably lies in the assumption that, for infants, their mother is unique just as for adults. However, adults know that their mother is that one spatiotemporal unit that (in most cases) gave birth to, lived with, and shared important moments with them. The extent to which infants have a historical understanding that allows them to think that "their mother is just one" is unclear.

This seems to be an overall problem with studies involving infants of different ages, including 1-year-olds and older: the findings are interpreted as if infants recognized units throughout time, attributed exclusive properties to them, and saw them as qualitatively unique. However, these studies do not usually consider whether properties are being associated with qualitative identities. For this reason, we end up not knowing whether and in which situations infants attribute properties to and recognize units across time.
4.3.1. Representing history and individual properties in infancy

Throughout this work, we have discussed why artifacts and agents are sometimes seen as unique in value and properties, and significantly different from identical-looking replicas. We suggested that representation of history is crucial for that. For example, older children attributed the knowledge of a drawing to the Winnie-the-Pooh toy who observed the children drawing on a sheet of paper but not to its replica (Gutheil et al., 2008). This happened because, first, children identified the qualitative identity of the event: i.e., a "watching" event with exclusive epistemic implications ("exclusive" since the knowledge was about an event-caused property only accessible to the observer). Second, children also represented the event's numerical identity: children represented it as an episode involving Pooh₁ and only Pooh₁ —which they tracked in space and time, distinguishing it ("the one who knows") from Pooh₂.

Analogously, the infants' capacity to represent entities as bearers of unique properties or value depends on (1) their capacity to identify events with exclusive implications for event participants (if any), as well as (2) recognize event participants throughout time.

The challenge to represent events with exclusive implications is twofold. First, infants have to learn how to recognize the countless kinds of events that happen around them: from "buying" to "kissing", multiple events happen in front of the infants' eyes but their implications, exclusive or not, are largely opaque. We will see that infants can already identify some kinds of events; however, much of what happens around them is arguably unintelligible and dependent on event concepts that they still have not acquired. Second, even when infants identify a kind of event, the implications they imagine might not yet correspond to that of older children and adults. For example, infants seem to be able to recognize "watching" events, expecting observers to "know x" after "watching x" (Buttelmann et al., 2018). However, there is a debate on whether epistemic

states are seen as individual-specific. For example, Burnside and colleagues' (2020) study suggests that 16-month-olds might not restrict epistemic states to observers (here, the knowledge of an object location), generalizing them to non-observers. Therefore, even if infants recognize an event, the implications might not be unit-specific.

In addition to the capacity to recognize events and unit-specific implications, infants also have to recognize the units whose properties were affected by the events throughout time (point 2). Let us assume that infants attribute to an event participant, and only the event participant, the knowledge of a specific event —say, they believe that "Pooh₁ knows about x". Even if this is the case, Pooh₁ will only remain the carrier of a particular knowledge if, first, infants *remember* the existence of "the Pooh who knows x". Not necessarily "remember" in the sense of recalling the past event (Hoerl & McCormack, 2018), but remembering that there is a spatiotemporal unit that knows x. Second, infants have to *recognize* Pooh₁ as being "the Pooh who knows x" when they see it. Would infants still recognize Pooh₁ after, say, taking a nap? If infants fail to remember or recognize Pooh₁ as "that one", what they will see is just "*a* Pooh" with no individual-exclusive properties —just the properties derived from "being a Pooh".

The earliest evidence that infants can remember and recognize specific entities outside continuous tracking is 14 months of age (Moore & Meltzoff, 2004). In this study, the authors found that infants who saw a bell being hidden in a container searched for it in the container the day after. Crucially, this only happened when infants returned to the same room where they saw the bell being hidden, not when they were taken to a different room with an identical-looking container. Therefore, infants seemed to recognize the spatiotemporal existence of the container and the bell, and not just think that "that kind of container has bells".

Nonetheless, Moore and Meltzof (2004) adopted repetitive routines to ensure that infants encoded key features of the room and the location of the bell in their first visit at the lab. These features were also highlighted multiple times on the testing day to ensure recall. In sum, Moore and Meltzof's (2004) experiment seems to reflect the concern that remembering and recognizing spatiotemporal units after daybreak might be difficult. In this sense, we need studies that illuminate the factors that make infants remember and recognize some entities throughout time, comparing their performance with those of older children and adults. After all, the world has countless entities —arguably, even adults just remember and recognize a small fraction of the units they encounter throughout time.

The recognition of an entity as a "carrier of uniqueness" involves non-trivial challenges. First, infants have to identify kinds of events and represent their exclusive implications for event participants. Second, infants have to recognize the event participants throughout the time. In the next section, we will see that, when interpreting their findings, researchers overall assume that infants do both. However, we will suggest that their findings could also be explained by infants connecting properties to the entities' *qualitative identities*, such as their kinds. In this case, whether units are recognized throughout time is irrelevant: as long as infants identify an item as, say, a rattle, they might expect it to make noise when shaken even if they do not remember seeing it before, let alone being shaken. Our goal is not to suggest that, for infants, events have never consequences for or tell something about particulars, but to highlight that this should be treated as an empirical question. By doing that, we could have a better idea of how the connection of exclusive properties to units develops.

4.3.2. Connecting properties to qualitative identities versus units

Adults hardly remember the countless people, dogs, birds, trees, cars, etc. that they encounter on the streets. We potentially even cross paths with some of them multiple times and never realize that we are re-encountering them. Usually, determining what kinds of people, animals, and objects they are informs our behavior well enough —we know we can buy ice cream from the *ice-cream seller* and that we think we should avoid a *rottweiler* because we believe that rottweilers are dangerous. However, some units are kept in mind and reidentified throughout time, such as family members, work colleagues, pets, (some) objects we own, etc. Since those units might recurrently play a relevant role in our lives, being able to recognize and learn about them throughout time might be particularly useful. Be it as it may, keeping track of particulars seems to be a cognitively costly approach reserved to some units.

We have no reason to think that this should be different with infants. In addition, we do not really know what is needed for infants of different ages to successfully remember and recognize units throughout time. Despite that, the developmental literature often assumes that infants connect properties to specific units and recognize them across time. Here, we will propose that infants could be connecting properties to qualitative identities such as kinds (e.g., "dogs", "rottweilers"). This would allow infants to learn about the world and use their knowledge even if they do not recognize units throughout time.

For example, let us consider memory studies that employ the so-called "deferred imitation paradigm" (see Bauer et al., 2000, for a review). These studies found that infants younger than 1 year of age remember, even a week later, how to make a rattle-like artifact make noise —leading some researchers to conclude that infants can recall their past with that artifact (Fivush & Bauer, 2010; Carver & Bauer, 2001; Bauer, 1996). This conclusion, however, is unwarranted. Infants could have just learned that "'rattles' make noise when shaken" without ever remembering the very rattle nor the episodic event where the rattle is shaken. This is also true even if they restrict the function to a specific-looking rattle (Hayne et al., 1997): they could just think that "'rattles with such and such features' make noise when shaken". In this case, they would expect the function from any item that exhibits the relevant qualitative identity since it is not bound to a specific unit.

This possibility does not seem too far from adults' own reality: to use a particular fork, we do not have to recall whether and how we have used it in the past. We just know that "forks are used 'like that'" —a generic form of knowledge learned from our past experiences with forks, but whose experiences do not have not to be remembered (Hoerl & McCormack, 2019). Infants from very early on seem capable of representing different kinds of entities and of learning generic information about them, like artifact functions (e.g., Stavans & Baillargeon, 2018; Parise & Csibra, 2012; Gliga & Csibra, 2009). Therefore, they might have succeeded in different deferred imitation tasks by resorting to their knowledge of kinds.

Infants could have done the same in experiments in which they connected properties to agents. For example, consider the following cases. Hamlin and colleagues (e.g., Hamlin & Wynn, 2011; Hamlin et al., 2007) found that infants as young as 5 months of age attribute positive and negative valences to geometrical-shaped presented in a stage depending on whether they helped or hindered another agent from going uphill. Specifically, when asked to choose between the helper and the hinderer, they showed a preference for the helper. Also, 6-month-olds prefer geometrical-shaped agents who, in a cartoon, were seen interfering in an aggressive interaction between two other agents, rather than a non-interfering agent (Kanakogi et al., 2017). Finally, infants as young as 12-month-olds prefer animated agents who give a ball back in a ball game to agents who keep it (Scola et al., 2015). Therefore, from very early in development, infants

distinguish action events that are prosocial from those that are not, influencing their assessment of agents (see also Powel & Spelke, 2018, for prosociality attribution based on imitation). However, in all these studies, it is unclear whether infants believe that, for instance, "triangle-shaped agents are nice" (a generic belief) or, as the authors seem to assume, that "the triangle-shaped agent who took part in the event is nice" (a unit-specific belief).

In principle, both generic and unit-specific interpretations are possible. Nevertheless, how researchers operationalized some of these studies makes generic beliefs particularly likely. For example, in Kanakogi and colleagues (2017), infants first watched agents in cartoons, and then, in the test phase, they were asked to choose among agents glued to a panel (such a procedure was also adopted, for instance, by Schlingloff et al., 2020; Powel & Spelke, 2018; Scola et al., 2015). The unit-specific belief depends on them thinking that the units crossed from the 2D cartoon to the physical world (19-month-olds, for example, do not expect this to happen; Revencu & Csibra, 2021). In contrast, if infants believe that "triangle-shaped agents are nice", they do not even have to remember seeing a specific triangle agent. They simply have to recognize the "triangle-shaped" identity as the carrier of positive valence.

A similar point can be made about Tatone and colleagues (2015), who found that 12month-olds represent social relations based on giving events. For example, they expect a squareshaped blue agent who performed a sequence of giving actions to also give items in the test phase —crucially, only when the agent interacts with the specific-looking receiver that was seen before (say, a circle-shaped green agent). The authors conclude that "infants interpret giving actions as indicative of *a dyad-specific social relation* (between Giver and Givee)" (Tatone et al., 2015, p. 54; our italic). However, it could also be that the social relation is between "square-shaped blue agents and circle-shaped green agents" (i.e., a generic belief) —which means that the relation could involve any agents that happen to share the relevant qualitative identity. Even though this study does not mix cartoons and printed characters, a "dyad-specific" social relation still supposes that infants recognize the test agents as *the* agents that they saw before —which, in turn, supposes that they remember seeing those agents. The generic belief just supposes that they distinguish qualitative identities, whether they recognize the very agents from the past or not.

Another study that used cartoons with geometrically-shaped characters has found that 15month-olds both represent "one-to-one" relations of social dominance between agents (e.g., A dominates B; Mascaro & Csibra, 2012), and also form hypotheses about the structure of social groups (e.g., if they saw that A dominates B, and that B dominates C, then they expect A to dominate C; Mascaro & Csibra, 2012). Analogously to Tatone and colleagues (2015), we cannot know whether the "one-to-one" dominance relations and the group structure involve specific individuals or, instead, any agents holding the relevant qualitative identities. Again, if the claim is that the dominance relations and structure involve particulars, then infants have to believe that the agents acting in different scenes are the same individuals —which could obviously be the case, but awaits empirical evidence.

Infants could have connected properties to qualitative identities also in studies involving live interactions with human actors. For example, Buresh and Woodward (2007) found that 13-month-olds restrict "action goals"⁴ to specific agents —for example, they do not expect a fair-haired female actress to reach for the same object previously reached for by a dark-haired male actor. Here too, the findings can be interpreted in two possible ways: they connected the action

⁴ Authors such as Diesendruck et al. (2015) understood Buresh and Woodward's (2007) study as being about attribution of "object preferences". However, the authors themselves framed it as attribution of "action goals". An action goal might be grounded on preferences or not. Here, however, this nuance is not crucial: whether the study shows attribution of "action goals" or "preferences", we are interested in whether infants link them to particulars or to qualitative identities.

goal to a qualitative identity (e.g., to "dark-haired men", "men", "dark-haired people", etc.), or they connected it to the unit, i.e., the actor that took part in the object reaching events. In this case, they could have tracked the actor unit in the here and now and distinguished him from others perhaps making the association of the goal to a unit more feasible than in cartoons with spatiotemporally discontinuous agents. However, the experiment did not rule out the possibility that infants formed a generic belief from the reaching event. They just seemed to restrict the goal because no twin was present to reveal its generality⁵.

In a different study with human actors, Saylor and Ganea (2007) found that 14-month-olds seem to represent one-to-one relations between agents and toys —believing that an actress's ambiguous request ("where is the ball?") refers to the red ball that she previously played with rather than a blue ball played by another assistant. However, other interpretations than "one-to-one relations" are possible. First, infants could have linked the requester's qualitative identity to "red balls" —therefore, believing that she wanted "*a* red ball" and not giving the blue ball. Second, maybe infants just linked the requester's qualitative identity to the kind "ball". In this case, any ball would do. However, before making the request, the actress placed the red ball's container on the floor, while the other ball's container was placed on the floor by someone else. Consequently, the infants' attention could have been dragged towards the container the actress just moved away from before making the request, making them select the red ball.

Finally, a similar interpretation based on generic beliefs can also be proposed for Tomasello and Haberl's (2003) findings (and also follow-ups such as Moll & Tomasello, 2007,

⁵ The authors explicitly equate representation of particular agents to distinguishing qualitative identities: "early in the first year of life, infants are able to perceive the difference between faces, [voices and face-voice relations. The question then is whether] infants link perceptual representations of agents with their analysis of the agent's goal" (Buresh and Woodward, 2007, p. 289-290). However, a particular should still be a particular even if their "face and voice" are the same as someone else's —after all, the agents have different numerical identities. The question should be whether infants restrict the goal to an agent unit *even* if this agent shares their qualitative identity with others.

and Moll et al., 2007). Their study develops as follows: Experimenter 1 plays with the infant with two different unfamiliar toys, while Experimenter 2 observes it. Then, Experimenter 1 leaves the room, and Experimenter 2 introduces a third unfamiliar toy to the infant. When Experimenter 1 returns, she expresses excitement at the sight of the toys and says: "That's so neat! Can you give it to me?", to which infants tended to respond by giving the toy introduced by Experimenter 2.

Tomasello and Haberl's (2003) study could indicate that infants represent one-to-one relations between agents and toys, giving Experimenter 1 the toy unit she was not yet connected to. However, other explanations are also possible. Infants could have connected different *kinds of toys* to *"kinds of agents"* —i.e., the agent's qualitative identity (e.g., "blond-haired women", "blond-haired people", etc.). Alternatively, the study could indicate an association between units and kinds: e.g., infants might have connected kinds of toys with specific agent units. In these three cases, we could expect infants to give the (kind of) toy not included in the association. We tested the hypothesis that infants actually form associations between object *kinds* and agents in Chapter 3.

In summary, the findings discussed in this section could still have emerged even if infants did not identify *the* toy someone played with, or *the* "nice" agent seen before. Infants could have just connected properties and relations to qualitative identities, e.g., thinking that "triangle-shaped agents are nice" and selecting the agent that exhibits the critical identity. Analogously to studies with older children, the extent to which infants connect goals, prosocial dispositions, relations, etc., to units could probably be tested through the use of replicas. Studies with replicas are very persuasive in showing that a property is exclusively linked to a unit, as the only thing that distinguishes the object from replicas is its spatiotemporal dimension. The main problem with the infant literature is not suggesting that infants associate properties with individuals, but *assuming*

that this is the case. This assumption prevents us from investigating the conditions needed for both the attribution of individual-exclusive properties and the recognition of units as carriers of "individuality".

4.3.3. The earliest evidence that infants attribute individual properties to units

In the previous section, we have discussed multiple studies that unwarrantedly assumed that infants attribute properties and relations to particular units in the face of events. We have argued that they do not disambiguate whether infants make attributions to properties to kinds or units —-for example, through the use of replicas. However, replicas are not the only way to convincingly show that infants link properties to individuals. At least one study seems to show that infants as young as 18 months of age can do so by showing that they can *revise* one's past and update the individual's mental state (Király, Oláh, Csibra, & Kovács, *in prep*).

At first glance, Király and colleagues (*in prep*) experiment looks like many other theory of mind tests: the participants observed two different-looking toys being placed in different boxes in the presence of two experimenters. Then, when one of the experimenters (E1) was away, the other experimenter (E2) changed the location of the objects. After that, infants observed different situations depending on the condition they were in. In the "traditional" False Belief condition, E2 called E1 back to the room; here, infants were expected to think that E1 does *not* know the correct location of the objects —after all, E1 did not see that the objects swapped locations. In the Revised False Belief condition, infants were taken to an adjacent room, where they see E1 peeking into the experimental room through a one-way mirror. Here, infants were expected to think that E1 knows the correct location of the objects —by seeing that E1 had visual access to the room, infants would

think that E1 "actually saw" the swapping event. In other words, infants would revise their belief about E1's knowledge state by reinterpreting the past.

In both conditions, upon return, E1 pointed at one of the boxes and asked the participants to give her the toy. In the traditional False Belief condition, infants tended to give her the toy in the box that was *not* pointed at. Arguably, infants thought that E1 did not know where the toy she wanted was. However, in the Revised False Belief condition, infants tended to give her the toy in the box that she pointed at —they believed that E1 knew the current location of the toys, therefore she was pointing at the location with the toy she wanted. Importantly, in a control condition where the one-way mirror was covered and E1 was found reading a book, infants responded as in the traditional False Belief Condition, giving the toy from the box E1 did not point at. Altogether, these findings suggest that infants encoded the past —revising it in the face of new evidence and, consequently, revising E1's knowledge.

