Early constraints on the imagination: The realism of young children

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Abstract

The imagination of young children has notable constraints. The outcomes and possibilities that they imagine rarely deviate from the everyday regularities they have observed and remembered. Their reality-based imagination is evident in a variety of contexts: early pretend play, envisioning the future, judgments about what is possible, the instructive role of thought experiments, tool making and figurative drawing. Overall, the evidence shows that children's imagination helps them to anticipate reality and its close alternatives. This perspective invites future research on the scope of children's thinking about counterfactual possibilities, their ability to make discoveries about reality on the basis of thought experiments, and the ways in which cultural input can expand the scope of the possibilities that they entertain.

Early constraints on the imagination: The realism of young children

In developmental research, the imagination is often linked to the generation of creative or unusual possibilities and children's early capacity for make-believe is seen as a potential index of those generative abilities. In line with this perspective, researchers have documented intriguing individual differences among children in their engagement with imaginary companions and imaginary worlds, and examined potential links to variation in social understanding, story-telling and divergent thinking (Taylor, 1999; Taylor & Carlson 1997; Taylor, Mottweiler, Aguiar, Naylot & Levernier, 2020; Trionfi & Reese, 2009). This focus on the imagination of young children, as exemplified by their pretend play, is sometimes accompanied by concerns that an overly academic curriculum, with limited opportunities for make-believe, might stifle the development of children's imagination (Lillard & Taggart, 2019; Weisberg, Hirsch-Pasek, Golinkoff, Kittredge & Klahr, 2016).

This paper adopts a different perspective toward the development of the imagination. Rather than highlighting individual differences among children in their engagement with an imaginary world, especially in the context of pretend play, children's wide-ranging disposition to recruit their knowledge of the real world when engaged in various activities calling on the imagination is highlighted. More specifically, the focus is on children's use of their imagination as a vehicle for entertaining unrealized but realistic possibilities, including situations that they are likely to face in the future and artefacts that could be created via innovative activity. An important implication of this approach is that even if young children's imaginative abilities are especially evident during an early 'high season' (Singer & Singer, 1990), their imagination plays a continuing role in their navigation of reality.

To demonstrate the wide scope this perspective, findings from several domains are reviewed: children's pretend play, their thinking about the future, judgments about what is possible, learning from thought experiments, tool-making and figurative drawing. Arguably, their ability to reason from false or exotic premises, their enjoyment of fantastical narratives, and their invention of imaginary companions index a more fantasy-oriented imagination than the current proposals imply. However, scrutiny of the available evidence invites a cautious assessment of those capacities. The paper concludes with a discussion of the developmental trajectory of the imagination.

Pretend Play

As noted, pretend play is often viewed as a vehicle enabling children to set everyday reality aside and to become absorbed in a make-believe world. At the same time, there is a considerable body of evidence showing that the pretend worlds that children construct are guided by their understanding of the everyday regularities and activities that they have observed in the real world. For example, young children make sense of a partner's pretend actions by imagining what the outcome of those actions would be in reality. Having watched Naughty Teddy, a puppet, pour pretend milk from an empty carton onto the floor, 2-year-olds applied a sponge to the appropriate spot when asked to: "dry the floor where it's all wet". Similarly, having watched Naughty Teddy pick up a tube of toothpaste and squirt pretend (i.e., non-existent) toothpaste onto the tail of one of two pigs, 2-year-olds used a tissue on the correct pig when asked to: "clean the pig who's all dirty" (Harris & Kavanaugh, 1993; Experiment 5). In these two examples, children's pretend actions show that they imagine the outcomes (milk on the floor; toothpaste on a pig's tail) that would ordinarily result from familiar actions such as squeezing or pouring and respond in an appropriate pretend fashion.

More evidence for this conclusion comes from 2-year-olds' verbal descriptions of pretend episodes. Having watched Naughty Teddy pour pretend tea from an empty teapot over the head of a toy monkey, they described the pretend action (e.g., "poured" "put"), the imaginary substance ("tea"), its direction (e.g., "on" "over") and the victim ("monkey"). Asked about the state of the monkey's head, they said that it was "wet". Again, they assumed that the outcome of pretend pouring would correspond to the outcome of real pouring (Harris & Kavanaugh, 1993, Experiment 6). Two-year-olds' ability to imagine the consequences of pretend transformations is also revealed by their picture choices (Harris, Kavanaugh & Dowson, 1997; Kavanaugh & Harris, 1994). Having watched an experimenter engage in pretend actions, such as pretending to squirt ketchup onto a pig's leg, they appropriately chose a picture showing the pig in its pretend transformed state (i.e., with ketchup on its leg) rather than its actual, untransformed state.