"Revision" is the critical ingredient in Király and colleagues' (in prep) to show that infants remember the past event and the agent units involved —after all, if they ignore/do not remember the past event, no knowledge attribution can be revised. And crucially, since infants seem to believe that knowing the toys' location depends on witnessing the episodic event, it is unlikely that they would extend this knowledge to replicas/twins who did not witness it, even though this study did not explore this possibility directly. In sum, 18-month-olds seem to be able to distinguish individuals by their past, which in turn might confer individuals exclusive properties and qualitatively distinguish them from one another.

To our knowledge, only Cacchione and colleagues (2013) study also tried to explore whether infants can represent past events and their consequences for particulars. Fourteen-montholds were divided into two groups: the "informed" group and the "uninformed" group (names used

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by us, not the authors, for the sake of clarity). Only participants in the informed group learned that the experimenter's toys can be turned inside out into different things —e.g., a pig can be turned into a ball. Then, both groups observed a bunny being placed inside a box and, later, a carrot being retrieved from it. The critical finding is that the uninformed group searched for the bunny inside the box and the informed group refrained from it —arguably, they believed that the carrot *is* the bunny that they previously saw. In short, both groups seemed to remember that a bunny was placed in the box, but only the informed group (1) inferred a past "inside-out event" that transformed the bunny and (2) concluded, for this reason, that the carrot and the bunny are the same toys.

Their conclusion, if correct, would indicate that infants as young as 14 months of age can think about past events and their consequences for particulars. However, Cacchione and colleagues' (2013) findings could be explained differently. The informed group could have just learned during training that the experimenters' toys can have multiple identities, which made them less prone to encode the inside-out toy placed into the box as "a bunny". In other words, maybe the bunny was just encoded as "an inside-out toy"; then, later, infants just took the carrot to be it. In fact, object individuation studies have already shown that infants may fail to distinguish different-looking objects of the same kind when they are seen one after the other (e.g., Xu, Carey, and Quint, 2004). Therefore, no inference of a "transformation event" necessarily took place in Cacchione and colleagues' (2013) experiment, just a failure to notice the changes in the toy's appearance.

The ability to represent and revise past events is likely more than what is needed to link exclusive properties to particulars based on their past. For example, infants could fully forget that they saw an agent witnessing an object hiding event. Despite that, they could still believe that the specific agent knows the object's location by (i) connecting this knowledge to the agent while the event takes place and (ii) recognizing the agent throughout time as being the one who carries the knowledge —which means that infants have to identify the agent by her *spatiotemporal* history, but not necessarily remember the event. That said, Király and colleagues' study (*in prep*) seems to constitute robust evidence that infants unambiguously attribute properties to specific units. Future studies could test whether infants are capable of (i-ii) at a younger age, and independently of their capacity to remember and revise past events.

4.3.4. Concluding remarks on uniqueness in infancy

Entities have exclusive histories, i.e., they have a unique spatiotemporal trajectory and take part in exclusive episodic events. These events, in turn, may have implications for the entities' properties or value, making them qualitatively distinct from each other. To represent this qualitative uniqueness, infants have to (1) identify kinds of episodic events and their exclusive implications, and (2) remember and recognize the units that carry "such and such" event-caused properties throughout the time. In principle, (1, 2) would allow infants to represent some entities as "carriers of uniqueness" even if they forget the past events —e.g., they could think that a plush toy is wet but forget that someone washed it.

Overall, the literature has shown that infants of different ages identify some kinds of episodic events, such as "watching", "helping", and "giving". These are significant findings, as they show that infants, sometimes even before their first year of life, can already infer implications from some of the events that they observe. However, infants probably lack countless other event concepts held by adults of their community. From "purchasing" to "kissing", infants probably observe multiple events that are opaque. In this sense, the acquisition of event concepts should increase the number of situations that infants identify as having exclusive consequences for units.

In addition, even if infants represent events such as "watching", "helping", or "giving", we still have to determine how they understand these events. Critically, the literature generally assumes that, for infants, these events tell something about particular entities —e.g., that infants think that a specific agent "is prosocial" for helping another agent go uphill. However, instead of particular entities, they could believe that these events reveal properties about the agent's *kind* — therefore, a generic belief not restricted to the individual that helped. Relatedly, infants' social cognition could be "kind-based", representing social relations (e.g., dominance and mutualism) among kinds of entities rather than specific individuals. Infants could also associate epistemic states with the entities' kinds instead of particulars. This "radically kind-centered view" is hardly correct, but empirical studies are needed to show its limits and illuminate the circumstances in which infants make individual-based associations. Future research with infants could get inspiration from studies with older children that used replicas to assess whether infants restrict a property to a unit or not.

Finally, the connection of properties to specific units will only last as long as infants remember and recognize them throughout time —for example, recognizing that the agent they see is "that" prosocial agent. The situations in which infants re-encounter units are varied, from finding an object that was hidden inside a box in the "here and now" to re-encountering the object long after, in a different location and with changed perceptual features. Arguably, these situations impose different obstacles for unit recognition. Multiple studies have shown that infants can track entities in the here and now, e.g., objects moving from behind panels or being placed inside boxes. However, even then, infants might fail to distinguish particulars by their appearance when they belong to the same kind (Xu, Carey, and Quint, 2004). We need more studies with infants exploring

the situations in which they will both remember and recognize units, which is a precondition for seeing them as "carriers of uniqueness".

5. Conclusion

Throughout this work, one of our main goals was to reflect on the reason some entities are believed to hold value and properties that make them "unique" —i.e., qualitatively distinct from all others, even identical material replicas. We suggested that the reason lies in the representation of their history, including the episodic events that entities take part in. Based on that, we reviewed the literature with children, trying to, first, determine whether they believe that some artifacts and agents are unique; and second, illuminate the role that historical representations had in it. Our discussion about children served as an important comparative parameter for our review of the infant literature. In contrast with studies with children, it is generally not clear whether infants associate properties to particular entities or to their qualitative identities, such as their kinds.

As it is now, we know little about how the capacity to represent uniqueness develops in infancy. In developmental cognitive science, the infants' capacity to represent kinds of objects seems to have been much more explored so far. Perhaps the lack of exploration of infants' capacity to represent unique entities is based on the overall assumption that they do so in multiple studies. This work tried to raise skepticism over this assumption. In addition, we proposed two requisites for infants to be able to represent unique entities that could guide future research, namely: infants have to be capable of (1) identifying kinds of events with exclusive implications and (2) recognizing event participants throughout time. Illuminating how these two factors develop and interact with each other might give us a more precise idea of the extent to which infants recognize some entities as carriers of uniqueness.

Chapter 3

Object kinds influence 13- and 24-month-olds' interpretation of ambiguous requests

1. Introduction

Imagine the following situation: a person sees a whole Margherita pizza among others in a pizzeria's display case. Margherita is her favorite kind of pizza, and she wants a particularly appealing-looking slice that caught her eye. When her turn comes up, she points at "it" and tells the server she wants "that one". Crucially, her pointing and verbal request are ambiguous as to what they are about, just a kind of pizza or a particular slice of it (after all, we also use pointing to indicate kinds; Csibra & Shamsudheen, 2015). The server wrongly assumes that she merely indicates the kind of pizza she wants: Margherita, instead of Marinara or Pugliese. Conclusion: he gives her a less appealing piece of Margherita with less cheese. As the line behind her is long, she accepts the unattractive slice and leaves.

The crucial premise of the present study is that one's responses to ambiguous requests may reveal their assumption about whether others want a kind of object or a particular. However, instead of adults, we aim to understand what infants think others want.

Ambiguous requests have already been used in developmental studies, such as Tomasello and Haberl (2003; see also Moll & Tomasello, 2007, and Moll et al., 2007). In their study, infants observed an experimenter making an ambiguous request "can you give it to me" while looking towards a set of toys. Infants tended to hand the experimenter the toy they have *not* played with before, i.e., a new toy. However, the objects looked very different from each other, and it is unclear whether infants believed that the requester wanted the new toy because they thought it was a new *kind* of toy. If the set of objects belonged to the same kind, would infants still give the new item? We have distinct predictions for different age groups based on how infants seem to prioritize kindrelated and unrelated properties throughout development. We will discuss this development next and then specify and justify our predictions.

1.1. Representing kind-related and unrelated properties throughout development

Infants can already represent exemplars of kinds around their first year of life, such as recognizing something as "a ball" or "a cat" (e.g., Parise & Csibra, 2012; Gliga & Csibra, 2009; Xu & Carey, 1996). To a great extent, kinds inform what to expect from objects. For example, their knowledge about "balls" and "cats" might tell them that the cat they see can meow and the ball can bounce, even if they have never seen that specific cat and ball before. In other words, infants expect entities to show "dispositions" or "essences" associated with their kinds (Gelman, 2003). Countless entities surround infants, and kind representations help them make those entities more familiar and predictable.

Crucially, kinds also influence how infants make sense of others' behavior. For example, Spaepen and Spelke (2007) explored how 12-month-olds interpret others' reaching behavior. Infants watched a hand reaching for one of two objects multiple times —say, reaching for a black female doll instead of an alternative object. Then, in the test phase, infants either saw the agent reaching (1) the black female doll again or (2) the alternative object. The authors found that infants were surprised (i.e., looked longer at the screen) when the agent reached for the alternative object if this alternative object belonged to a *different kind* (e.g., a truck). Interestingly, however, they did not look longer if the alternative object belonged to the *same kind* (i.e., a white male doll) — even though infants seemed to encode the dolls' perceptual contrast (see Experiment 3, p. 141). Their findings suggest that infants believe that others' goal is to reach for a *kind of object*, i.e., "a doll", and not a specific object of a kind, "*the* doll".

Infants' interpretation that others want to reach for a kind of object is in line with the "special status" that they seem to assign to kinds. For example, 12-month-olds distinguished two different kinds of objects (e.g., a cup and a truck) appearing from behind a screen one after the

other. However, they did not distinguish two objects of the same kind (two cups), even though they differed in size, color, or both (Xu et al., 2004)⁶. Infants only distinguished two objects by their colors if they learned that the objects were different *kinds of tools* (i.e., if infants learned that the red tool is to pour salt, and the green tool is to pound a peg) (Wilcox et al., 2008). Additionally, 6-month-olds only remembered that a doll head was placed behind a panel if they had the means to conceptualize it as a *face* — when the head was shown upright but not upside down (Kibbe & Leslie, 2019). In other words, infants seemed to encode the object's kind but not its perceptual features, identical across objects. Finally, young infants believe that others use novel words to name kinds rather than other properties such as shape (e.g., Dewar & Xu, 2009). In sum, evidence from different sources highlights that kinds over all other object properties are what infants generally believe names are about, remember, and track.

Importantly, this does not mean that infants only represent the objects' kinds: even before their first year of life, properties such as size, rigidity, etc. (e.g., Rocha et al., 2006; Bourgeois et al., 2005) and affordances (e.g., Ziemer et al., 2012; Devouche, 1998) influence how infants manipulate objects. However, even though infants represent these properties, they might believe that kind-related properties are more relevant. For example, infants are not blind to two cups' different colors, textures, and sizes but might see them as secondary since they play little or no role in the cups' function as a tool to drink liquids. Consequently, infants are less likely to track these differences (e.g., Xu et al., 2004) or think that others' goal is to reach for a particular object because of them (Spaepen & Spelke, 2007).

⁶ Wilcox and Baillargeon (1998) found that even infants younger than 1 year of age might individuate objects based on featural information with specific changes in the paradigm. We are not suggesting here that infants cannot do it. However, kind contrast might help infants individuate objects when featural contrast does not.

Kinds also seem to be relevant for children older than three years of age, who have, e.g., increased motivation to learn about and remember information about them (see Cimpian, 2016, for a review). However, differently from infants, children seem to attribute high relevance to particulars for their individual-specific properties. For example, boys and girls as young as 3 and 4 years of age show distinct preferences for objects of the same kind that only differ in color (Yeung & Wong, 2018; Weisgram et al., 2014; Picariello et al., 1990). Additionally, children might also prefer specific objects over others of the same kind for reasons unrelated to material properties, such as ownership and history (e.g., Pesowski & Friedman, 2019; Marsh et al., 2018; Gelman & Davidson, 2016; Hood et al., 2016; Gelman et al., 2012; Hood & Bloom, 2008). Finally, children think that particulars are also important for others: for example, they might believe that their objects should not be exchanged, even by identical replicas (McEwan et al., 2016). In sum, from a child's perspective, an object might be relevant for reasons not reducible to its kind.

In sum, early in development, cognition seems to prioritize kinds and kind-related properties fully. Even though infants represent properties unrelated to kinds, those seem to be secondary: infants are more likely to encode kinds. However, objects seem to become individually relevant later in development. Children believe that objects can be significant for reasons unrelated to their kinds, ranging from their color to their history. Therefore, they might be more prone than infants to encode particulars and their individual-related properties.

1.2. Are ambiguous requests about kinds of objects or particulars?

Based on the previous discussion, we hypothesize that (1) early in development, infants are "kind-centered", encoding kinds and kind-related properties but not particulars and individualrelated properties. However, (2), infants become more likely to encode particulars and their individual properties later in development. We explored these hypotheses by asking how they encode others' interactions with objects and respond to their ambiguous object requests. Our study is based on the behavioral paradigm developed by Tomasello and Haberl (2003) and also implemented by Moll and Tomasello (2007) and Moll and colleagues (2007).

In Tomasello and Haberl (2003), two experimenters and the infants played with different toys. At some point, one of the experimenters left the room, and the remaining experimenter introduced a new toy, playing with it for a minute. By the end of the playing time, the toys were put side-by-side on a tray in front of the infant; the other experimenter returned to the room and, after seeing the set of toys, she said, ambiguously: "Oh look! Look there! Look at that one there! Can you give it to me?". Both 12- and 18-month-olds tended to select the toy they had not played with the requester yet, i.e., the "new toy".

Crucially, to give the new toy, infants had to associate the requester with the objects they played with so that these toys were disregarded as potential request goals. However, the question is whether infants associated the requester with *kinds* or *particular toys*. Tomasello and Haberl (2003) and follow-up studies used different kinds of toys. Consequently, we cannot know whether infants inferred that the requester wanted a new *kind of* toy or a new particular toy (i.e., regardless of its kind).

We designed our experiment with two conditions: one with different kinds of toys ("Different" condition) and another with different-looking toys of the same kind ("Same" condition). We tested 13- and 24-month-olds, expecting both of them to give the new toy in the Different condition —e.g., give the doll instead of the cat the requester played with before. However, in the Same condition, we only expected 24-month-olds to give the new toy —e.g., give the new doll instead of the doll the requester played with before. The reason is that we do not

expect 13-month-olds to encode the requester's interaction with particulars but with *kinds of objects* (e.g., "a doll"). They might fail to tell the new and the old toy apart, or even if distinguished, infants might think that any toy will do because they belong to the same kind: the agent-kind association is what matters for their decision (e.g., as in Spaepen & Spelke, 2007). Therefore, they will not consistently give the new toy in the Same condition. In contrast, 24-month-olds should successfully encode the requester's interaction with specific objects, giving the new particular in the Same condition.

Because 13-month-olds will fundamentally encode agent-kind associations, we expect them to (1) give the new and the old object randomly in the Same condition, and (2) give both objects more frequently in the Same condition than in the Different condition (Table 1). However, such outcomes could also be explained differently. Someone could argue that the pairs of toys are perceptually similar in the Same condition (or at least more similar to each other than in the Different condition). The toys being similar to each other, infants could struggle to tell apart the new and the old toy or simply have less clear that the ambiguous request could be about the new "but perceptually similar" toy. From this perspective, perceptual contrast, not kinds, would be the relevant factor behind their giving responses.

To control for perceptual-based explanations, aside from familiar objects, we tested participants with unfamiliar objects. By using unfamiliar objects, we could introduce the same pairs of objects in the Different and the Same conditions, keeping perceptual contrast constant. We manipulated object kinds through names and functions: in the Different condition, each pair contained toys with different invented names and functions (e.g., one is a stamp and the other is a magnet), while in the Same condition, the toys had the same name and function (e.g., both are magnets). We decided to manipulate name and function because prior research showed that infants believe that names and function indicate kind-membership (e.g., Futó et al., 2010; Dewar & Xu, 2009; Wilcox et al., 2008; Xu et al., 2005; Booth & Waxman, 2002). If infants are guided by the objects' kinds and not by perceptual contrast, they should give the new toy in the Different condition but not in the Same condition, just as predicted for familiar toys.

| TABLE 1Which toy will participants give to the requester?(prediction for familiar and unfamiliar objects) | | | | | | | |
|---|--|------------|--|--|--|--|--|
| | Same condition (e.g., doll vs. doll)Different condition (e.g., doll vs. cat) | | | | | | |
| 13-month-olds | Chance | New object | | | | | |
| | Two-objects giving: More in Same than in Different | | | | | | |
| 24-month-olds | New object | New object | | | | | |
| | Two-objects giving: Same amount in Same and in Different | | | | | | |

2. Methods

This experiment was inspired by the paradigm used by Tomasello and Haberl (2003), Moll and Tomasello (2007), and Moll and colleagues (2007). However, our design had critical design differences. First, we manipulated familiarity and kind (same kind, different kinds). Second, we used pairs rather than triads of toys to make it easier for infants to track and select objects. Third, participants were tested across four trials instead of just one so that each of them produced multiple responses instead of a single "success/fail" response. Fourth, we also considered trials where participants gave both toys. Finally, differently from Tomasello and Haberl's (2003) paradigm, we labeled both familiar and unfamiliar toys with their category names at least three times to ensure that the participants identified the toys as members of the same or different kinds.