Two-year-olds can also imagine two successive pretend transformations (Harris, Kavanaugh, Meredith, 1994). For example, having watched as either pretend milk or pretend talcum powder was tipped into a container and the container was subsequently inverted over a toy horse, they correctly anticipated the distinctive outcomes of these two different pretend sequences, describing the horse as "wet" in the case of the pretend milk but "powdery" in the case of pretend powder (Harris et al., 1994; Experiment 2). Walker-Andrews and Harris (1993; Experiment 2) showed that 3-year-olds can track pretend transformations that are subsequently reversed. For example, children watched as the experimenter rolled two toy pigs on some cardboard, explaining: "These piggies like to roll in mud." Next, the experimenter 'cleaned' one pig with a cloth and asked children, "to clean the pig who's all dirty." Children chose the pig that remained 'dirty'. By implication, they understood the initial change to both pigs, the reversal of that change for one pig and acted appropriately on the other.

Finally, preschool children use their knowledge of reality not only to interpret a play partner's pretend enactments, but also to reject a play partner's deviations from reality (Van de Vondervoort & Friedman, 2017). In three studies, 3- and 4-year-olds observed a play partner move animal figurines while making either the wrong sound (e.g., "oink" for a duck) or the right sound (e.g., "woof" for a dog). Children were much more likely to protest wrong sounds (e.g., "that's not what ducks say" or "it goes quack") than right sounds.

Overall, these studies of pretense comprehension point to three conclusions. First, 2- and 3-year-olds use their knowledge of everyday reality (e.g., tipping a teapot or bottle causes liquid to pour downwards) to infer an imaginary outcome (e.g., the surface below will end up wet). These reality-based inferences are indexed via several measures: children's appropriately targeted pretend reparations, their verbal descriptions of imaginary outcomes, their selection of pictures depicting imaginary outcomes and their protests at unrealistic deviations. Second, guided by the pretend actions of a play partner, 2- and 3-year-olds can imagine novel possibilities. Toddlers are unlikely to have actually seen tea poured over a monkey's head or ketchup squeezed onto a pig's leg. Yet these novel possibilities can be constructed in children's imagination, guided by their knowledge of everyday reality and by their play partner's enactment. When that play partner inverts a container, children realize that its make-believe contents will not travel upwards or laterally, but downwards, that traces of the make-believe liquid or substance will end up on the surface below, and that those traces can be removed with a cloth, etc. Thus, the sequences and outcomes that children imagine are guided by their understanding of familiar, everyday regularities even if the specific possibilities enacted by a play partner are novel. Finally, 2- and 3-year-olds can use their imagination to enter into a fiction. They conjure up imaginary outcomes, map those imaginary outcomes onto a picture or

description, or produce an appropriate continuation with their pretend responses. By implication, guided by a play partner, 2- and 3-year-olds are able to enter into imaginary worlds, but they assume that those imaginary worlds operate in terms of the same constraints and regularities as reality itself.

Are similar reality-based constraints at work in children's spontaneous production of pretense? In the U.S. and Europe, observational studies of early pretend play have repeatedly shown that toddlers re-enact familiar scripts or routines. In a wide-ranging review, Bretherton (p. 18, 1984) concluded that: "The content of early pretending is drawn from and reproduces the infant's everyday experience (sleeping, eating, telephoning, going for a ride)." Distinguishing between "the enactment of fairly realist scripts" and "fantasy scripts", she argued that young children's play is typically based on their realist understanding (Bretherton, 1984, p. 36). Older preschoolers, aged 3 to 5 years, display a richer thematic repertoire, but again, a variety of familiar scripts account for most of their pretend production: packing, going to the store, cooking, and having a meal (Garvey, 1977). Detailed observational studies of pretend play support these conclusions. For example, Haight et al. (1999) observed the development of pretend play among 2-, 3- and 4-year-olds growing up in middle-class families in Chicago and Taipei. In both settings and across all three age groups, realistic pretend involving familiar activities (e.g., eating, shopping) predominated. Non-realistic play based on fantasy or magic was infrequent in Chicago and very rare in Taipei.

Outside the industrialized world, children are likely to have opportunities to observe adults' work activities. Reflecting that observational access, children of the Efe (a community of foragers in the Democratic Republic of the Congo) and of the indigenous Maya of San Pedro (a modernizing, agricultural town in Guatemala) often engage in work-themed pretense (e.g.,

pretending to shoot animals with a bow and arrow; making tortillas out of dirt) (Morelli, Rogoff & Angelillo, 2003). Similarly, Gaskins, Haight and Lancy (2007, p. 188-9) note that a considerable portion of Kpelle childhood: "is taken up with a two-step process of observing adult activity and then incorporating these scenes and the accompanying actions and speech forms into realistic pretend play episodes…Pretend play for the Kpelle remains grounded in what the children have observed in their daily lives." Based on observational work in a Yucatec Mayan village in Mexico, Gaskins et al. (2007, p. 194) report that most of the time, the themes and roles of such pretend play: "represent a generalized reenactment of adult life that the children have directly observed or participated in." Indeed, "pretending as invention of things beyond the children's real world …is remarkably rare, if in fact, it exists at all" (Gaskins, 2013, p. 230).

Comparing the play of children of Aka forest foragers and Ngandu subsistence farmers, Boyette (2016) found that the re-enactment of subsistence activities (e.g., fetching 'water' with miniature containers; 'cooking' inedible leaves in a sardine can) is the dominant type of pretend play: 87% among the Aka and 68.5% among the Ngandu. Indeed, Boyette (2019) notes that parents in foraging and farming communities sometimes encourage work-themed pretense by providing miniature implements: baskets, bows or spears. Children's pretend re-enactment of adult routines can also extend to the reenactment of local ritual activities or the commercial practices of neighboring groups (Boyette, 2019).

Some investigators have looked for episodes of fantasy play, especially in contrast to the reality-themed pretense described above. For example, Gosso, Morais and Otta (2007) observed pretend play in five different cultural groups of Brazil. Of the characters that children assumed or attributed during their play, almost all (approaching 90%) were either real people (e.g., a parent or other adult) or animals (e.g., a dog or turtle); few were fantastic characters (e.g., a vampire or

a tentomon). A similar bias emerged in the themes that children re-enacted. Most echoed

everyday life, including work routines and caregiving. Few (less than 5%) involved fantasy.

Indeed, fantasy characters and themes were completely absent from the least urbanized group,

Parakanã Indians from Paranowaona in northern Brazil, who have neither television nor

telephones. In short, these findings from more traditional or rural communities echo those found

in urban settings: early pretend play reflects what children have observed of local scripts and

practices. Their pretend world largely reflects the reality of their everyday lives.

Imagining the future

The above emphasis on the way that familiar reality infuses children's imagination might

be regarded as an excessively negative or withholding portrait. However, if many outcomes are

recurrent, an unbridled disposition to entertain rare or unlikely possibilities will be less accurate

in imagining what the future holds than an imagination attuned to those prior regularities. Thus,

if a primary function of the imagination is to anticipate what is likely to happen in light of stored

information about past regularities, the retrieval of reality-based information will facilitate such

future-directed imagining. Indeed, when amnesic patients were asked to generate imaginary

experiences, they imagined scenarios that were much less rich and coherent than those imagined

by control participants with normal memory functions (Hassabis, Kumaran, Vann & Maguire,

2007). Schacter, Addis and Buckner (2007) concluded that remembering the past and imagining

the future are associated with the same highly specific brain system. Imagining the future might

require greater constructive activity than remembering the past – a claim reinforced by fMRI

findings (Addis, Sacchetti, Ally, Budson & Schacter, 2009) – but richer memories of the past

enable the construction of more detailed simulations of the future. Indeed, adults report more

vivid and detailed mental images of future events when they envision them occurring in a recent,

familiar setting (e.g., a college campus) rather than a more remote setting (e.g., a high school) (Szpunar & McDermott, 2008). Thus, the richness of imagined future episodes varies depending on the availability of relevant memories.

The proposal that children's envisioning of the future is guided by their observation and memory for past reality is consistent with these adult findings. Granted such connections, we can expect children's ability to imagine the future to increase with age, in line with age changes in their memory for the past. Moreover, within age groups, the richness with which individual children remember the past is likely to be a predictor of the richness with which they envision the future. Finally, granted children's increasing ability to remember what has actually happened and to imagine what is likely to happen in the future, we may expect them to engage in increasingly realistic planning. Below, evidence supporting these three predictions is reviewed.

Busby and Suddendorf (2005) asked preschoolers about what they had done yesterday and what they were going to do tomorrow. Less than one third of 3-year-olds answered these two questions correctly (as judged by parents), whereas more than half of 4-year-olds did so. Consistent with the proposal that remembering the past and envisioning the future are connected processes, children within each age group responded with a similar level of accuracy to questions about the past and questions about the future. In a follow-up study of 3- and 4-year-olds, Suddendorf (2010) found that, even allowing for individual differences in age and verbal fluency, the numbers of answers given to questions about the past and the future were correlated across individuals.