2.1. Design

We explored the following factors: kind (different kinds, same kind), familiarity (familiar toys, unfamiliar toys), and age (13-month-olds, 24-month-olds). All factors had a between-subject design. Therefore, we tested 8 different participant groups (2*2*2).

2.2. Participants

This study was approved by the United Ethical Review Committee for Research in Psychology (EPKEB; reference number: 2017/87). We analyzed data from 192 infants from Budapest, Hungary, from two age groups: 13-month-olds (N = 96; Mean age = 413 days, range 396 days to 499 days) and 24-month-olds (N = 96; Mean age = 740 days, range 707 days to 760 days). Additional participants were excluded either for failing to complete at least two (out of three) familiarization trials or at least two (out of four) test trials (see Table 2). The exclusion rate was high due to our strict *a priori* criteria to consider a response valid (see 2.4. Coding).

| TABLE 2 Exclusion rate | | | | | | | | |
|---|--|--|--|--|--|--|--|--|
| Familiar objects | | | | | | | | |
| 13-month-olds (Different and Same conditions) | 24-month-olds (Different and Same conditions) | | | | | | | |
| Total = 51 For failing fam. phase = 43 For failing test phase = 07 Experimental error = 01 | Total = 22 - For failing fam. phase = 15 - For failing test phase = 07 | | | | | | | |
| Unfamiliar objects | | | | | | | | |
| 13-month-olds (Different and Same conditions) | 24-month-olds (Different and Same conditions) | | | | | | | |

| Total = 51 | Total = 19 | | | | |
|--|---|--|--|--|--|
| For failing fam. phase = 29 For failing test phase = 22 | For failing fam. phase = 3 For failing test phase = 16 | | | | |

2.3. Materials

The experiment comprised two phases: familiarization and test. In the familiarization phase, a pair of familiar toys was used (a ball and a dog^7). In the test phase, four different pairs of toys were used across trials. In the "Different" condition, the participants saw pairs whose toys belonged to *different kinds* (e.g., a doll and a cat); in the "Same" condition, the pairs contained toys that belonged to the *same kind* (e.g., two different-looking cats) (see Table 1). Additionally, we also manipulated whether participants saw pairs of *familiar kinds of toys* (e.g., cats, cars) or *unfamiliar kinds of toys* (e.g., unusual objects with specific functions, produced for the experiment; see Table 1). Overall, the familiar objects belonged to categories whose names Hungarian 9-month-olds know ((Parise & Csibra, 2012)).

The unfamiliar toys were specially made for the experiment. The objects were visually distinguishable from each other by their color and shape, and their size allowed easy manipulation by both 13- and 24-month-olds. The same pairs were used in the Same and in the Different conditions. However, in the Same condition, the toys of a pair shared the same function and name (i.e., a Hungarian-sounding pseudoword), while in the Different condition, the toys' function and name differed from each other (see Table 1).

⁷ The ball and the dog were changed to a car and a bear when participants were tested with unfamiliar toys. The car and the bear were smaller and easier to hand to the experimenter. Also, we replaced the ball because participants constantly wanted to throw it to the requester, delaying the session.

| TABLE 3 Object sets used with different groups of participants | | | | | | | | | |
|--|-----------------|-------------------|----------------|---------------|--|--|--|--|--|
| FAMILIAR TOYS | | | | | | | | | |
| | TRIAL 1 | TRIAL 2 | TRIAL 3 | TRIAL 4 | | | | | |
| DIFFERENT ⁸ | b-basemele | 19 m | | | | | | | |
| Category name | book car | doll cat | bottle phone | bear / duck | | | | | |
| SAME | | T.S | | | | | | | |
| Category name | car car | cat / cat | phone phone | bear / bear | | | | | |
| UNFAMILIAR TOYS | | | | | | | | | |
| | TRIAL 1 | TRIAL 2 | TRIAL 3 | TRIAL 4 | | | | | |
| DIFFERENT | ~ | 8 | | | | | | | |
| Function | light marker | magnet stamp | jump / blow | sound spin | | | | | |
| Category name | "tegi" "pádu" | "kabó" "düpi" | "kitő" "gété" | "baku" "todó" | | | | | |
| SAME | 2 | | 18 * | | | | | | |
| Function | light / light | stamp / stamp | jump / jump | noise noise | | | | | |
| Category name | "pádu" "pádu" | ''kabó'' ''kabó'' | "gété" "gété" | "todó" "todó" | | | | | |

⁸ Twenty-four-month-olds saw a boat and a plane instead of a book and a baby bottle, respectively. During our pilot tests, they showed a strong disinterest for the book and the baby bottle. However, we decided to keep the book and the bottle for 13-month-olds since we did not know whether they were familiar with boats and planes.

2.4. Procedure

Infants visited the CEU Babylab with their caregivers for a 20-min long session (including warm-up, familiarization, and test phase). Sessions were conducted in the native language of the infant (Hungarian) and in the presence of the caregiver. The procedure was identical for infants in the Different and the Same conditions. However, it had some minor differences depending on whether the toys were familiar or unfamiliar. We indicate those differences in the general procedure described below.

2.4.1. Warm-up phase

Upon arrival, infants participated in a warm-up activity with two experimenters and the caregiver in a quiet room. The experimenters freely played with the infants with toys from the laboratory to get them accustomed to the new environment. They asked the infants to hand them cubes of different colors to encourage them to interact with them and give toys upon request (the dependent measure of the present study). The experimenters concluded the warm-up activity when infants seemed comfortable with the situation.

2.4.2. Familiarization phase

The purpose of this phase was to (1) familiarize the infants with the requesting game and (2) assess whether they were willing to respond to requests. After the warm-up stage, the participant, the caregiver, and the experimenters (who played the roles of the requester and the player) sat at a square table. The infant was seated on the parent's lap, 90° to the player and 180° to the requester (see Figure 1; the requester is wearing black). The familiarization developed throughout three trials:

- First trial: the player and the participant played with a ball (or a dog) for approximately 15 seconds. Meanwhile, the requester just observed them playing. At the end of the playing time, the requester held out her hands towards the middle of the tray where the ball was placed and asked: "can you give me the ball?" (Figure 1).
- Second trial: the player and the participant played with the second familizariation toy (e.g., a dog) for another 15 seconds while the ball was left aside on the tray. The requester again just observed them playing. In the end, the player placed the dog beside the ball on the tray, moving the tray towards the participant. The requester quickly pointed at the dog, held out her hands towards the middle of the tray, and asked: "can you give me the dog?".
- Third trial: no playing time happened in this trial. The player aligned the toys again and moved the tray towards the participant. Then, the requester held out her hands towards the middle of the tray and asked, without pointing: "can you give me the ball?" (i.e., she asked for the toy that was introduced first, which we counterbalanced across participants).



Figure 1. First familiarization trial. The requester held out her hands and asked: "can you give me the ball?".

The participants had two attempts per trial to give the requested toy. If they selected the wrong toy, the requester corrected them verbally (e.g., "not the ball, the dog!"), and the player handed the requester the correct toy. The requester showed excitement and placed the toy back on the tray, asking the child for it a second time. Participants had to give a valid response in at least two familiarization trials to be included in the study (see 2.6. Coding).

2.4.3. Test phase

2.4.3.1. Familiar objects

The toys used in the familiarization stage were put away, and the first of the four test trials began. All the four test trials unfolded as follows (see summary on Table 4):

- The player handed a toy (e.g., a car) to the requester, who played with it with the infant. During playing time (duration ≈ 20 seconds), the toy was often used according to its primary function (e.g., rolling the car) and referred to by its category name (e.g., "car") at least three times. Meanwhile, the player simply observed their interaction.
- 2. The player subtly cleared her throat to indicate the end of the playing time. The requester informed the infant that she had to leave. While the requester was away, the player: (1) placed the car (i.e., the "old toy") either on the left or on the right side of the tray (counterbalanced), saying that *"the car goes here!"* and (2) introduced a second toy (e.g., a boat) (i.e., "new toy"), playing with it for around 20 seconds.
- 3. The player placed the new toy beside the old toy and said, *"the boat goes here!"*. The requester then returned to the room and, while facing the toys, she held out her hands and said, ambiguously: *"Wow, look! That's so neat! Can you give it to me?"*. Notably, she

looked in the direction of the tray but not at any specific toy.

While the requester approached the table, the player moved the tray within the infant's reach. Then, the requester sat at the chair, held out her hand towards the middle of the tray, and, looking at the infant, repeated the request: "*Can you give it to me?*". She repeated the request once more in case of no response.

4. After the participant's response, the toys were put away, and a new trial began with a new pair of toys and the experimenters swapping their player and requester roles.



2.4.3.2. Unfamiliar objects

The test phase with unfamiliar objects was the same except for the following:

- The playing time with unfamiliar objects was approximately 40 seconds instead of 20 seconds. Pilot testing showed that infants were still too interested in unfamiliar toys if they played with them only for 20 seconds, not giving them later.
- 2. In the second part of the trial, when the player introduced a new toy in the requester's absence, she contrasted the kind-membership of the toy pair (based on Booth & Waxman,

2002). For example, when she introduced the new toy, she said (1) "look, this is a 'tegi'" and showed its function, then she took the old toy and either said (2.a.) "look, this is not a 'tegi', this is a 'pádu'!" OR (2.b.) "look, this is also a tegi!" while showing the old toy's function. We intended to facilitate the encoding of the toys' same or different categories with this procedure.

2.5. Counterbalancing

In the familiarization phase, we counterbalanced the experimenter who played the requester role (E1 or E2) and the object that was introduced first (ball or dog). The left-right side of the toys on the tray was constant.

In the test phase, the experimenters introduced the same pairs across trials (see Table 3). However, the new and old toys varied across participants. For example, in Trial 2, the doll was the new toy for half of the participants, while the cat was the new toy for the other half. The toys had preassigned sides. For example, the doll was placed on the right and the cat on the left of the tray. Consequently, for half of the participants, the new toy was on the right side, and for the other half, on the left. The side of the new toy across trials was either (s1) "left, right, right, left" or (s2) "right, left, left, right".

Finally, in the test phase, we also counterbalanced the experimenters who played the requester role across trials: (r1) "e1, e2, e1, e2" or (r2) "e2, e1, e2, e1". We randomly divided the participants into four groups with different requester and side orders: (s1, r1), (s1, r2), (s2, r1), and (s2, r2).

2.6. Coding

For each trial, we coded the participants' giving responses as follows:

- New toy: infants gave the requester the toy she did not play with before;
- Old toy: infants gave the requester the toy she played with before;
- Both toys: infants give the requester both toys at once.

Handing, throwing, and pushing the toys towards the requester were considered "giving". Importantly, we only considered a giving response valid if it was directed to the requester, and not to the player or caregiver.

Additionally, in the test phase, we only considered valid giving responses that happened *within 4 seconds* —from the time the participant grasped the toy to the moment they initiated the giving action. The 4-second time frame was necessary to ensure that the giving responses happened under the same communicative context. For example, participants often grasped a toy just to play with it, initially ignoring the request; then, while holding the toy, the participants would finally pay attention to the experimenter's verbal request and hands-out gesture. In this context, the toy infants were holding was arguably more salient than the other, so they could have given it because it is where their attention lies or because they think the experimenter simply wants what they are holding up. The 4-second time frame avoided this kind of "context-diversity" in the responses we analyzed.

Our coding criteria were much stricter than Tomasello and Haberl's (Tomasello & Haberl, 2003). In fact, with 12-month-olds, the authors also considered "giving" the action of *touching* a toy. We understand the motivation behind their decision: giving actions are not easy for infants this young, and our stricter criteria produced way more invalid trials and subjects than in their study. However, pilot experiments showed that participants often ignored the requests and simply

grasped the toys to play with them. We feared that a "softer" criteria would have generated too much noise in the data, especially since our paradigm contained not one but four trials. Therefore, we decided beforehand to adopt strict criteria of giving.

All the sessions were filmed using three cameras and fully coded by the author. At least 40% of each participant was also coded by a second experimenter who did not participate in the study. We edited the videos so that only the request and the participants' responses were kept, ensuring that the coder could not distinguish the new from the old toy. Disagreements were discussed until coders reached an agreement. We tried to ensure that all the cases susceptible to different interpretations were double-coded. The number of valid trials across conditions is summarized in Table 5.

| TABLE 5 Number of valid trials per condition ("one" and "both" indicate the amount of trials where one and both objects were given) | | | | | | | | | | | | |
|---|---------------|------|-------|------------|------|---------------|-----|------|------------|-----|------|-------|
| | 13-month-olds | | | | | 24-month-olds | | | | | | |
| | Familiar | | | Unfamiliar | | Familiar | | | Unfamiliar | | | |
| | One | Both | Total | One | Both | Total | One | Both | Total | One | Both | Total |
| Diff. | 73 | 6 | 79 | 68 | 2 | 70 | 86 | 1 | 87 | 73 | 9 | 82 |
| Same | 70 | 12 | 82 | 63 | 6 | 69 | 58 | 30 | 88 | 74 | 4 | 78 |
| Total | 143 | 18 | 161 | 131 | 8 | 139 | 144 | 31 | 175 | 147 | 13 | 160 |

3. Results

We used a Bayesian multinomial regression model to analyze infants' giving choices. We assumed that, in each trial, infants would choose to give one or both toys, and in the former case, they would choose between the new toy and the old toy. Additionally, we assumed that infants'

choices were made according to an underlying multinomial probability distribution. We modeled these probability distributions using two parameters: (i) p_{BOTH} , the probability that both toys are handed to the experimenter, and (ii) p_{NEW} , the conditional probability that infants give the new toy to the requester given that only one of the two toys was selected.

We expected infants to give both toys rarely. We consulted adult Hungarian speakers and they believed that the request sentence we used was about a single object (even though numerosity was not linguistically marked). Also, our pilot tests indicated that giving both was not a frequent kind of response. Based on that, we chose the prior on the probability p_{BOTH} towards lower values. For p_{NEW} , we used a prior centered on 0.5 and skeptical of extreme values. This means that we did not inform the model a priori that infants should be more or less likely to give the new vs. the old toy. We transformed p_{BOTH} and p_{NEW} into log-odds to run a generalized linear regression (McElreath, 2020), but we report the analyses in probability terms.

For each group of participants, the Bayesian model yielded a credible estimate for the two values that interest us: the probability that infants give both objects and that infants give the new toy given that they did *not* give both. The model also allowed us to estimate the differences between these values by pair type (i.e., different versus same), age, and toy familiarity. The findings are described below and summarized in Table 5. The posteriors on the overarching parameters p_{NEW} (one for each participant group) are displayed in Figure 2 (familiar toys) and Figure 3 (unfamiliar toys).

3.1. Familiar objects

For 13-month-olds, the mean of the p_{NEW} -posterior was 0.72 (89% credible interval = [0.63, 0.80]) in the Different condition. This suggests that, in the Different condition, 13-month-olds

tended to give the new toy more often than chance. In the Same condition, the *p*_{NEW}-posterior was centered at 0.57 (89% credible interval = [0.47, 0.67]), indicating that 13-month-olds also tended to give the new toy more often than chance in this condition (but chance values are marginally possible in this case). Importantly, even though 13-month-olds were likely to give the new toy in the Same condition, they were less likely to do so compared to infants in the Different condition: the difference between Different and Same regarding *p*_{NEW}-posterior was at 0.15 (89% credible interval = [0.03, 0.28]). Finally, the difference between Different and Same conditions regarding *p*_{BOTH} was centered at -0.06 (89% credible interval = [-0.13, 0.01]), suggesting that 13-month-olds were more likely to give both toys in the Same condition than in the Different condition. However, chance values were also marginally possible.

In the case of 24-month-olds, the most likely value for p_{NEW} -posterior was 0.73 (89% credible interval = [0.66, 0.81]) in the Different condition. This suggests that, in the Different condition, 24-month-olds tended to give the new toy more often than chance. In the Same condition, p_{NEW} -posterior was at 0.59 (89% credible interval = [0.48, 0.68]), indicating that 24-month-olds gave the new toy more often than chance, although chance values were still marginally possible. Even though 24-month-olds were likely to give the new toy above chance in the Same condition, they were less likely to give it compared to the Different condition: the difference between Different and Same regarding p_{NEW} -posterior was at 0.15 (89% credible interval = [0.04, 0.28]). Finally, 24-month-olds seemed more likely to give both toys in the Same than in the Different condition: the difference between Different and Same condition: the difference between Different and Same than in the Different condition: the difference between Different and Same than in the Same condition: the difference between Different and Same conditions regarding p_{BOTH} -posterior was at -0.29 (89% credible interval = [-0.37, -0.22]).

Finally, we compared the difference between the Different and the Same condition (D-S) across age groups. Regarding p_{NEW} , D-S was the same for 13- and 24-month-olds: the p_{NEW} -

posterior was at -0.002 (89% credible interval = [-0.15, 0.15]). However, D-S was different across age groups for p_{BOTH} . The p_{BOTH} -posterior was at 0.23 (89% credible interval = [0.13, 0.34]). Simply put, the difference between the Different and the Same conditions was higher for 24-month-olds. However, note that the age groups showed the same pattern of responses: they were more likely to give both toys in the Same than in the Different condition.