To circumvent potential problems that children might have in generating past and future activities, especially those appropriately associated with the temporal terms 'yesterday' and 'tomorrow', Hayne, Gross, McNamee, Fitzgibbon and Tustin (2011) asked preschoolers to

describe particular activities from their immediate past or future that parents had reported as having happened or as going to happen. Both 3- and 5-year-olds succeeded in talking about such past and future events but there was a marked age change in the richness of their reports – with 5-year-olds producing more than four times as many descriptively accurate clauses as 3-year-olds. In line with the findings of Busby and Suddendorf (2005), children within each age group responded with a similar level of accuracy to the past and future event questions. Again, even after controlling for age and language ability, there was also a strong correlation between the numbers of clauses that children reported for the two types of event. Finally, as might be expected if contemplation of an event from one's past and one's future draw on related processes, almost half of the clauses included a reference to the self for each type of event.

Arguably, these studies called for only a weak form of imagining because children may have focused on future activities that were very similar to past activities. When parents nominated future activities, they may have targeted activities that they knew to recur in their children's lives. How far do young children draw on their memory for the past when they contemplate a novel future activity rather than a recurrent activity? To answer this question, Richmond and Pan (2013) asked preschoolers about future possible events involving a novel combination of three elements (i.e., a person, a place and an object). For example, a child might be asked: "Tell me about something that might happen in the future involving your sister at the beach with a flower." Consistent with the proposal that future events are imagined by combining previously experienced elements, the number of episodic details that children generated in recalling past events was a predictor of the number of details they generated in imagining novel future events.

Research with children beyond the preschool period confirms the continuing close

relationship between memory for the past and imagining the future. Coughlin, Lyons and Ghetti (2014) asked 5-, 7- and 9-year-olds and adults to generate events from their past or likely future in response to particular cue words (e.g., pet, school). Raters coded participants' responses for the inclusion of episode-specific, contextual details – as opposed to more generic information. Individuals' scores for episode specificity for past events predicted their scores for future events. Wang, Capous, Koh and Hou (2014) asked European American and Chinese American children ranging from 7 to 10 years of age to talk about past and future events. For both groups, the amount of detail that children recalled in describing past events was a strong predictor of the amount of detail they generated in imagining future events. In addition, European American children recalled more detail than Chinese American children, not just when describing past events, as found in earlier studies of memory, but also when imagining future events.

The studies just reviewed – with amnesic adults and with children – reveal a consistent connection between detailed recall of the past and the ability to envision the future. Insofar as memory typically involves the recall of real episodes from the past, these studies are consistent with the claim that imagining what will happen in the future is linked to the recall of past reality. However, it should be acknowledged that the developmental findings are correlational. Is there any experimental evidence showing that recall of the past promotes the ability to anticipate and plan for the future? Developmental research has shown that between the ages of 3 and 5 years, preschoolers increasingly select items needed to deal with future contingencies – for example, selecting puzzle pieces if they are to re-visit a room with a puzzle board (Atance, 2015). Are children better at such planning if they are prompted to engage in a recall task, especially one that highlights links between the past and future self? Chernyak, Leech and Rowe (2017) allocated children aged 3 to 5 years to one of four groups and invited them to talk about events

from different time points. Subsequently, children were more likely to give a reminder to the experimenter at the end of the study (as requested of them earlier) and to provide appropriate explanations for taking particular items on a future trip (e.g., water for a walk through the forest) if they had talked about the near past or the near future. Chernyak et al. (2017) argue that such conversations were beneficial because, unlike conversations about either the present or the distant future, they highlighted children's extended self across time. Consistent with that interpretation, children in those two groups made more frequent references to the self than did children in comparison groups.

In summary, children, like adults, draw on similar processes when they remember the past and imagine future possibilities. Individual differences in memory for the past, as well as variation that is a function of age and culture, are reflected in similar patterns of variation in imagining the future. Children's future planning can be facilitated by highlighting continuities between past and future self. By implication, memory for past reality contributes to imagining what the future holds.

Judging what is possible

If young children envision what could happen in the future by drawing on their imagination, and if their imagination is constrained by what they have regularly observed in the past, they are likely to underestimate the wide scope of possible outcomes. More specifically, they will claim that a variety of unlikely and hard-to-imagine outcomes cannot actually happen. Research on children's judgments of what is possible versus impossible provides strong and consistent evidence of this underestimate.