3.2. Unfamiliar objects

For 13-month-olds, the most plausible value for p_{NEW} -posterior was 0.59 (89% credible interval = [0.48, 0.69]) in the Different condition. This suggests that, in the Different condition, 13-month-olds tended to give the new toy more often than chance, but chance values were still marginally possible. In the Same condition, p_{NEW} -posterior was centered at 0.49 (89% credible interval = [0.40, 0.58]), indicating that 13-month-olds gave a toy at random. Infants were also more likely to give the new toy in the Different than in the Same condition, although chance values were also possible: the difference for p_{NEW} -posterior was at 0.09 (89% credible interval = [-0.04, 0.23]). Finally, the difference between Different and Same conditions regarding p_{BOTH} was -0.02 (89% credible interval = [-0.09, 0.03]). Since the mean is close to zero, we interpreted this result as indicating no difference between conditions.

In the case of 24-month-olds, p_{NEW} -posterior was at 0.77 (89% credible interval = [0.69, 0.85]) in the Different condition. This suggests that, in the Different condition, 24-month-olds tended to give the new toy above chance. In the Same condition, the p_{NEW} -posterior was centered at 0.71 (89% credible interval = [0.62, 0.78]), indicating that 24-month-olds also tended to give the new toy above chance here. This age group seemed slightly more likely to give the new toy in the Different than in the Same condition (with chance values also marginally possible): the
difference for p_{NEW} -posterior was at 0.06 (89% credible interval = [-0.04, 0.17]). Finally, the difference between Different and Same conditions regarding p_{BOTH} was at 0.05 (89% credible interval = [-0.01, 0.12]). Therefore, differently from other participant groups, 24-month-olds were slightly more likely to give both toys in the Different condition than the Same condition with unfamiliar toys (but chance values are marginally possible).

We compared the difference between the Different and the Same condition (D-S) across age groups. Regarding p_{NEW} , D-S was similar for 13- and 24-month-olds: the p_{NEW} -posterior was at -0.03 (89% credible interval = [-0.13, 0.21]). We interpreted this result as showing the same D-S across age groups since the mean was close to zero. However, D-S was different across age groups for p_{BOTH} . The p_{BOTH} -posterior was at -0.07 (89% credible interval = [-0.16 0.01]). The difference between the Different and the Same conditions was higher in 24-month-olds than 13month-olds (where no difference was found). Also, note that 24-month-olds were more likely to give both in the Different condition than in the Same condition.



Figure 2. Probability of giving the new object given that only one was chosen. Posterior distributions by condition, familiarity, and age. Gray diamonds indicate true means.

All the findings are summarized below (Table 5).

| TABLE 6 Which toy did the participants give to the requester? | | | | | |
|--|-----------|----------|--------------------------------------|-----------------------------------|--|
| Familiar toys | | | | | |
| | DIFFERENT | SAME | DIFF vs. SAME (p _{NEW}) | DIFF vs. SAME (<i>p</i> BOTH) | |
| 13-month-olds | new toy | new toy* | DIFF > SAME* | DIFF < SAME* | |
| 24-month-olds | new toy | new toy* | DIFF > SAME | DIFF < SAME | |
| Unfamiliar toys | | | | | |
| | DIFFERENT | SAME | DIFF vs. SAME (p _{NEW}) | DIFF vs. SAME (<i>p</i> BOTH) | |
| 13-month-olds | new toy* | chance | DIFF > SAME* | DIFF = SAME | |
| 24-month-olds | new toy | new toy | DIFF > SAME* | DIFF > SAME* | |
| * chance values (or no difference) are still marginally possible given credible intervals. | | | | | |

4. Discussion

Tomasello and Haberl (2003), Moll and Tomasello (2007) and Moll, Carpenter, and Tomasello (2007) showed that, in the face of ambiguous requests, infants tend to give to the requester the object they have *not* played with yet —i.e., the new toy. To give the new toy, infants had to associate the requester with the objects they already played with, so that these toys were disregarded as potential request goals. In our study, we wanted to scrutinize how infants encoded these objects. Specifically, they could have connected the requester to the *kind* of object they played with (e.g., "doll") or to the particular object (e.g., "*the* doll").

If infants connect the requester to kinds of objects, they should give the new toy in the Different condition: e.g., she played with "a doll", not with "a cat". However, they should give the

toys randomly in the Same condition: she played with "a doll", and the new toy is "just another doll". From a "kind-sense", the "new toy" is not new. Potentially, infants might even fail to tell the new and the old toy apart if their perceptual differences were not encoded. In contrast, if infants connect the requester to particular objects, they should give the new toy in both conditions since in none of them the requester had played with the new *particular* toy yet.

We tested infants with both familiar and unfamiliar kinds of objects. We used unfamiliar objects to disentangle whether kinds or perceptual contrast influenced infants' decision to give. Finally, we also tested different age groups expecting a developmental change. We will discuss each of our hypotheses next and see to what extent our findings support or contradict them.

4.1. First hypothesis: 13-month-olds associate agents with kinds of objects, not with particulars.

We expected 13-month-olds to give the new toy only in the Different condition, since it is a new kind of object and not merely a new particular. We found that infants were more likely to (i) give the new toy in the Different condition than in the Same condition and (ii) give both toys in the Same condition than in the Different condition (here, only in the case of familiar toys). These results are in line with our predictions, indicating that 13-month-olds connected the requester to the *kind* of object they played with before. Based on that, they disregarded the object as a potential request goal, giving the new kind of toy. However, contrary to our predictions, 13-month-olds still gave the new object above chance level when it belonged to the same kind —just not as often as in the Different condition. Therefore, infants could also connect the requester to the *particular* object she played with before, disregarding it as a potential request goal and giving the new particular toy. Differently from the Same condition with familiar objects, infants tended to give the toys randomly in the Same condition with *unfamiliar* objects. This seems to reflect an overall difficulty in giving the new toy when unfamiliar toys are involved. Even in the Different condition, where infants (1) gave the new toy above chance and (2) gave it more than in the Same condition, the results were not as strong as with familiar objects. Maybe infants' interest in exploring these unfamiliar toys hindered their capacity to identify and give the new toy overall⁹. However, infants randomly gave the toys in the Same condition because the lack of kind contrast made the encoding of the objects harder.

In principle, two alternative explanations might account for infants' stronger performance when objects belong to different kinds than the same kind. First, infants might more easily encode and remember the *kind* of toy they played with the experimenter, and think that she wants the new *kind* of toy. Specifically, in the face of different kinds of objects, infants might be more likely (1) to encode perceptual distinctions and tell apart the new and the old toy (e.g., Wilcox, Woods, & Chapa, 2008) and (2) to think that agents want the new kind of object (e.g., Spaepen and Spelke, 2007). This explanation is in line with suggestions that representations of kinds have priority in early development (e.g., Cimpian, 2016). Note that we used the same pairs of toys across conditions when objects were unfamiliar, and infants still showed a stronger performance in the Different condition. Therefore, it is about kind contrast and not merely perceptual contrast (see "4.3. Third hypothesis").

Alternatively, our stronger findings with different kinds of objects could be unrelated to infants giving priority to kinds. Rather, kind contrast was an "additional contrast" that helped them encode the objects. The Different condition introduced kind contrast *and* individual-specific

⁹ In fact, 13-month-olds' interest in exploring unfamiliar toys could have also reduced their willingness to give *any* toy, which is reflected in the reduced number of valid trials with unfamiliar toys compared to familiar toys (Table 5).

differences, while the Same condition only had individual-specific differences (e.g., spatiotemporal information and featural contrast). Thanks to having more "sources of contrast" in the Different condition, infants' performance was more robust than in the Same condition. In sum, kind contrast facilitated infants' object encoding because it was an "extra ingredient", not because it is "more special" than kind-unrelated differences.

Nevertheless, the findings with unfamiliar toys do not fit well the interpretation that kind contrast is just "an extra ingredient". With unfamiliar toys, infants gave the toys randomly in the Same condition. Consequently, kind-unrelated differences did not have any effect. Since the Different condition used the same pairs of objects, we have no reason to suppose that kind-unrelated differences had any effect in this condition either. Most likely, they gave the new toy only because of kind contrast. This might be true for familiar objects as well: even though they can encode particulars, kind-contrast could have relieved them from encoding other differences. In sum, infants seem to more easily connect agents to the *kinds* of objects they interact with than to particular objects of a kind.

4.2. Second hypothesis: later in development, 24-month-olds can associate agents with particular objects, not only agents with kinds of objects.

We expected 24-month-olds to give the new object in both the Different and the Same conditions, since both conditions introduce a new particular. Our findings with 24-month-olds were very similar to 13-month-olds. They tended to give the new toy above chance level in both conditions, which is in line with our hypothesis but no different from our youngest age group. Additionally, kind contrast also influenced 24-month-olds' performance: they were more likely to give the new toy in the Different condition than in the Same condition, regardless of familiarity.

Therefore, by their second year of life, infants are still more likely to connect agents to the kinds of objects they interact with than to particular objects of a kind.

We did find some particularities involving 24-month-olds' responses but they do not affect the interpretation above:

- Giving new (unfamiliar objects): differently from 13-month-olds, 24-month-olds gave the new object above chance level in the Same condition. We suggested that 13-month-olds' strong interest in exploring unfamiliar toys might have hindered their capacity to identify and give the new object in the Same condition. However, for being older, 24-month-olds might have been more capable of identifying and giving the new toy in this condition.
- Giving both (unfamiliar objects): differently from 13-month-olds, we found a probability difference between Different and Same condition among 24-month-olds. Also, they were slightly more likely to give both toys in the Different condition than in the Same condition —which we did not predict. However, this finding might not be very reliable, as the probability difference is only based on 13 trials (or 8% of all trials). As a comparison, with familiar objects, 24-month-olds gave both objects in 31 trials (or 18% of all trials) (see Table 5).
- Giving both (familiar objects): the difference between Different and Same condition was higher in 24-month-olds than 13-month-olds (even though both age groups gave two objects more often in the Same than in the Different condition). This age difference could be related to their capacity to handle the two objects at once: the familiar toys we used might have been a bit too big for 13-month-olds, making both-toys giving harder for this age group. Consequently, 13-month-olds could have been more prone to select one toy at random rather than giving both objects at once. Their difficulty to give two toys at once

might be responsible for their lower both-toys giving rates, i.e., 11% of all trials versus 18% in 24-month-olds (see Table 5).

4.3. Third hypothesis: infants' responses to ambiguous requests are based on kind contrast and not perceptual contrast.

If we had only tested infants with familiar toys, we would not know whether kind or perceptual contrast caused the differences between the Different and the Same conditions. Someone could have argued, for example, that a doll and a cat are perceptually more dissimilar from each other than two cats. Therefore, telling apart the new and the old toys could be harder the more perceptually similar toys are from each other. Also, infants could think that a perceptually more dissimilar new toy is more "novel" and therefore more likely to be the requester's target. In sum, perceptual contrast could have consequences regardless of the objects' kinds.

For this reason, we conducted experiments with unfamiliar toys and kept perceptual contrast constant across conditions (see Table 3). First, our findings show that, even though perceptual contrast was the same, infants of both age groups tended to give the new toy more often in the Different than in the Same condition. Second, 24-month-olds also tended to give both unfamiliar toys more often in the Different condition than in the Same condition. Even though we originally expected "Same > Different", our finding does not align with the perceptual contrast hypothesis, which would predict no difference. Finally, we found no difference in "giving both" rates for 13-month-olds. However, infants gave both toys in only 6% of the trials; this rate might have been too low to detect any difference (with familiar objects, 13-month-olds gave both toys in 11% of the trials; see Table 5). Therefore, the experiments with unfamiliar toys suggest that kind

contrast and not perceptual contrast produced the differences in infants' responses across conditions.

Someone could still argue that perceptual contrast in the Different condition is higher than in the Same condition even though the same objects were used —after all, different names and effects are also perceptually different. However, different reasons make this explanation unsatisfactory. First and foremost, names and effects are not accessible at the time of responding to help infants distinguish and give the new toy. Second, it is unclear why different colors, shapes, and textures would not produce the same responses in the Different and the Same conditions if only perceptual contrast grounded these responses. We suggest that these properties are not enough because, in our study, they are not cues of *kind contrast*. Wilcox and colleagues (2008) showed that infants distinguished two objects successively appearing from behind a screen just by their color as long as infants learned that those objects are different kinds of tools. Therefore, it is not about perceptual contrast *per se* but whether the perceptual contrast indicates different kinds of objects.

4.4. Summary of the findings

Previous studies (e.g., Tomasello and Haberl, 2003) have shown that infants can encode the experimenter's interactions with objects. Based on this knowledge, infants believe that the experimenter's request is about the object they have not yet played with together. We wanted to scrutinize how infants represent the connection between the experimenter and the objects they played with. We expected a sharp developmental change: priority of "agent-kind" encoding at 13 months of age and priority of "agent-particular" encoding at 24 months of age. However, our findings demonstrated a similar picture for different age groups. First, kind-based representations are more prominent at both ages. Second, although less robust, infans of both ages can encode "agent-particular" associations (except 13-month-olds when objects are unfamiliar).

4.5. Contributions to the current debate

We investigated whether infants represent relations between agents and kinds or between agents and particulars. No other study has addressed this question in infants except Spaepen and Spelke (2007). Our findings have some similarities and also some fundamental differences with theirs. Similarly to their study, infants are likely to build "agent-kind" connections. Based on this connection, infants tend to give the new toy in the Different condition more often than in the Same condition. For example, infants give the requester a newly introduced cat more often than a newly introduced doll if they previously played with another doll. However, in contrast with Spaepen and Spelke's (2007) study, infants did seem to represent "agents-particular" connections as well: they gave the new toy above chance level even if it was "just another doll", although less often than if it was "a cat". Maybe Spaepen and Spelke's (2007) looking time measure was not sensitive enough to detect "agent-particular" associations, since they seem less likely to be encoded than "agent-kind" associations.

Another potential issue in Spaepen and Spelke's (2007) study involves the interpretation of their findings as revealing "agent-kind" associations. The pairs "truck and doll" and "doll₁ and doll₂" are not only different regarding whether they belong or not to the same kind: they also show different perceptual contrasts. Intuitively, a truck and a doll are perceptually more dissimilar from each other than two dolls. Therefore, infants could have been surprised by seeing the agent switch her reaching to a "dissimilar object", but not a "similar object". We used the same pairs of unfamiliar toys across conditions to keep perceptual contrast constant and rule out this explanation. In line with the authors' suggestion, we found that kinds and not perceptual contrast base the infants' representation of the agents' object-directed goals.

Finally, our study was the first to investigate representations of "agent-object" associations across age groups. However, we did not find any fundamental age difference. Both 13- and 24month-olds seem able to connect agents to particular objects. Except for 13-month-olds with unfamiliar objects, infants tended to give the new object to the requester also in the face of objects of the same kind. However, their responses are more robust in the face of different kinds of objects, probably because "agent-kind" associations are more likely to be encoded than "agent-particular" associations. Future research could investigate whether, later in development, this asymmetry between kinds and particulars disappears, with children giving the new object equally often in the Different and the Same condition. Maybe older children are exposed to more situations where tracking specific objects matter, habituating them to encoding particulars as well as they encode kinds. Alternatively, children might need reasons to encode some particulars as well as kinds: the world has countless particulars, and keeping them and their individual features in mind might be too cognitively demanding. Consequently, children might be selective on the specific objects that they encode —e.g., if an item is owned by the agent, making the distinction between particulars potentially relevant.

5. Conclusion

To understand the social world, infants have to make sense of others' behavior towards themselves, other agents, and crucially, towards inanimate objects. Encoding others' relations with objects might help them understand the agents' interactions with them. For example, studies have shown that infants consider previous agent-object interactions when predicting the object an agent will reach for (Spaepen & Spelke, 2007; Woodward, 1998). From this perspective, revealing how infants encode agent-object relations could allow us to assess better how they interpret agents' behavior towards objects.

Previous studies found that infants consider whether the requester played with an object or not when deciding what to give after an ambiguous request (e.g., Moll & Tomasello, 2007; Moll, Carpenter, & Tomasello, 2007; Tomasello & Haberl, 2003). In these studies, infants specifically gave the object that the requester had not yet played with together —i.e., the "new object". However, it is unclear whether infants thought that the requester had not yet played with "that *kind* of object" or with "that *particular* object". For this reason, we used a similar paradigm but manipulated whether the new toy belonged to the same or a different kind. We found that 13- and 24-month-olds are more likely to give the new object when it belongs to a different kind than if it belongs to the same kind. This finding indicates that infants are more likely to encode relations between the agent and *kinds* of objects, giving the kind of object not yet connected to the agent. We also found that infants encode "agent-particular" relations, but they seem to happen less often than "agent-kind" relations.

Therefore, "agent-kind" relations seem easier to encode than "agent-particular" relations, in line with multiple studies suggesting that kinds have a special status for infants and children (see Cimpian, 2016, for a review). Overall, developmental studies have not yet paid attention to the contrast between kinds and particulars in how infants represent relations, so many questions are still open. For example, studies with older children and adults could answer how long the encoding advantage of "agent-kind" relations lasts and whether the probability of encoding "agent-particular" relations increases in particular circumstances. Additionally, we do not know whether, once encoded, "agent-kind" and "agent-particular" relations are equally *retained* —potentially, there might also be an asymmetry in retention as well, with "agent-particular" relations being more

easily forgotten. Addressing those questions could give us a better idea of how agent-object interactions can influence infants' expectations about others' behavior towards objects.

Chapter 4

The influence of object kinds in event encoding

1. Introduction

In our daily lives, we observe events that reveal what properties certain entities have, e.g., we see a toy squeaking and conclude that the toy squeaks. From very early in development, we show some capacity to encode and recall such dispositional properties. For example, in the study by Richardson and Kirkham (2004), 6-month-olds watched two objects, placed in different squares on the screen, making distinct sounds (e.g., "boing!" vs. "bing!") before disappearing. After that, the empty squares moved, and participants heard one of the sounds again. The authors found that infants looked longer towards the square that contained the object that played the sound (i.e., the critical location). Therefore, infants seem to have encoded at least two dimensions of the event: the sound's perceptual features and the current location of the square linked to the object that produced the sound.