Shtulman and Carey (2007) presented children aged 4, 6 and 8 years and adults with a storybook describing a mix of possible, impossible and improbable events. Possible events were

ordinary events (e.g., eating an apple); impossible events defied everyday causal constraints (e.g., walking through a wall); and improbable events were unlikely but not impossible (e.g., finding an alligator under the bed). When asked if the events could really happen (e.g., 'Could a person walk through a wall in real life?'), all age groups systematically judged that the possible events could happen whereas the impossible events could not. There was, however, a marked age change in judgments of improbable events. Four-year-olds incorrectly judged most improbable events to be impossible, 6-year-olds judged about half to be impossible, 8-year-olds judged one third to be impossible; only adults correctly judged them all to be possible.

Follow-up experiments showed that the errors on improbable items could not be attributed to a misunderstanding of the modal verb 'could' nor to children's thinking that they were being asked what could happen 'under normal circumstances'. In a final study, 4-year-olds were shown pairs of pictures, with one depicting an impossible event (e.g., walking through a brick wall) and the other an improbable event (e.g., finding an alligator under the bed) and asked to sort the pictures into different containers. Even on this forced choice task, 4-year-olds were prone to error. At some point, half tried to place both pictures in the container for impossible outcomes. As a further wide-ranging probe, Shtulman (2009) presented children and adults with events from the domains of physics, biology and psychology. The same pattern emerged across all domains: children and adults correctly judged the impossible events to be impossible but there was a marked increase with age in the acknowledgment that improbable events could happen.

A plausible explanation for this robust developmental pattern is that children arrive at judgments about future possibilities by consulting their limited imagination (Shtulman & Carey, 2007). Their imagination is constrained by the real events that they have observed in the past. Asked if someone can eat an apple, they can readily imagine someone doing that, having often

seen such an event – and they judge it to be possible. Asked if someone could walk through a brick wall, they have difficulty in imagining someone doing that – having never observed such an event – and they judge it to be impossible. Asked if someone could find an alligator under their bed, they have difficulty in imagining such an event, having never observed such an event – and they judge it to be impossible. Thus, outcomes that are readily observed and easy to imagine are judged possible whereas outcomes that are rarely observed and hard to imagine are judged impossible. Hence, young children end up ignoring the important conceptual distinction between what is hard to imagine and impossible and what is hard to imagine but nonetheless possible.

Lane, Ronfard, Francioli and Harris (2016) probed the proposed relationship between children's imagination and their judgments of possibility in more detail. They asked 4-, 6-, and 8-year-olds if various impossible and improbable outcomes could happen but before making each possibility judgment, half of the children were asked to close their eyes, to try to imagine the outcome in question, and to report on their success or failure. Replicating earlier findings (Shtulman, 2009; Shtulman & Carey, 2007), children improved sharply with age in recognizing that improbable outcomes could occur. Importantly, the same pattern of judgment emerged irrespective of whether or not children had been asked to close their eyes and imagine a given outcome before making their judgment. More specifically, being asked to imagine an improbable outcome (e.g., painting polka dots on an airplane) did not boost children's belief that such an event was possible. By implication, when making possibility judgments, children relied on their restricted imagination, whether they were externally prompted to use their imagination or not. Indeed, there was a robust relationship between children's reports on their imagination and their possibility judgments. Children who reported being able to imagine a given outcome were more likely to claim that it could actually happen. In addition, reports in which children described

imagining an ordinary cause for the outcome were associated with the claim that it could happen.

Why do children make more and more correct judgments about improbable events as they get older? Building on the hypothesis that such events are hard to imagine, two different explanations are feasible. First, as they age, children might become more resourceful in imagining improbable events such as finding an alligator under the bed. For example, they might increasingly envision rare contingencies (e.g., an alligator escaping from a zoo, or a house built alongside a swamp) that could account for such an improbable outcome. Alternatively, children might increasingly resist the error of treating their imagination as an accurate guide to what can and cannot happen. More specifically, having found it hard to imagine a given outcome, they might engage in a supplementary appraisal based on known causal facts – effectively asking themselves if a broad causal constraint prevents the outcome in question. Their initial intuition that a hard-to-imagine event cannot happen would be consolidated in some cases (e.g., walking through a brick wall could not happen because bricks always constitute a solid barrier) but undermined in others (e.g., finding an alligator under the bed could happen because no causal law invariably prevents it).