The Richardson and Kirkham's (2004) study is connected to a broader discussion on "object files" (e.g., Kahneman et al., 1992; see Green & Quilty-Dunn, 2021, for a review). Object files are representations that "register" the features we observe on specific objects, such as the objects' sounds. Crucially, these files remain connected to their respective objects across location changes — the reason infants identified the sound's critical location even though the squares moved.

However, how infants' "files" connected to the objects is unclear. As Kirkham and colleagues (2012) noticed, Richardson and Kirkham (2004) did not explore whether the objects' features mediated this connection. On the one hand, infants could have connected "boing!" to "rattles". Then, in the test phase, they identified the critical location by (1) remembering that the sound is produced by a rattle and (2) remembering which location contained a rattle. In sum, *what* the objects were might have mattered. Infants could have had difficulties identifying where the

sound came from if both locations contained rattles, as remembering the locations with "a rattle" would not be enough: they would have to determine *which* rattle is the one that made a particular sound. On the other hand, infants could have directly linked the sound to the spatiotemporal object in a specific square. In this case, they would identify the critical location regardless of the objects' qualitative identities; something like "*the one* that makes 'boing!' was there". Since Richardson and Kirkham (2004) always used pairs of different objects, we cannot know whether object identity was relevant for infants' performance or not.

Kirkham and colleagues (2012) aimed to address this issue. In Experiment 2, the authors used identical-looking objects that produced different sounds. They found that 6-month-olds did not look longer towards the critical location after hearing a particular sound. They also compared 6-month-olds' performance with identical-looking and with different objects (Experiment 1), finding a significant interaction. Together, their findings indicate that, in 6-month-olds, object features mediate sound-location associations. They may remember that the sound was produced by "a rattle", but when both objects are rattles, they fail to determine where the sound comes from. Only at 10 months of age do infants look longer at the critical location in the condition with identical objects.

However, infants' success at 10 months of age in identifying the critical location regardless of condition (identical vs. different objects) can have different explanations. One possibility is that, at this age, infants started to associate files to spatiotemporal objects directly, and they do so regardless of whether the objects look identical (e.g. "rattles") or different (e.g., "rattle" vs. "cat"). Alternatively, they could still rely on the objects' different identities to encode and recall the sound events when identity contrast is available; nevertheless, they resort to direct associations with spatiotemporal objects when identity contrast is unavailable. From this perspective, qualitative identities would mediate "object-sound" associations by default and potentially facilitate event encoding and recalling.

The present study asked whether object identity contrast facilitates event encoding and recalling in *4-year-olds* —therefore, way older than Kirkham and colleagues' (2002) participants. The assumption is that "object-file" associations could be mediated by identities at an older age. We specifically focused on kind contrast, as multiple studies show that early cognition gives "special attention" to kinds, including a more accurate memory for properties they connect to kinds than individuals (see Cimpian, 2016, for a review). In this sense, remembering that a rattle makes "boing" and a cat makes "bing" could be easier than remembering which sounds specific rattles make. Analogously, it could be easier to remember the locations of "a rattle" and "a cat" than "the one that makes boing" and "the one that makes bing". Even if children identify the critical location whether the events involve identical or different kinds of objects, they could make fewer mistakes when different kinds of objects are involved.

Our experimental design was inspired by Kirkham, Richardson, Wu, and Johnson (2012), and Richardson and Kirkham (2004). Children watched events with pairs of objects playing different sounds and moving with the rhythm. In the test phase, with the objects out of their view, they heard one of the sounds again. They were asked to indicate the box with the object making the sound¹⁰. Crucially, the participants were exposed to both pairs with different kinds of objects (e.g., a duck and an apple) and pairs with identical objects (e.g., two identical-looking bunnies) (within-subject). We expected them to succeed in both conditions, selecting the critical location

¹⁰ Differently from Kirkham's studies (e.g., Kirkham and colleagues, 2012), we explicitly instructed children to indicate the location of the sound. We conducted a pilot version without explicit instructions, measuring first look and looking time. However, children did not seem to look towards any particular location and disengaged very easily as they had no explicit goal to pursue.

above chance. However, we hypothesized that children would make fewer mistakes identifying the critical location when the objects were different than identical.

2. Methods

The experiment was conducted online given COVID-related restrictions. Even though it was inspired by Kirkham, Richardson, Wu, and Johnson (2012) and Richardson and Kirkham (2004), our design has crucial differences. First, in the original studies, each participant repeatedly watched multiple identical videos throughout the session: the infant watched the same pairs of objects producing the same sounds in the same order, and the objects' locations were always the same in the test phase. In contrast, we varied the trials for our 4-year-old participants (see 2.6. Counterbalancing). We were not interested in seeing whether children can index sound events to locations after prolonged training. Instead, we wanted to compare their performance across conditions (different vs. identical objects) without training to see which situations were more easily encoded.

The second difference from Kirkham and colleagues' studies is that we did not want the two objects to "magically" appear and disappear on the screen. In their paradigm, during the familiarization phase, the objects appeared on the screen every time they made a sound and disappeared in thin air when inactive. Then, in the test phase, infants heard a sound while the objects were absent. We thought that the objects' frequent appearances and disappearances could confuse children, so they always remained on the screen. Before the test phase, children saw the objects being covered with boxes. Therefore, we blocked visual access to the objects without disrupting their spatiotemporal representation. The idea that a sound comes from a specific location seems more feasible this way, as it can still be linked to a hidden object.

Third, instead of just having objects in the scene, an experimenter ostensibly showed them at the beginning of each trial. Specifically, children heard the experimenter saying "look!" while she held an object at the center of the screen. Next, she placed the object on one of the shelves and repeated the procedure with another item (see 2.5. Procedure). We introduced the objects this way (1) to promote the participants' encoding of the objects' kinds (evidence indicates that communication promotes encoding of object features; Marno et al., 2014; Yoon et al., 2008; Shamsudheen, 2020) and (2) to increase their attention and engagement with each video via childdirected speech. The experimenter was also present in the video when covering the objects with boxes, and her voice was heard in the test phase asking to indicate the box the sound comes from. Throughout the movies, only the experimenters' hands and arms were seen.

2.1. Participants

We analyzed 32 4-year-olds from Budapest, Hungary (mean age = 4 years 3 months; range = 3 years 10 months to 4 years 11 months). Five additional participants were excluded either for failing to complete the second single-object trial (N = 3) or for not having at least two valid trials per pair type (N = 2). Children were recruited through the participant database of the Cognitive Development Center at the Central European University, and they were native Hungarian speakers. The parents of the children received *Bookline.hu* vouchers to purchase children's books online for their participation. This study was approved by the United Ethical Review Committee for Research in Psychology (EPKEB).

2.2. Apparatus

This study was conducted online. We used two online apps: "Slides" to exhibit the movies, and "Zoom" to record the parents' consent. In addition, we used "QuickTime Player" to record the experiment.

2.3. Stimuli

Participants watched 10 movies: 2 with a single object (duration = 35 seconds each) and 8 with two objects (duration = 52 seconds each). We describe their structure below (see Table 1 for an illustrated summary).

Each movie had two parts: familiarization and test phase. The familiarization phase displayed two shelves vertically aligned on a green wall. Children either watched an experimenter introduce a single or a pair of objects (one item at a time). She held each object at the center of the screen, showed it from different angles, and said, "look!". After showing an object, the experimenter placed it on one of the shelves. Only the experimenter's arm and hand were visible. The single object trials contained a phone (first trial) and a plush dog (second trial). The pairs were: a duck and an apple, two identical bunnies, a cup and a banana, and two identical cars, introduced trial by trial in a randomized order (see 2.6. Counterbalancing).

Once all objects were on their respective shelves, the experimenter removed her hand from the scene. At this moment, each object played a unique, 3-second-long musical sound and synchronously moved with the rhythm. The objects played their respective sounds 3 times; in the case of pairs, the items played alternately (6 sound events in total). The sounds played by each object of a pair always contrasted in two dimensions: rhythm and musical instruments (e.g., the duck played drum-based music, and the apple played harmonica-based music). Therefore, the two objects within a pair played very distinct sounds from each other.

After the objects played their sounds, children observed the experimenter's hands entering the scene with two identical-looking boxes to cover the objects. In the case of single-object videos, the experimenter covered the object and the empty shelf. The green background darkened completely so that only the boxes were visible. Then, the boxes revolved around the screen center clockwise or counterclockwise (counterbalanced), stopping when horizontally aligned. An attention-getter (a rotating star) appeared at the center-top of the screen with the short sound of a water drop. While the star was visible (duration = 3 seconds), children heard the experimenter's voice again, asking the following question: "where does the sound come from?". Afterward, one of the sounds children heard during the familiarization phase played again (duration = 4 seconds). The boxes remained visible for 4 more seconds and disappeared with the movie's end.





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sound come from?". The question is followed by one of the sounds from the familiarization phase (duration = 4 s; j; musical symbols were not presented). The boxes remained visible for 4 more seconds after the sound and then disappeared.

2.4. Design

The session comprised 10 trials: 2 single-object trials and 8 two-object trials. Two-object trials either had a pair of identical or different kinds of objects (factor 1: pair type; within-subject design). The two-object trials were divided into two blocks: we used four distinct pairs in the first four trials and used them again in the last four trials. Even though the same pairs were used across blocks, their test phase was different: if object A's sound played in the test phase of the first block, object B's sound played in the test's second block, and vice-versa. Therefore, the critical location changed across videos with the same object pairs so that children would fail to respond correctly if they just repeated their response for the particular object pair.

In addition, the trials were also different as to whether or not the sound that played in the test phase was the same sound that played last during familiarization (factor 2: sound recency; within-subject design). For example, children saw a particular object playing before the boxes occluded the pair; then, in half of the trials, children heard this object's sound during the test phase ("recent"), while the other half heard the other object's sound ("old"). Arguably, identifying the correct box could be harder in "old" than "recent" trials. Therefore, we intended to check whether differences between par types (different vs. identical) would be influenced by sound recency.

2.5. Procedure

Children participated from their homes through Zoom in the presence of their caregivers. The experimenter conducted the 15-minute-long sessions in their native language (Hungarian). Before the beginning of the session, the experimenter explained to the children that they would "play a fun game with special toys that play fun music" and that all they have to do "is show in which box they are".

The first trial aimed to familiarize children with the game. Children watched a video with a single object (a phone) making a specific sound and were told to indicate where the sound comes from in the test phase. Given that just a single object was present, all the child had to do was to point at the box containing the object. In case of wrong or no response, the experimenter mentioned the mistake and repeated the trial until children selected the correct box. Five out of 32 subjects needed to repeat this trial (one of them three times).

The second trial aimed to exclude children who fail to identify the object's location even if one object is present. Children watched a black plush dog making a specific sound. Everything else was the same as in the first trial, except that the object had a different location in the test phase. Children had only one chance to identify the object's location successfully, and no feedback was given. The experimenter continued with the session if they failed, but we excluded them from the analysis (see 2.7. Coding).

The second trial was followed by two blocks of 4 two-object trials (N = 8 trials in total). Before starting it, the experimenter praised the children's performance and said that the game would change. She said that they were "prepared to play the real game" with two toys and that their goal was to find the box with the toy playing music. After that, children watched and responded to the first 4-trial block without any feedback about their responses. The experimenter praised them at the end of the block but said they made some mistakes. She justified the second block as "a chance to improve". It developed as the first block, with different sounds playing in the test phase (consequently, the critical location also changed).

2.6. Counterbalancing

We did not counterbalance single-object trials. In the first trial, participants watched the experimenter placing a cell phone on the bottom shelf, and in the test phase, the cell phone was located in the right box. In the second trial, children watched the experimenter placing a plush dog on the top shelf, and in the test phase, the dog was located in the left box.

Two-object trials were counterbalanced across participants. In common, each child watched trials that were equally distributed regarding (1) pair type (identical, different), (2) event recency (recent, old), (3), target's box (left box, right box). However, we varied the trial order for each of these dimensions (trial blocks are indicated with parentheses):

- Pair type (different, identical):
 - (1) (D, I, D, I), (D, I, D, I); or

(2) (I, D, I, D), (I, D, I, D).

• Event recency (recent, old) across trials:

(i) (R, O, O, R), (R, O, O, R); or

- (ii) (O, R, R, O), (O, R, R, O).
- Target side (left, right) across trials:

(a) (L, L, R, L), (R, R, L, R); or

(b) (R, R, L, R), (L, L, R, L).

We crossed (1-3), generating 8 different trial sequences (e.g., 1-i-a, 1-ii-a, 1-ii-b, 1-ii-b, etc.). In addition, we counterbalanced the object pairs themselves, doubling the number of sequences to 16. We had four pairs: (A) duck and apple, (B) two identical bunnies, (C) cub and banana, (D) two identical cars. By varying pairs, counterbalancing sequences such as (D, I, D, I), (D, I, D, I) could be either (A, B, C, D), (A, B, C, D), or (C, D, A, B), (C, D, A, B).

2.7. Coding

We measured children's correct box selections via pointing or labeling (e.g., "right"), only including trials where children selected one of the boxes. Trials that children pointed at both boxes or selected a box after the box disappeared were considered invalid.

All the sessions were filmed online and fully coded by the author. A second experimenter coded 20% of the participants. Coders discussed unclear cases and disagreements until they reached an agreement.

3. Statistical Analysis

To test whether pair type (being identical or belonging to different kinds) impacted children's selection of the critical location upon hearing a sound event, we constructed a series of generalized linear mixed models (GLMM). Object pair type (Identical vs. Different) was a fixed effect predictor. We included children's ID as a random effect to account for repeated measures within individuals. To control for the effect of the recency of the sound event over the selection, we generated a complex model (m1), which included object pair type and sound recency in the intercept and included the interaction between these conditions. Factor labels were transformed to numerical variables and centered before the analysis.

We constructed a reduced model (m2) removing Object type from the intercept to achieve model convergence. Subsequently, we constructed a simplified model (m3) and additionally removed the interaction between sound recency and object type. The reduced model (m2) and simplified model (m3) failed to converge. For this reason, we constructed two additional generalized linear mixed models (GLMM) and included object pair type (Identical vs. Different) as a fixed effect predictor and children's ID as a random effect. With these models, we wanted to test whether Identical and Different trials were different *within* Recent (m4) and Old (m5). Models 4 and 5 did not converge, therefore are uninterpretable.

Finally, in order to assess whether there was a difference in the share of successful and unsuccessful trials within each Object Type and Sound Recency, four additional models were constructed: Identical-Recent (m6); Identical-Old (m7), Different-Recent (m8), and Different-Old (m9). These models test whether success in each of these four cases is above chance. Two of these four models (m6 and m9) converged and are as such interpretable, while models m7 and m8 failed to converge and thus are uninterpretable.

4. Results

We constructed a series of generalized linear mixed effect models to test whether there is a significant effect of pair type, sound recency, and their interaction on the performance. The results are displayed in **Table 1**. However as the models did not achieve convergence, significant results such as the interaction between Object type and Sound recency in m1 should be considered uninterpretable. Note also that the evaluation of the z-values indicated no main effect of Object type.

| Table 1. Results omodels | f generalized linear | r mixed effect analy | sis: complex, reduce | ed, and simplified |
|--------------------------|----------------------|------------------------|----------------------|--------------------|
| | β | SE | Z | р |
| Complex model (n | n1)† | | | |
| Intercept | 0.484 | 0.223 | 2.167 | 0.03 * |
| Object type | -0.032 | 0.304 | -0.106 | 0.92 |
| Sound recency | 0.220 | 0.315 | 0.699 | 0.48 |
| Object: Sound | -1.389 | 0.595 | -2.334 | 0.02 * |
| Reduced model (m | 12)† | | | |
| Intercept | 0.484 | 0.223 | 2.169 | 0.03 * |
| Object type | -0.026 | 0.297 | -0.086 | 0.93 |
| Sound recency | 0.215 | 0.312 | 0.690 | 0.49 |
| Object: Sound | -1.387 | 0.594 | -2.333 | 0.02 * |
| Simplified model (| (m3)† | | | |
| Intercept | 0.469 | 0.218 | 2.156 | 0.03 * |
| Object type | 0.025 | 0.289 | 0.088 | 0.93 |
| Sound recency | 0.217 | 0.307 | 0.709 | 0.48 |
| † model did not co | onverge, and thus si | ignificant results are | uninterpretable | |

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To further explore whether there was a difference between pair types (Different vs. Identical) according to sound recency (Recent vs Old), we constructed two additional models: m4 (Recent), and m5 (Old). Similar to models 1-3, m4 and m5 failed to converge, thus being uninterpretable. The evaluation of the z-values indicated no main effect of Object type within either the Recent or Old. Results are presented in Table 2.

| Table 2. Results of generalized linear mixed effect analysis by Sound recency | | | | | |
|---|--------|-------|--------|--------|--|
| | β | SE | Z | р | |
| Recent sound condition (m4) [†] | | | | | |
| Intercept | 0.034 | 0.260 | 0.131 | 0.90 | |
| Object type- Identical | 0.587 | 0.400 | 1.467 | 0.14 | |
| Old sound condition (m5) [†] | | | | | |
| Intercept | 1.067 | 0.490 | 2.176 | 0.03 * | |
| Object type- Identical | -0.881 | 0.516 | -1.709 | 0.09 | |
| † model did not converge therefore significant results are uninterpretable | | | | | |

Finally, we evaluated whether there was a significant difference in the share of successful and unsuccessful trials among each of the four cases: Identical-Recent (m6), Different-Recent (m7), Identical-Old (m8), Different-Old (m9). These models test whether there is a greater likelihood of success over chance in each case. Results are presented in **Table 3**. Models m6 (Identical-Recent) and m9 (Different-Old) converged and yielded interpretable results, indicating a greater likelihood of successful trials over unsuccessful trials. Models m7 (Different-Recent) and m8 (Identical-Old) failed to converge and therefore are uninterpretable. The evaluation of the z-values indicated that the share of successful trials is not significantly greater than unsuccessful trials in Recent-Different and Old-Identical cases. A visualization of performance in each sub-condition is presented in Figure 1.

| Table 3. Results of generalized linear mixed effect analysis within Object type-Sound Recency sub-conditions. | | | | | |
|--|-------|-------|-------|--------|--|
| | β | SE | Z | р | |
| Identical-Recent (m6) | | | | | |
| Intercept | 0.620 | 0.305 | 2.031 | 0.04 * | |
| Different-Recent (m7)† | | | | | |
| Intercept | 0.034 | 0.260 | 0.130 | 0.90 | |
| Identical-Old (m8)† | | | | | |
| Intercept | 0.138 | 0.263 | 0.525 | 0.60 | |
| Different-Old (m9) | | | | | |
| Intercept | 0.897 | 0.410 | 2.185 | 0.03* | |
| † model did not converge, and thus results are uninterpretable | | | | | |



Figure 1. Average selection of critical location per pair type (Different vs. Identical) and sound recency (Old vs. Recent). Children selected the critical location above chance level for different objects and old sound, and for identical objects and recent sound. No difference across conditions was found.

5. Discussion

The present study investigated whether object kinds influence event encoding in 4-yearolds. Children watched events where pairs of objects, either identical or of different kinds, alternately played different sounds and moved with the rhythm. In the test phase, they heard one of the sounds again while boxes covered the objects. The "game" consisted of identifying where the test sound came from, the box on the left or the right.

We expected children to succeed regardless of condition (identical vs. different kinds) overall. However, we predicted that they would make fewer mistakes with different kinds of objects than identical objects. Cognition seems to prioritize kinds (see Cimpian, 2016, for a review), and recalling that a rattle makes "boing" and a cat makes "bing" could be easier than remembering which sounds specific rattles make. Analogously, it could be easier to remember the

locations of the different kinds of objects than the locations of "the one that makes boing" and "the one that makes bing".

We also manipulated sound recency: whether the sound children heard in the test phase was the last sound they heard during familiarization ("recent") or the one that preceded it ("old"). We expected "old" to be harder than "recent" for selecting the critical location: the longer time span could affect children's sound recalling and sound-object mapping. In this sense, "old" trials could either hinder children's performance in the identical and different trials equally or more prominently in identical trials, which we expected to be harder than different trials for event encoding and recalling.

Our task turned out to be harder than we had assumed. Children only selected the critical location above chance in two situations: First, when the objects were different and the test sound was "old" (for short, "different-old"); Second, when the objects were identical and the test sound was "recent" ("identical-recent"). We expected children to generally select the critical location above chance, although we predicted they would perform better in the Different than in the Identical condition. We did not find any difference between Different and Identical, not even when we compared them separately for "old" and "recent".

In principle, the fact that children succeeded in "different-old" but not "identical-old" aligns with the hypothesis that event encoding is easier with different objects than with identical objects. However, this does not explain why children did not succeed in "different-recent". For some reason, children could have encoded better the kinds of objects that they watched playing music first. For example, if the duck played music second to last, it was also the first object to play in the trial —which might have favored the encoding of the sound-kind association and facilitated children's performance in "old sound" trials. We are unaware of any study reflecting about and

exploring order effects in children's learning about kinds of objects, so further research is needed to ground this interpretation.

The fact that children succeeded in "identical-recent" but not "identical-old" aligns with the hypothesis that tracking spatiotemporal objects and recalling sounds directly connected to them is not trivial: the longer the time span is, the harder it is to identify the location of the object that makes the sound. Additionally, our findings might indicate that children do not rely on direct connections between sounds and spatiotemporal objects for pairs with different objects. If this was the case, analogously to identical objects, they should have succeeded in "different-recent" and not in "different-old". However, note that comparisons between pair types did not reveal any significant difference, even when distinguished by sound type. Therefore, the hypothesis that children use different representational strategies depending on the presence or absence of kind contrast has only partial support from our findings.

6. Conclusion

Children regularly observe events that reveal what properties particular objects have, e.g., they see a toy squeaking and conclude that it squeaks. Kirkham and Richardson (2004) found that infants as young as 6 months of age already show some capacity to encode and recall such dispositional properties. From the perspective of the object file theory (Green & Quilty-Dunn, 2021), their participants seemed to (1) "register" the sound events into different "representational files" and (2) link these files to the objects that produced the sounds.

However, their study did not clarify how files connected to their objects (Kirkham et al., 2012). On the one hand, the objects' qualitative identities could have mediated these connections. For example, infants could have connected a "boing" sound to "rattles"; then by remembering where the rattle is hidden (instead of, say, the cat), they can infer where the "boing" sound comes

from. On the other hand, infants could have directly connected the sounds to the spatiotemporal objects, thinking that "the *one* that makes 'boing!' is hidden there" regardless of their qualitative identity.

Kirkham and colleagues (2012) found that qualitative identities mediate object-sound connections in 6-month-olds. Specifically, infants successfully identified where the sound came from when the hidden objects belonged to different kinds (e.g., a rattle and a cat) but not when they were identical (e.g., two identical-looking rattles). By 10 months of age, the featural contrast was unnecessary to succeed: infants identified the sound's spatial source whether the objects looked identical or different. However, we do not know whether they associated files to spatiotemporal objects directly across conditions or if they were "forced to do so" only when objects were identical. In short, qualitative identities could still mediate "object-sound" associations by default and facilitate event encoding and recalling even at an older age.

Through a paradigm inspired by Kirkham and colleagues (2012) and Richardson and Kirkham (2004), this study tested 4-year-olds' representation of two types of object files: one where kinds mediate "object-file" associations, and another where objects and files are directly connected. If kinds mediate and facilitate object-file associations, children should make fewer mistakes identifying the source of a sound when the hidden objects are different than identical. However, children should show similar performance across conditions if files are directly connected to objects regardless of their identity.

Our findings were not entirely consistent with any of the hypothesized object file representations. In principle, kinds seemed to facilitate encoding and recall of object-sound associations. Children succeeded with different objects, but not identical objects, in more demanding trials —namely, when the time between the moment they heard the sound in the test phase and the last time they heard it during familiarization was longer. However, in less demanding trials, children failed with different objects and succeeded with identical objects. This outcome is unexpected whether children connect sounds to objects directly or through kinds —in both cases, children should have succeeded with different objects. We might need lab-controlled experiments and potentially more participants to see whether these findings are replicated (in which case, we currently lack an adequate interpretation for them) or whether they were just the byproduct of a potentially noisier online procedure.

Chapter 5

Factors driving children's motivation to learn about individuals*

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1. Introduction

From trains to sea creatures, young children's knowledge about the living and non-living world around them is truly remarkable. Children do not acquire this knowledge by passively soaking it up — rather, they actively seek out new information from their environment. The world is abundant with information, and at any given moment children can choose to learn about any number of things in their surroundings. How is it that children decide what it is to be learned? Though developmental psychology has made large strides in uncovering what children know about the world at various points in development, we lack a complete understanding of what children are motivated to learn about and, more importantly, *why* (for a review, see Ronfard et al., 2018).

In recent years, it has become clear that children are drawn to learn about kind-relevant information. For example, Cimpian and Park (2014) have shown that when given the choice to learn about kinds of entities (e.g. "Do you want to learn about pangolins?") or individual entities (e.g., "Do you want to learn about this pangolin"), children chose to learn about kinds. Interestingly, this was true even for objects children were already familiar with, like frogs and giraffes — suggesting that children's preference to learn about kinds of objects over specific objects is robust. This preference has been argued to reflect a universal cognitive bias towards kinds and kind-relevant information and serves as a "guide" for children in their immense challenge of deciding what to learn (see Cimpian, 2016, for a review).

Why might children be drawn to learning about kinds of entities? To address this question, it is fundamental to understand the importance of kinds for behavior and cognition. Kinds are useful for organizing the staggering diversity of entities in the world —from classifying two very different-looking creatures as "dogs" to distinguishing similar or even identical-looking entities into different categories, like edible and non-edible plants. This classification of the world, which

is to a great extent perceptually arbitrary, indicates one of the fundamental functions of kinds: not merely to distinguish entities by their appearance but, instead, by their "essence" (Gelman, 2003; but see Noyes & Keil, 2019). Kind-based essences lead us to expect that members of a kind should commonly produce a particular behavior or have a certain function — for example, we think that dogs should bark "because they are dogs" and knives should cut "because they are knives" (Prasada, 2000). In this sense, by seeking information about kinds, children might be trying to discover those properties that entities are supposed to have just for belonging to the kinds they belong to.

Crucially, however, kind-essential properties should not be confused with statistically prevalent properties. For example, even though a majority of Canadians are right-handed, people consider the generic statement "Canadians are right-handed" to be false, arguably because they do not think that right-handedness is an essential property of being Canadian (Prasada et al., 2013). And the opposite also holds: even though most sharks do not bite swimmers, people believe that the statement "sharks bite swimmers" is true (Prasada et al., 2013). Kind-based essences tell us about "propensities" or "inclinations": we expect instances of a kind to behave according to their essence, regardless of whether they actually do. Indeed, people tend to treat instances that violate expectations about their kinds as *exceptions* (Prasada, 2000). Children hold the same expectations. For example, when they are taught that toys from a novel category, "blickets", are magnetic, they persevere in trying to make other blickets work as magnets — even in the face of clear evidence that the new blickets are not magnetic (Butler & Markman, 2012; Butler & Tomasello, 2016).

In sum, kinds relieve us from the need to discover what each new particular instance "is up to" when we encounter it, because we attribute kind-based essences to them (Ferguson & Waxman, 2017). However, despite their fundamental importance, we do not only represent, create expectations, and care about entities because of their kinds. Our cat is not equivalent to others', even if they look virtually the same: we attribute a unique importance to them, and expect them to have unique habits, skills, and other idiosyncrasies. We value original paintings more than replicas and ascribe special meaning to specific places based on unique memories we hold there. These ordinary examples highlight that individuals themselves are often relevant for reasons *beyond their kinds* — we think and care about them as individuals in and of themselves (Bloom, 2000; Newman & Bloom, 2012). Consequently, a theory on conceptual development should also go beyond why children learn about kinds of entities: any comprehensive theory of conceptual development must also account for why children seek out and learn specific information about particular individuals in their environment.

To date, the literature on children's propensity to learn about kinds does not help us understand children's potential interest in individuals in and of themselves. More specifically, we know little about the factors that drive young learners to seek out specific information. Specific information can provide a richer, more fine-grained understanding of an entity: the expectations and value we attach to individuals are often not only informed by their kinds, but also by the idiosyncratic information we connect to them. Understanding the factors that motivate children to learn specific information will elucidate how we end up representing and learning about individual entities in the world.

The goal of the current study is to reveal which factors lead children to seek out specific information about individual entities. We propose that children will be driven to learn specific information in at least two situations. First, children may seek out specific information when they believe that a particular entity is unambiguously connected to them, like their cat or favorite cup. Specific information is valuable in these contexts because holding fine-grained knowledge about these entities might help children navigate their world more effectively —for example, by giving them more precise expectations about their cat's behavior, or helping them distinguish their favorite cup from others'. Given that holding fine-grained knowledge about each and every entity in the world is unfeasible, children should prioritize entities that are recurrent, or might become "protagonists", in their everyday lives.

While there are many factors that connect children to particular entities, in this study, we focus on **ownership**. Ownership is a relational concept that connects children (i.e. the owners) to their objects (i.e. owned entities) and has been shown to affect how children represent and reason about entities. For example, Gelman and colleagues (2012) found that children prefer toys an experimenter tells them are theirs over identical replicas¹¹. Additionally, children show enhanced memory for their own objects, re-identifying them after a delay (Gelman et al., 2014) and recalling distinctive features (e.g., a pencil mark) that separate their object from replicas (Gelman et al., 2016). Children track the history of owned objects even when those objects are undesirable (e.g., a plain piece of wood), or cannot be distinguished from other same-kind tokens (e.g., one of several identical items; (Gelman et al., 2016). Moreover, children are better able to track novel objects that are owned by them (i.e., "This is yours!") compared to novel objects that are introduced to them in non-specific ways (e.g., as exemplars of a kind; "This is *a toma*"), suggesting that ownership grants objects a special status in reasoning and memory (Gelman et al., 2014). Here, we hypothesize that ownership will also affect children's information-seeking behavior and

¹¹ Note that ownership is not always enough to make them prefer an object over replicas. For example, Gelman and Davidson, 2016, have shown that children are attached to *some* of the toys that they own (for example, toys they sleep with), preferring them more than newer replicas. In these cases, it seems that what connects them to their toys in a special way is their shared history, a history that they interpret for whatever reason as valuable. For the present discussion, however, it is enough to say that ownership alone might lead to greater liking of the owned object (aka "endowment effect"; e.g. Hood et al., 2016).

consequently, they will be more interested in acquiring fine-grained information about objects they own than about objects that they do not own.

A second factor that might motivate children to seek out specific information is familiarity with an object's kind. If children believe that they know enough about the category of a particular entity, but know nothing about specific individuals *within* that category, they may be compelled to learn specific information about that individual. For example, if given a choice to learn specific or kind-relevant information, children may be more interested in learning about *a particular* cat or ball, rather than about cats or balls in general. Because children already know the essential properties of familiar kinds, like cats or balls, they might choose to learn whether an individual cat or ball is, for whatever reason, particularly interesting or special. After all, such knowledge might potentially inform their future thinking or behavior — for example, knowing specific information about a cat or a ball may help them recognize that particular cat or ball in the future, or differentiate that cat or ball from others.

In the current study, we will also explore whether **category familiarity** impacts children's motivation to seek out specific information. Note that the effect of familiarity was also explored in Cimpian and Park (2014)'s original investigation of children's drive to learn about kinds versus individuals. Their results revealed that children prefer kind-based over specific information regardless of whether the entities were familiar (e.g., a giraffe) or novel (e.g., a pangolin) for the children. However, in this design, the researchers treated familiarity as a binary construct. This is problematic because in the real world, familiarity is often a spectrum: a child might know some things about giraffes, for example, that they have long necks and are found in zoos, but still not know *all* of their defining features, such as what they eat and where they can be found in the wild. In short, giraffes might only be familiar *to some extent*. Therefore, in (Cimpian & Park, 2014), it

is possible that children sought out kind-based information about familiar animals because even though children knew *some things* about these animals, acquiring additional kind-based information may be useful for gaining a broader understanding of their essence.

In sum, merely being acquainted with a kind of entity might be insufficient to reduce children's interest in kind-based information: they also have to believe that they already know what is most relevant about the kind —that is, that they already know its *essence*. When it comes to animals, there is no singular fact that defines their essence: children consider a wide range of facts to be fundamental for animal categories, like food preferences, typical habitats, etc. (Greif et al., 2006). In contrast, the essence of other types of entities is not as multi-faceted and may be more narrowly captured by a single, overarching attribute. Compared to animals, the essence of *artifacts* may be more clearly defined: children think that an artifact's function is *the* defining property of that artifact (Greif et al., 2006) and that artifacts were designed for a single purpose (Kelemen & Carey, 2007). In this way, artifact familiarity may be seen as more binary: they are either familiar or not.

Thus, in the current study, we explore whether **entity type** interacts with entity familiarity to influence children's information-seeking behavior. When confronted with familiar artifacts with known functions, children might think that they already know what is most important about those artifact kinds. Therefore, we hypothesize that children will be more likely to choose to learn specific facts about familiar artifacts compared to novel artifacts with unknown functions. In contrast, since children are less likely to know all the essence-defining facts about familiar kinds of animals, we hypothesize that children will seek out specific information for novel and familiar animals at similar rates.

To test the effect of ownership (owned by the child or not), familiarity, and entity type (animal or artifact) on children's motivation to learn specific versus kind-based information, we developed an online paradigm based on Gelman and colleagues (2012; 2014), and Cimpian and Park (2014). In each trial children are presented with trios of identical items (e.g., three identical cats). The experimenter begins the trial by telling the child who each item belongs to: one cat belongs to the child, one to the experimenter, and the third one belongs to nobody. The crucial phase of the study is when children are asked if they "want to find out something new and cool "about cats" (i.e. a *kind-based* fact about the kind) "or... something cool about [*my*, *your* or *nobody's*] cat?" (i.e. a *specific* fact about an individual). Whether children are asked about their item, the experimenter tells them a novel, kind-based fact about cats (e.g., "cats jump as high as an elephant!"); if they choose to learn a specific fact, the experimenter tells them the same fact, but in a specific form (e.g., "my cat jumps as high as an elephant!"). The trios' entity type (artifact vs. animal) and familiarity (e.g., cars vs. blickets) is counterbalanced across trials.