These two developmental accounts, one implying an increasingly elaborative imagination, and the other implying a growing reliance on known causal constraints, lead to different predictions about the way that judgments of impossibility will be justified as children get older. The first account predicts that younger children will report hypothetical negative outcomes for both impossible events ("You can't walk through a brick wall because you'd bump your head) and improbable events ("You can't find an alligator under the bed – only a toy one), but increasingly confine such negative reports to impossible outcomes, as they get older – thanks

to their more elaborative imagination. However, absent any type of supplementary appraisal, children should rarely if ever invoke causal facts. By contrast, the second account predicts that although younger children will rarely invoke causal facts in their justifications, older children will increasingly do so. Notably, they should increasingly invoke causal facts (e.g., "walls are solid") rather than reporting hypothetical negative outcomes (e.g., "you would bump your head"). The justification data reported by Shtulman and Carey (2007) lend clear support to the second account. The proportion of hypothetical negative outcomes mentioned in justifications declined with age whereas the proportion of factual claims markedly increased.

The second account also offers a plausible explanation for contextual effects on children's possibility judgments. Children aged 5- to 7-years are more likely to judge that improbable events, (e.g., a girl owning a pet zebra; a boy drinking onion juice) can happen if asked to think about them "in a country very far away" rather than locally (Bowman-Smith, Shtulman & Friedman, 2019). Arguably, children are less familiar with the causal constraints in unfamiliar settings and hence more likely to concede that improbable events could happen there.

In summary, when thinking about what could happen, younger children rely on their limited imagination and wrongly conclude that hard-to-imagine events cannot happen. Older children increasingly use a supplementary analysis to identify outcomes that are not subject to any known causal constraint – even if the exact way in which such outcomes might be realized remains hard to imagine. Hence, they become better able to anticipate rare but possible events.

Engaging in thought experiments

Adults sometimes use their imagination to engage in thought experiments that permit them to draw new conclusions about the way that reality works, in advance of direct, empirical investigation with actual materials Indeed, thought experiments are a central feature of

argumentation in both philosophy and science (Bascandziev & Harris, 2020). To the extent that children's imagination is guided by real-world regularities, they, like adults, should be able to engage in such instructive thought experiments. Yet, it is often assumed that young children learn best from direct engagement with concrete materials. The Montessori curriculum is guided by that assumption (Lillard & Taggart, 2019); it is implicit in the metaphor of the child as a scientist who engages in hypothesis testing via active exploration and observation (Gopnik & Wellman, 2012); and it is also implied by recent reviews of the benefits of guided play in which children explore concrete materials aided by adult scaffolding (Weisberg et al., 2016).

Given this emphasis on young children's engagement with concrete materials, the possibility that they might also learn about the world by engaging in thought experiments, as opposed to direct investigation, has rarely been considered. Yet, as argued earlier, children are able to imagine what would happen in a pretend world that reflects many of the regularities of the real world and is therefore aptly described as a Twin Earth (Lillard, 2001). Granted such parallels between the pretend world and the real world, it is feasible that children can, like adults, engage in thought experiments and thereby make discoveries about how the real world works. Recent findings support this speculation.

In predicting the fate of a ball dropped into one of three curved and crisscrossed tubes, each leading down to a separate cup, 2- and 3-year-olds often say that the ball will end up in a cup positioned directly under the point of insertion – as if carried there by gravity – whereas the ball will be constrained by the walls of the curved tube into which it is inserted and end up in a different cup. Importantly, children persist in making gravity errors even after successive trials with visual feedback about the ball's final location (Hood, 1995). Also, when children are given

trials with transparent tubes allowing them to see the non-vertical trajectory of the ball inside the tube, they revert to making gravity errors with opaque tubes (Hood, 1995, Experiment 3).

Joh, Jaswal and Keen (2011) asked if prompting children to use their imagination would help overcome these gravity errors. Children in the 'Imagine' condition were asked on each trial: "Can you imagine the ball rolling down the tube?" Children in the 'Wait' condition were told on each trial: "The ball is going to roll down the bumpy tube." Finally, children in the 'Look' were asked to look at the apparatus on each trial. Children receiving the 'Imagine' prompt made more correct predictions than gravity errors whereas children in the other two conditions did the reverse. Similar findings emerged in a follow-up study with two rather than three tubes (Palmquist, Keen & Jaswal, 2017): Children given the 'Imagine' prompt made correct predictions on almost all trials whereas children given control prompts performed at chance. In sum, these studies show that, when prompted to use their reality-based imagination, children can override the gravity bias and correctly anticipate where the ball will end up.

Bascandziev and Harris (2010) asked whether prompts to use the imagination lead only to a transient, trial-by-trial improvement on the tubes task or can lead to a more stable insight that supports improved performance even when the imagination prompt is withdrawn. Three-year-olds in a control group were given only a generic prompt to pay attention to the tubes to find the ball. Children in two experimental groups were prompted to visualize the way that the ball could not pass through the walls of the tube or the way that it would travel inside the curved tube. These two prompts led to greater selection of the correct cup and fewer 'gravity' errors, not only on training trials but also on subsequent post-test trials when no prompts were given. By implication, as they imagined the ball's downward trajectory, children were reminded of the constraints imposed by the solid walls of the tube and this overrode their naive heuristic that the

ball's trajectory was governed by gravity alone. More generally, these findings show that insofar as children's imagination is constrained by reality – they cannot, for example, readily imagine one solid object passing through another – it can serve as a mental laboratory, or Twin Earth, where they can make discoveries and undermine misconceptions about the real world.

Innovation and Problem Solving

Human technological progress is unmatched by that of any other species, but the study of human prehistory also reveals millennia of technological stasis. Indeed, some groups of hunter-gatherers have survived despite using approximately the same tool kit over tens of thousands of years. Moreover, despite the prominence of the ratchet metaphor implying the irreversible, forward thrust of human cultural and technological change (Tennie, Call & Tomasello, 2009), there are notable examples of technological regression and loss (Henrich, 2017). By implication, the pace of technological innovation in recent centuries is unlikely to be an informative guide to the human disposition toward innovation, especially by young children. Indeed, recent developmental research confirms that young children are surprisingly poor at creating tools. Instead, they are gifted pupils who attend sedulously to the techniques used by others, reproducing them with fidelity. Below, a spate of recent studies is reviewed showing that young children have difficulty in imagining what kind of tool they could make to overcome an obstacle even when suitable materials are visible nearby. Yet when shown a suitable tool made from those materials, they readily put the tool to use.

Tennie et al. (2009) found that most 4-year-olds were able to imitate a demonstration of how to make a loop from woolen filament, pass the loop through a mesh, and use it to lasso a baited vertical arm. By contrast, none of the great apes tested (chimpanzees, gorillas, orangutans and bonobos) copied the demonstration. Arguably, children's capacity for exact imitation is

beneficial in ensuring the transmission of opaque techniques not easily discoverable by an individual (Harris 2012). Yet, it is noteworthy that none of the children tested by Tennie et al. (2009) were able to produce a loop without a demonstration.

In another test of innovation, no 4-year-old came up with the idea of pouring water from a nearby beaker into a narrow transparent tube so as to raise and retrieve a peanut positioned at the bottom of the tube. Even when the tube was already partially filled with water, thereby lifting the peanut part way, only 17% of 4-year-olds added more water (Hanus, Mendes, Tennie, & Call, 2011). Older children – 8-year-olds – performed better, with 40% succeeding on the empty tube and 75% succeeding on the partially filled tube. In a follow-up study, Nielsen (2013) confirmed that an adult demonstration was very helpful for young children. In a variant of the peanut task, few 4-year-olds (only 14%) poured water from a bottle into a tube to retrieve a plastic monkey. However, after a demonstration of how water poured into the tube would lift the monkey without making it fully accessible, 61% of the unsuccessful children realized that they could succeed by pouring more water into the tube.

Beck, Apperly, Chappell, Guthrie and Cutting (2011) presented children with a sticker in a bucket located at the bottom of a narrow, plastic cylinder. When offered a choice of tool, most children appropriately chose a hooked rather than a straight pipe cleaner to lift the bucket by its handle. Yet when offered a straight but pliable pipe cleaner, less than 10% of 3- to 5-year-olds and less than 50% of 5- to 7-year-olds realized that they could bend it to form a suitable hook. Even among older children (aged 7-11 years), only about two thirds successfully fashioned and used a hook. Yet, when the experimenter showed children how to bend a pipe cleaner – almost all those who had failed to make a hook then did so, using it to lift the bucket – even though this specific use of a hook had not been demonstrated to them.

This pattern of faithful imitation combined with limited innovation is not confined to children in Western communities. Using the hook task, Nielsen, Tomaselli, Mushin and Whiten (2014) compared the performance of mostly middle-class 3- to 5-year-old children from Brisbane with children from five impoverished Bushman communities where children typically lack access to prefabricated toys. Such lack of access leads them to make their own toys. Hence, Bushman children might be more innovative in toolmaking than Westernized children. However, only 11% of Brisbane children and no Bushman children autonomously formed a hook even if many did so after an adult demonstration.