We expect ownership, familiarity, and entity type to act as "gravitational poles" attracting children's interest towards specific facts and away from kind facts. When given the choice between learning specific or kind-based information, we predict that children will request more specific information about owned entities than about unowned entities [Hypothesis 1: *Ownership Status*]. While ownership alone might not be strong enough to remove children's kind-bias altogether (i.e. it is still possible they request kind-information at above chance levels), we hypothesize that, when objects are owned by the child, individual information becomes more highly prioritized. Analogously, we predict that children will request more specific information about familiar artifacts than about unfamiliar artifacts [Hypothesis 2: *Familiarity and Entity Type*]. We do not

expect to find such a preference for specific information when asked about familiar versus unfamiliar animals because, as outlined earlier, children might believe that important kind-based facts about familiar animals are still unknown. Together, we aim to uncover key factors that motivate children to learn about individuals —and, more broadly, to lay the groundwork for future research on what motivates children to learn information that is not about kinds.

2. Methods

2.1. Sample size planning and power analyses

Drawing on Cimpian and Park (2014), the closest and most informative study to date for the current research, we anticipated a small- to medium- effect size to emerge (Cohen's d = .35). A power analysis using G*Power found that to detect a small - to medium- effect (partial eta squared = .04) with 90% power in a within-subjects ANOVA with interactions and main effects (alpha = .05, and non-sphericity correction = 1) 55 participants were needed.

2.2. Participants

Fifty-five children participated in this study (an additional three were tested but failed to meet the inclusion criteria, see below). Children were recruited through the participant database of the Cognitive Science Department, at the Central European University in Budapest, and they were native Hungarian speakers (mean age = 4.86 years, range 4.17 years - 5.75 years; 58% girls). We selected this age group as it represents the time at which children are just beginning formal schooling in Hungary and is consistent with past research on children's preferences for seeking out kind versus specific forms of information (Cimpian & Park, 2016). This study was approved

by the United Ethical Review Committee for Research in Psychology (EPKEB; reference number: 2021-53).

Parental and child consent were obtained prior to the study. For their participation, children received *Bookline.hu* vouchers to purchase children's books online.

2.3. Stimuli and Procedure

We selected 12 cartoon-like pictures: 6 animals and 6 artifacts (see Figure 1). Half the pictures were likely to be familiar, and the other half were novel. All items were labeled during the study. For novel items we selected six CVCV Hungarian-sounding novel words, previously used in word-learning tasks (Pomiechowska & Csibra, 2020). The approved Stage 1 version of this protocol was published on Open Science Framework prior to the onset of data collection (https://osf.io/4d3jg/).

| Experimental Factors | Familiar Animals | Unfamiliar Animals | Familiar Artefacts | Unfamiliar Artefacts |
|-----------------------------|---|---|--|--|
| Child Owned Items | | | | |
| | Kind Fact : Dogs can understand more than 200 words. | Kind Fact: Modis eat on their bellies as if they were tables. | Kind Fact : Guitars were created 3.500 years ago. | Kind Fact: Blickets can paint toys. |
| | Specific Fact : Your dog can understand more than 200 words. | Specific Fact : Your modi eats on his belly as if it was a table. | Specific Fact :Your guitar was created 3.500 years ago. | Specific Fact : Your blicket can paint toys. |
| Experimenter Owned Items | | | | |
| | Kind Fact: Cats can jump as high as an elephant. | Kind Fact: Tomas can balance on their trunks. | Kind Fact: Trains, when broken, are put in the ocean to be houses for fish. | Kind Fact: Daxes can make star- shaped sandwiches. |
| | Specific Fact: My cat jumps as high as an elephant. | Specific Fact : My toma can balance on his trunk. | Specific Fact : My train is broken and was put in the ocean to be a house for fish. | Specific Fact: My dax can make star- shaped sandwiches. |
| Nobody's Items | | | | |
| | Kind Fact : Ducks sleep with one eye open. | Kind Fact: Wugs can use their horn to fish. | Kind Fact: Cars have 30 thousand parts. | Kind Fact: Larps can light up with clapping. |
| | Specific Fact : That duck sleeps with one eye open. | Specific Fact : That wug can use his horn to fish. | Specific Fact : That car has 30 thousand parts. | Specific Fact : That larp can light up with clapping. |

Figure 1. Summary of the images and facts (kind or specific) organized by the three experimental variables (ownership, familiarity, and entity type).

Children were tested individually online via Zoom. Parents were instructed to leave the vicinity and not interfere with the child's behavior. If the child was too shy to play alone, the parent remained present but was instructed to remain neutral (i.e. to not prompt the child to respond in a specific way). Participants watched a full-screen Powerpoint presentation controlled by an experimenter, who guided them through the study. Children were told that they would learn about different kinds of animals and toys, some familiar, and some new, and that some items would belong to them, some to the experimenter, and others would belong to nobody. After each round of the game, children got to keep their items in a big blue treasure chest presented on the screen throughout the study (see Figure 2).

Each trial began with three identical items entering the screen, that varied in terms of entity type (i.e., animals vs. artifacts), and familiarity (see Figure 2 for an illustration of a trial). The experimenter drew children's attention and named the items enthusiastically (e.g. "Wow, look! Cats!"). This was followed by the Ownership Presentation Phase, when children were informed that the item on the left belonged to the experimenter (e.g. "This is my cat."), the middle item belonged to the child (e.g. "This is your cat."), and the item on the right belonged to nobody (e.g. "And this cat belongs to nobody."). A pointing finger appeared on screen to indicate each item, as ownership information was introduced by the experimenter. During the Question Phase, children were asked to choose if they wanted to learn specific or kind-based information (e.g. "Do you want to learn something new and cool about your cat or about cats?"). The specific object referenced during the Question Phase jiggled and was highlighted by a blue light. Similarly, when the kind was referenced, all three objects on screen jiggled and were highlighted simultaneously. Each question contrasted kind-based and specific information, but the target of the specific information

was varied within participants (child owned = "your cat"; experimenter owned = "my cat", no owner = "that cat").





Figure 2. Experimental display of single trial sequence (identical cats). There are twelve trials in total.

The experimenter introduced specific facts (e.g., "my cat jumps as high as an elephant!"), or kind-based facts (e.g., "cats jump as high as an elephant!"), as per childrens' choice. The facts provided were identical, except for the individual versus kind format. At the end of each trial, children's items were stored in their treasure chest. A new trial, with a different trio of identical items, followed until the study was completed. Participants saw a total number of 12 trials, with an equal number of familiar / unfamiliar items, and artifacts/animals. We counterbalanced the order of presentation of individual and kind information in the Question Phase. Child owned/Experimenter owned/Nobody's trials (N=4 each) were introduced in a random order.

2.4. Exclusion criteria

Participants were excluded if they refused to participate, or had a known diagnosed developmental disorder or delay. Individual trial were excluded if any of the following occurred: a child failed to provide a single response to the target prompt (i.e. refuses to select any information, or chooses both); external interference (e.g., a parent verbally directs the child to

respond in a specific way, a sibling interrupts the trial); technological error (e.g., the computer display freezes in a way that disrupts the child's ability to view the stimuli); or experimenter error (e.g., the experimenter provides an incorrect prompt). Based on these criteria, three participants were excluded: one due to refusal to participate in the study, and two due to external interference. Additionally, we excluded 11 trials (from three different participants) because children failed to make a choice.

2.5. Pilot testing, feasibility, and timeline

We completed pilot testing on a sample of Hungarian children (N = 10 children, average age = 5 years 4 months, range = 4 years 1 month to 6 years 9 months) which has established the feasibility of our paradigm in a Zoom format. All children completed the task and remained engaged for the entire duration of the experiment. We found no floor or ceiling effects in their choices to learn specific information. Prior to the onset of data collection, we also tested an additional 14 participants to train a new experimenter. We did not look at this data, and the decision to switch from "training" to "testing" was made based on the experimenter's ability to correctly follow the experimental procedure.

2.6. Outcome-neutral criteria

A number of quality checks have been performed to ensure the successful testing of our proposed hypotheses. First, our pilot testing confirmed that children are motivated to learn the facts we selected for this experiment. During the test portion of the experiment, every child chose to learn either a kind-based or specific fact. This was true across all trials: no trial or participant had to be excluded from pilot testing due to failure to make a choice or disinterest in the experiment. This quality check was critical because it ensured that we were able to capture our primary measure of interest — children's motivation to learn. In addition to confirming children were sufficiently engaged in the experiment, our pilot testing also confirmed that the design was able to capture variability in children's preferences for specific versus kind information, as demonstrated by no floor or ceiling effects in the distribution of pilot data. Finally, previous research had established that child ownership could be manipulated in an experimental context similar to ours (e.g., Gelman et al., 2016) and that the items used here were similar to those that had been successfully used in previous experimental manipulations of familiarity/novelty with children (e.g., Park & Cimpian, 2014).

2.7. Analytic plan

2.7.1. Confirmatory analyses

To test whether ownership status, familiarity, and entity type impacts children's selection of kind versus specific information, we conducted a generalized linear mixed model (GLMM)¹², with the ownership status (child's, experimenter's, nobody's) as a fixed effect predictor (Hypothesis 1), and an interaction term that included familiarity (novel vs. familiar) and entity type (artifact vs. animal; Hypothesis 2). To account for repeated measures within individuals, we included children's ID as a random effect. Children's choice of information (kind versus specific) in a given trial was the outcome variable. The model was specified as:

 $Children's \ information \ preference \ (kind \ vs. \ specific) \sim Ownership \ Status + Familiarity \ * \ Entity \ Type + (1 \mid ID)$

¹²The power analysis is based on estimates from a within-subjects ANOVA due to lack of prior research available to estimate model parameters for a GLMM.

Hypothesis 1: Ownership Status Post Hoc Tests: If a main effect of ownership status emerges from the analysis, we will conduct follow-up one sample t-tests within each ownership group to determine whether children's preference for kind information differs significantly from chance (50%). If there is no main effect of ownership status, we will conduct a single follow-up t-test (collapsing across ownership groups) to test whether children's preference for kind information differs significantly from chance.

Hypothesis 2: Familiarity and Entity Type Post Hoc Tests. If a significant interaction emerges between familiarity and entity type, we will probe this interaction by testing for simple main effects of entity type for familiar and novel trials separately. If a significant interaction does not emerge from the analysis, we will test for main effects of familiarity and entity type within the overall model.

2.7.2. Exploratory analyses

We planned to conduct a series of exploratory analyses to determine other sources of influence on children's preferences that are described in more detail below. So as to not blur the boundary between exploratory versus confirmatory analyses, we did not pre-register these exploratory analyses in the Stage 1 (initial) submission of this manuscript.

3. Results

We conducted a generalized linear mixed model with ownership status as a fixed effect predictor and an interaction term that includes familiarity and entity type. Children's subject ID was included as a random effect to account for repeated measurements within individuals. Children's choice of specific (coded as 1) versus kind-based (coded as 0) information was the outcome variable. We describe the results of this model below. Hypothesis 1: Influence of Ownership Status on Children's Choice to Learn Specific Information. A significant main effect of ownership status emerged from the model. When children were asked to learn about their own object, they preferred to receive specific information (children requested specific information 61% of the time; 95% CI = .51 - .70). This preference for specific information was significantly higher than when they were asked to learn about the experimenter's object (M = 39%; 95% CI = .31 - .47, Z = -4.96, p < .0001) or nobody's object (M = 52%; 95% CI = .44 - .61, Z = -2.18, p = .03). Children also preferred to learn about specific objects more often when they were asked to learn about nobody's object, relative to when they were asked to learn about the experimenter's object (Z = -2.87, p = .004).

To examine whether children's rates of selecting specific versus kind-based information differed significantly from chance , we conducted follow up one-sample, two-tailed t-tests within each ownership trial type against the 50% chance level. To conduct these tests, we first computed an aggregate preference score within each trial type (i.e. child-owned, experimenter-owned, and nobody-owned; n = 4 trials for each trial type). On child-owned trials, children selected specific information at rates significantly above chance, t(54) = 2.32, p = .02. On experimenter-owned trials, children selected specific information at rates significantly below chance, t(54) = -2.76, p = .008, indicating they had a preference for kind-based information. On nobody-owned trials, children's rate of selecting specific information did not differ significantly from chance, p = .56, suggesting children selected both specific and kind-based information at equal rates.



Figure 3. Proportion of trials in which children selected to learn about specific information over kind-based information as a function of the item's ownership status. Values above 50% indicate greater selection of specific information, values below 50% indicate greater selection of kind-based information. The dashed horizontal line (50%) represents chance performance.

Hypothesis 2: Influence of Entity Type and Familiarity on Children's Choice to Learn

Specific Information. Results from the generalized linear mixed model revealed no significant interaction between familiarity and entity type (Z = -1.43, p = .15), and no main effects of familiarity (Z = -1.35, p = .18) or entity type (Z = 1.60, p = .11).

3.1. Results from exploratory analysis

At first glance, entity type and familiarity do not seem to have an impact on children's learning preferences. However, their effects could have been precluded by the strong effect of ownership on children's information preferences. Specifically, our analyses included child-owned trials, in which children showed a strong preference for specific information. Therefore, we ran an exploratory analysis *without* child-owned trials to see if, and under what circumstances, effects of familiarity and entity type emerge. Since most items that children must learn about in their everyday lives do not belong to them, this exploratory analysis contributed to the ecological validity of our findings. We re-ran the generalized linear mixed model described above in Hypotheses 1 and 2 but without the child-owned trials (N = 431 total trials included in this analysis). The model specification was as follows:

Children's information preference (kind vs. specific) ~ Ownership Status + Familiarity * Entity Type + (1 | ID)

As in the confirmatory analysis described above, children preferred to learn specific information more often when asked about items owned by nobody (M = 52%; 95% CI = .44 - .61), relative to when they were about items owned by the experimenter (M = 39%; 95% CI = .31 - .47; Z = 2.95, p = .003). There was no significant interaction between familiarity and entity type (Z = -1.39, p = .16) and no main effect of entity type (Z = 1.61, p = .11). However, in contrast to the confirmatory analysis presented above, we detected a significant main effect of familiarity on children's information preference (Z = -2.85, p = .004). Children chose to learn specific information about novel items 33% of the time (95% CI: .25 - .41). This value was significantly below chance (t(54) = -4.10, p = .0001). However, children chose to learn specific information about familiar items 57% of the time (95% CI: 49% - 65%), a value that did not differ from chance (t(54) = 1.80, p = .08).



Figure 4. Proportion of trials in which children selected to learn about specific information over kind-based information as a function of the item's familiarity. Children chose to learn kind-based information more often when presented with novel compared to familiar items regardless of their entity type.

4. Discussion

This study investigated how ownership, familiarity, and entity type modulate children's preference to learn specific versus kind-based information. While previous research has shown that children prefer to learn kind-based over specific information (Cimpian & Park, 2014), here we showed that under certain circumstances children prefer specific information instead. Specifically, the current findings revealed that 4- to 5-year-old children preferred to learn about specific items rather than their kinds when the items were owned by the child. When asked about items that did not belong to them, items' familiarity influenced children's information preferences: they preferred kind-based information about novel items, but showed no preference for either specific or kind-based information when items were of familiar kinds. In contrast to our hypotheses, we did not find an effect of an item's entity type (artifact vs. animal) on children's information preferences. Below, we discuss the unique role of each of these factors in shaping children's preferences to learn new information.

4.1. The impact of ownership on children's learning preferences

When children were presented with items they owned, they preferred to learn something specific about them (e.g., something about *their* train). In contrast, when presented with items owned by the experimenter, children preferred to learn kind-based information (e.g., something about *trains*). Finally, when children were presented with items owned by nobody, they did not demonstrate any systematic preference for learning specific or kind-based information.

There are several possible explanations for why children prioritized learning specific information about their own items. First, specific information might be useful for items a child must keep track of and remember in future situations: from their cat's unique attributes to their

guitar's specific features, knowing their own items' idiosyncratic properties can give children a better idea of what to expect from their items in the future. Items owned by strangers are highly unlikely to be seen again, rendering specific information about them less valuable. Therefore, when given a choice between learning about an experimenter's specific item or about its kind, children may consider kind-based information more useful, as it could apply to other items of that same kind they might encounter in the future.

Second, children's preference to learn specific information about their own items may reflect an "endowment effect": simply owning something makes children like and value it more (e.g. Hood et al., 2016). Children view items they own as *special*, which might motivate them to seek out specific information about them because it may reveal the ways in which those items are distinctive. If an item's "specialness" underlies children's specific-learning preference, then this preference may also extend to special items that they do *not* own, but are special for other reasons. For example, children believe that objects that belong to renowned individuals like Barack Obama or Harry Potter are more valuable than items that belong to an individual with no special status to children (e.g., an experimenter; Gelman et al., 2015). Given that children also place increased value on items owned by relevant individuals, they may also prefer to learn specific information about those items. To test this hypothesis, future research could compare children's interest in learning specific information about items owned by individuals with or without a relevant status for children.

Though past research has found that children prefer to learn kind-based over specific information (Cimpian & Park, 2014), we only replicated this result when the item in question was owned by the experimenter. For items that had no owner, children showed no preference for specific or kind-based information — they chose to learn about both types of information at equal

rates. This could be a result of individual differences in children's interpretation of the items owned by "nobody". While some children may not have prescribed any special status to items owned by "nobody", others may have considered these items as potentially theirs, or a possible gift for someone they like, thereby increasing their interest for specific information about those items. For example, one child in this study insisted that the nobody-owned items were owned by her sister. In these cases, the *perspective* of establishing relevant ownership relations may have increased children's curiosity for specific information. Future studies are needed to test how children's perceived relations to items in their world influence their learning biases.

4.2. The influence of familiarity and entity type on children's learning preferences

Children's learning preferences did not vary as a function of the item's type (artifact versus animal) or familiarity. However, ownership had a strong effect on children's information preferences, and children showed a bias for learning specific information about items they owned. Therefore, we conducted an exploratory analysis in which we excluded child-owned trials, since these trials may have obscured the influence of familiarity and entity type on children's learning preferences. This exploratory analysis also contributed to the ecological validity of our findings, as most items children learn about in their everyday lives do not belong to them. Against our prediction, we did not detect an interaction between familiarity and entity type on children's learning trials), our study was underpowered for detecting this effect. Future studies exploring the effects of entity type and familiarity on children's learning preferences in the absence of ownership information may provide more insights into how these factors work together to shape children's learning preferences.

Our exploratory analyses did reveal a significant effect of items' familiarity, but not type (artifact vs. animal), on children's learning preferences. Children preferred to learn kind-based information about novel kinds, regardless of their type (artifact vs. animal). In contrast, children did not show a systematic preference for specific or kind-based information when presented with familiar kinds. Why might children prefer to learn kind-based information about novel, but not familiar kinds? Some children may have extensive knowledge and experience with the familiar kinds used in this study (e.g., trains, cats) and therefore think that they already know what matters most about that item's kind. Consequently, children's preference for specific and kind-based information.

These findings differ from previous research showing that children prefer kind-based information for both familiar and novel items (Cimpian & Park, 2014). This discrepancy may in part be explained by methodological differences across our paradigms, since our study was not designed to be a direct replication of Cimpian and Park's (2014) experiment. In our design, children were presented with three items at a time, and prior to choosing the type of information to learn about, children learned something distinctive about each item: one item belonged to the child, another to the experimenter, and the last to "nobody". This context may have motivated children to distinguish the identical-looking items further by learning specific information about them. Consequently, given that familiar items are not completely unknown to children, they might have felt particularly compelled, in the context of our study, to request specific information. As noted earlier, future research is needed to identify the full range of factors that motivate children to learn specific information.

4.3. Future directions

This study revealed key factors driving children's learning preferences in a forced choice scenario. However, it does not provide insight into what might drive children to *spontaneously* seek out information. In the current design, children were asked whether they preferred to learn specific or kind-based information. However, in children's everyday experiences, they are not frequently confronted with explicit requests to learn about one type of information over another. Rather, most often, children's information seeking is spontaneous: they might ask a question, or explore their environment, to figure out something they would like to know. To better understand children's curiosity as it unfolds "in the wild", future research should examine what sorts of information children request when they do so spontaneously, as well as what factors drive information seeking in the first place.

Finally, this study does not refute the important role that kind-based information plays in children's learning. Indeed, we found that when items are novel (and not owned by them), children prioritized learning kind-based over specific information, even though they lacked both kind-based and specific information about those items. This is in line with prior evidence indicating that kinds have a "privileged status" in human cognition that is also reflected, for example, in children's ease to reason about and remember kinds (Cimpian, 2012). However, our study is the first to address under what circumstances children prefer to learn specific over kind-based information. The current research represents an important next step in a broader research agenda focused on understanding children's own interest in selecting and seeking out different types of knowledge.

5. Conclusion

The current study explored how contextual information shapes children's learning preferences. This research is the first to test the effect of ownership on children's preferences when learning new information: children prefer to learn specific information about items they own, and kind-based information about items owned by a stranger (i.e., an experimenter). We also found that familiarity plays an important role in shaping children's learning preferences when those items are not owned by them: children choose kind-based information so long as they believe that there is still something relevant to be learnt about a kind, that is, when learning about novel animals or novel artifacts.

By the time young children first step foot in the classroom, they have an abundant knowledge about the world around them. They know what things are called, how they work, and why they behave the way that they do. But previous research has revealed that children do not value all types of information equally: when given the choice, children generally prefer to learn kind-based over specific information (Cimpian & Park, 2014). However, to successfully learn about the world around them, children must also choose to learn information that is specific to individuals. The current study revealed two key factors that shape children's preference in learning about individuals: ownership and familiarity. Together, these factors highlight that both previous knowledge about kinds and future relevance of specific items influence children's decision to learn new information.

Chapter 6

General discussion

Humans encounter countless entities in the world. We see multiple people, cats, trees, cars, pens, spoons, etc. —many of them for the first and only time. Despite that, it is not that they are unfamiliar to us: we have expectations about them because we represent them as *exemplars of kinds*. From behavior to function, we attribute to entities the properties we associated with their kinds. We expect something to meow and potentially scratch because we identify it as a cat. We also believe that an artifact has a writing function because we recognize it as a pen. By associating properties to kinds, the world becomes more intelligible without the need to learn about entities one by one.

Representing kinds and kind-related properties is fundamental for human adaptation. Therefore, the amount of attention that this capacity has received from the developmental literature, trying to unravel how it unfolds, is unsurprising. In addition, the abstract dimension of kinds also seems particularly intriguing. In their first two years of life, infants can already generalize a property they see in a few or even a single entity to countless others because they represent them as part of the same "kind basket" (Shamsudheen, 2020). In short, they can use the "here and now" to acquire knowledge that is not spatiotemporally constrained.

However, humans also connect individual properties to entities. From our mother to our pet, we regularly encounter some individuals, arguably increasing the need for fine-grained knowledge about them to inform our behavior more accurately. In addition, we might attribute individual value to them: our childhood teddy bear might be materially the same as countless others, but it is special for us as no other teddy bear is. In sum, we still see these entities as instances of categories but also as carriers of individuality.

Unique entities such as our mother, pets, childhood toys, etc., are a fundamental part of our mental lives. However, compared to research on kinds, fewer studies explored how the attribution

of individual-related properties develops. Maybe researchers assume that the attribution of individual-related properties as a "simpler capacity" that the attribution of kind-related properties builds on. For example, the development of abstractive capacities would allow children to generalize properties from "perceptually based and concrete" individuals to kinds (Cimpian & Erickson, 2012). From this perspective, the interesting question is how this "abstract move" from concrete individuals to kinds occurs.

However, we argued in Chapter 2 that individual- and kind-related properties are not merely distinct in scope: they have different representational grounds and, consequently, different demands. Individual-related properties depend on distinguishing entities by their *past*. A teddy bear replica or a mother's identical twin will not share the same value and mental content: although they look identical, they have distinct numerical identities, pasts, and, consequently, individualrelated properties. In contrast, we attribute kind-related properties to entities regardless of their history. We expect a pen to write and a cat to meow because of *what* they are, i.e., their *qualitative identity*. This "past-independence" allows kind-related properties to be generalized to individuals whose pasts are unknown.

A superficial look at the developmental literature gives the impression that infants associate properties with individuals. We discussed several of these studies in Chapter 2: infants supposedly connect properties to individuals in the face of different kinds of events, such as helping, giving, etc. For example, infants would think that a *particular* agent is "a helper" (e.g., Hamlin, Wynn, & Bloom, 2007). However, it could also be that they believe that that *kind* of agent is helpful. If we do not assume that property-individual associations are simpler to encode than property-kind associations, both possibilities are, in principle, feasible. That is an empirical question that, if

explored, could illuminate how likely infants are to connect properties to numerical and qualitative identities in different situations.

We tested whether infants represent associations with qualitative and numerical identities in Chapter 3. Our experiment was inspired by Tomasello and Haberl's (2003) paradigm (and the follow-ups Moll & Tomasello, 2007; Moll, Carpenter & Tomasello, 2007). They found that infants interpret someone's ambiguous object request as directed towards an object they have *not* played with yet, i.e., a new toy. Crucially, for that to happen, they needed to have associated the requester with the objects they played with so that these toys were disregarded as potential request referents. However, the question is whether infants associated the requester with *kinds* of toys or *particular* toys. For example, if infants encode that the requester played with a *particular* doll, they might think she wants a new doll. Nevertheless, if they encoded that the requester played with "*a* doll", it might be unclear which doll she is requesting¹³.

Our study investigated 13- and 24-month-olds and had two conditions: Different Kinds and Same Kind (between-subjects design). The premise was that if infants associate the agent with a particular object, they will give the new object in both conditions. Belonging to the same kind or to a novel kind would not make a difference. However, if infants associate the agent with a kind (e.g., a *doll*), they will give the *new kind* of object (e.g., a cat) but not a new object of the same kind (e.g., a *doll*). We predicted 13-month-olds to only give the new toy in the Different Kinds condition, but not in the Same Kind condition. Studies have shown that infants of this age are more likely to encode kinds than other object features (e.g. Xu, Carey, & Quint, 2004). However, we expected 24-month-olds to give the new toy in both conditions: they should be more likely to encode particular objects and associate them with agents.

¹³ The authors used unfamiliar instead of familiar kinds of objects. We said "doll" to simplify the illustration.

Infants of both age groups tended to give the new toy above chance in the Different and the Same conditions. However, they were more likely to handle it in the Different condition. Therefore, our findings indicate that infants can encode both agent-kind associations and agentparticular associations. Nevertheless, they also show that agent-kind associations are more "prominent" than agent-particular associations.

We tested infants with familiar and unfamiliar objects (between-subjects design). With unknown toys, the pairs were the same across conditions; what changed was whether the objects of a pair shared the same name and function or had different names and functions. Using the same items across conditions allowed us to rule out potential perceptual-based explanations of the results. For example, one could say that a cat and a doll are perceptually more distinct from each other than two cats; consequently, it is easier to distinguish the new and the old toys when they belong to different kinds. However, even when we used the same unfamiliar objects across conditions, the findings were similar: infants tended to give the new toy more often in the Different than in the Same condition. In sum, they seemed more likely to encode agent-kind than agentparticular associations with unfamiliar objects.

Differently from our findings with familiar objects, 13-month-olds were at chance when selecting among objects of the same kind —they only tended to give the new object above chance in the Different condition. In this case, 13-month-olds' interest in exploring unfamiliar toys could have hindered their capacity to select and give the new object in the Same condition. This is in accordance with the fact that our findings in the Different condition were also less robust with unfamiliar toys —but in this case, they probably still succeeded because the objects belonged to different kinds, which helped them encode the agent-object associations.

In a nutshell, our study indicates that infants between 13 and 24 months of age (1) can encode agent-kind and agent-particular associations but (2) agent-kinds associations are more robust. A fundamental contribution of these findings is to show that encoding associations with particulars did not seem "simpler" than kinds —if that was the case, we would have found no difference across conditions. Perhaps the main advantage of associating agents with kinds is that infants can learn about agents' interactions with objects without having to remember and recognize object-specific features and spatiotemporal information —even if they are capable of doing so.

Chapter 4 reports an online study that explored children's association of dispositional properties (object-produced sounds) with objects (inspired by Kirkham et al., 2012, and Richardson & Kirkham, 2004). Four-year-olds watched different movies with an agent (specifically, her arms and hands) ostensibly showing and placing a pair of objects on distinct shelves, i.e., a top shelf and a bottom shelf. Once the agent left the scene, the objects produced different musical sounds alternately (3 times each). Then, children saw the agent's hands bringing two boxes to cover the items. The boxes revolved around the screen center clockwise or counterclockwise (counterbalanced), changing from the top-bottom to a left-right alignment. We attracted the participants' attention to the center of the screen with an attention-getter, the moment in which they were asked "where does the sound come from?". They heard one of the sounds previously made by one of the objects. Participants had to indicate via pointing or side labeling ("left" vs. "right") the box with the object that plays the specific sound.

Crucially, the pairs of objects varied across movies, either belonging to different kinds (e.g., a duck and an apple) or to the same kind (e.g., two identical-looking bunnies) (within-subject design). We asked whether kind contrast facilitates children's encoding and recall of sound-object associations. Infants could have connected a "drumming sound" to "duck" and a "violin sound" to

"apple". Then, in the test phase, they identify the critical location by (1) remembering that the drumming sound is produced by a duck and (2) remembering which box has a duck. From this perspective, infants could have more difficulties if they have to recall, say, *which* of two identical bunnies made a particular sound: remembering which box has "a bunny" is not enough to solve the task. Alternatively, children could have directly linked the sound to the spatiotemporal object in a specific box so that the objects' kinds would play no role in the task. They would identify the critical location regardless of the objects' qualitative identities, something like "that box contains *the one* that makes a drumming sound".

Our findings were not fully consistent with any of the potential sound-object associations. In principle, kind contrast seemed to help with children's performance. Children selected the correct location above chance when objects were different, but not when they were identical, in our most demanding trials (i.e., trials with a longer temporal gap between the test sound and the last moment this sound was heard during familiarization). However, they failed to select the correct location with different objects in our less demanding trials, which is not compatible with the perspective that kind contrast facilitates event encoding. At the same time, the idea that children directly index sounds to spatiotemporal objects case in the less demanding trials and only in the different objects case in the more demanding trials. Future studies in the lab and with more participants are needed to see whether our findings replicate (in which case, we need better explanations to account for them) or resulted from our likely "noisier" online procedure.

In common, the experiments in chapters 3 and 4 aimed to show that associations with particulars are not more likely to be encoded than with kinds. Kinds might even increase the chances that infants encode associations from the situations they observe, as indicated by our experiment in Chapter 3 (although our findings in Chapter 4 are inconclusive). Crucially, encoding event participants as exemplars of kinds (e.g., the memory of someone playing with *a cat*) relieves them from remembering idiosyncrasies such as the entities' specific features and spatiotemporal trajectories. Individual peculiarities are often irrelevant: most of these entities will never be seen again; therefore, infants and children do not have to recognize nor interact with them later. Probably, that is why children seem to prioritize information about kinds rather than particulars (Cimpian & Park, 2014): acquiring and keeping idiosyncratic information about every object might be both cognitively costly and not worthy for entities that they will unlikely see again.

Children might usually prioritize kind-related information because they have no relation with the specific objects they encounter. However, what about objects that they have a connection with and might see again in the future? Chapter 5 explored children's interest in individual-specific information for objects that they own. Ownership is a historical relation that connects the owner with the owned object, and owners likely encounter their objects regularly. Therefore, in the case of owned items, children might prioritize information about particulars over kinds.

We tested 4- to 5-year olds with a paradigm based on Cimpian and Park (2014). Children watched a full-screen Powerpoint presentation online controlled by an experimenter. Each trial began with three identical items entering the screen, which varied in entity type (i.e., animals vs. artifacts) and familiarity (e.g., cats vs. some unfamiliar animal created for the experiment). The experimenter told children the ownership status of each object: one of them belonged to the experimenter, the other to the child, and the last one to nobody. Then, she asked children to choose if they wanted to learn specific or kind-related information (e.g., "Do you want to learn something new and cool about *your cat* or about *cats*?"). The target of the specific information (the child's, the experimenter's, or nobody's object) varied across trials.

We found that children prioritized individual-specific over kind-based information when they owned the objects, but not when they did not own them. They showed this preference regardless of entity type and familiarity. Regarding the experimenter's items, they chose to learn information about kinds, and showed no preference regarding nobody's items. Crucially, the effect of child ownership was so strong that we initially found no effect of familiarity or entity type. However, once we removed the trials where children were asked about their objects, we found an effect of familiarity: children preferred to learn information about unfamiliar kinds of items, but showed no preference for any particular type of information in the face of familiar items. In sum, when children believe that they have a relation with the objects, their preference for individualspecific information surpasses their preference to learn about the objects' kinds —including when they have no clue about their kinds.

We encounter countless particulars daily. Learning about and keeping track of each of them probably goes beyond our cognitive capacities. Therefore, cognition is selective about which particulars to give special attention to, i.e., which of them we will try to encode specific information about. Objects that we will likely encounter later are good candidates to receive dedicated cognitive attention: in these cases, object-specific information might be relevant for future interactions. Given that owned objects are often seen more than once, our participants might have felt motivated to learn specific information about their items. In our study, children even saw their objects moving inside "their blue chest" at the end of the trial, allowing them to keep track of their objects.

However, maybe the effect of child ownership is not just based on potentially seeing the object again. By connecting children to their objects, ownership also might have increased the objects' value. For example, Gelman and colleagues (2012) have shown that children prefer toys

an experimenter tells them are theirs over identical replicas. Consequently, children might have been more interested in learning individual-specific information about the objects they own because they care about them as particulars. Future studies could try to disentangle the specific factors that make children interested in individual-specific information about their objects. These factors could also be in place outside representations of ownership, giving us a more complete picture of the situations that favor the acquisition of individual-specific information.

Clarifying the concrete factors that increase children's interest for individual-specific information could also give us insights when exploring infants. Depending on their age, it is unlikely that infants have the concept of ownership. However, ownership might not be necessary. For example, if the value of individual-specific information increases for objects seen regularly, all infants need is to recognize them as *the* objects they know. This recognition of particulars throughout time is also needed to "reconnect" individual-specific properties to them: if an infant connects an individual property "A" to her cat but does not recognize him later, "property A" cannot be reconnected to the individual. As we discussed in Chapter 2, the extent to which infants see an entity and recognize it as "the one" they know throughout time and remember their individual-specific properties is also a territory that requires more exploration.

In summary, we have found that infants can encode individual-specific relations (agentparticular) but those are less likely to be encoded than relations with kinds. We have also seen that children need "good reasons" to seek individual-specific information: they do so when they own the objects, but not when they do not own them. Together, these studies seem to indicate that the representation of individual properties and relations are not the "general strategy" with which infants and children approach entities. It is important that future studies attempt to elucidate what makes infants and children more prone to seek out and encode individual-specific information.
Additionally, it is crucial to understand the demands behind the capacity to represent individualrelated properties and the entities that carry them, as we tried to define in Chapter 2. By understanding these demands, we can potentially investigate the existence of potential limits in the capacity to represent individual-related properties throughout development.

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