In sum, young children can identify a potentially suitable tool, copy its manufacture, and put it to use, but left to their own devices, they do not 'invent' a suitable tool. By implication, their failure to innovate is brought about by a lacuna at an early stage of the tool-making process, arguably a difficulty in imagining the kind of tool that would solve the problem, even if they are competent at the subsequent steps of tool manufacture and deployment. Follow-up studies cast doubt on two alternative explanations. Perhaps children in the preceding studies lacked experience with the materials or failed to understand that they were free to make something with them. However, even after experiencing the pliability of the pipe cleaners – i.e., by twisting a pipe cleaner around a pen – few 4- to 7-year-olds succeeded in making a hook (Cutting, Apperly & Beck, 2011). Moreover, when told that a puppet, the apparent owner of the materials, invited them to make something to solve the retrieval problem ("Heinz says he has some things here you can make something with to get the sticker"), the invitation had little impact.

Between approximately 5 and 8 years approximately a third to a half of children succeed at tool innovation, raising the question of what personality factors, if any, play a role. In two studies of the hook task, 5- to 8-year-old displayed the expected variation in performance, with

just under half making a hook (Beck, Williams, Cutting, Apperly & Chappell, 2016). However, success was not linked to individual differences on measures of divergent thinking or executive function. Indeed, it is unclear whether individual children perform similarly across different innovation tasks. We do not know, for example, whether children who succeed on the hook task would also solve the floating peanut task and vice versa. In short, it would be premature to assume that some children are distinguished by a precocious capacity for innovation. We are on safer ground in affirming the developmental claim, namely that from early to late childhood there is a steady increase in the proportion of children who successfully innovate on a given task. Variation in innovation is more clearly tied to development than to individual differences in personality.

Cutting et al. (2011) offer a persuasive analysis of this developmental change. Innovation tasks are 'ill-structured' in the sense that even if the goal is clear (e.g., the extraction of a sticker from a basket at the base of a cylinder), the potential means for reaching that goal are poorly specified. If the potential means for reaching the goal are dramatically narrowed – for example, if preschoolers are presented with a choice between two potential tools, a straight versus a hooked pipe cleaner – most correctly choose the hooked pipe cleaner. By contrast, if they are presented with similar materials – a piece of string and a straight pipe cleaner – but with no clear indication of the potential means, few children think of bending the pipe cleaner. By implication, young children are poor at imagining an appropriate tool when the range and type of tool that might be effective is poorly defined. Hence, we may speculate that older children are more innovative because, with respect to many practical problems, they have had more opportunities to observe and use an appropriate tool. In the course of development, their exposure to an increasingly diverse range of the tools heightens the probability that they will bring to mind a

suitable tool – for example, the use of a hook to lift an otherwise inaccessible basket – thereby converting an ill-structured problem into a more narrowly defined one, namely, how to create a hook, given the materials at hand. By implication, the increase with age in successful tool innovation can be plausibly attributed to a growing familiarity with a variety of tools.

Note that, according to this account, when children succeed on tool innovation tasks, they are neither inventing a tool *de novo* nor putting a familiar tool to a new or innovative use. Instead, children are drawing on their prior knowledge of tools and their causal effects on the real world. More specifically, in their imagination – i.e., before constructing a tool – they draw on their pre-existing knowledge to select the mental template for a tool that, once manufactured, will be suited to the particular task facing them. Clearly, such knowledge is likely to accumulate and broaden as their experience within the surrounding culture widens – thereby explaining the developmental improvement in tool manufacture. Indeed, according to this account, a measure of children's exposure, whether informal or structured, to a suitable tool is likely to be a stronger predictor of their tool-making than a blunter correlate of such exposure, namely their chronological age.

Drawing what does not exist

Young children are mostly figurative artists who spontaneously draw observable entities. Admittedly, their drawings often display only a modest likeness to the objects they seek to depict. For example, preschoolers may draw the human figure by means of a tadpole – a fusion of head and torso – to which arms and legs are attached. They may depict objects positioned on a table as if they were floating above a rectangular box not resting on a flat surface (Willats, 1977). Yet despite these challenges in representing 3-dimensional objects on a 2-dimensional surface, young children aim to portray observable entities. They draw human figures, animals, houses,

vehicles and so forth. They show few signs of wanting to depict a fantasy world or the non-existent entities that might populate it (Harris, 2020). Such figurative realism is an important cognitive achievement, likely unique to humans. When offered multiple opportunities to draw, chimpanzees only engage in scribbling or outline tracing (Saito, Hayashi, Takeshita & Matsuzawa, 2014). Even when prompted to engage in a simple, figurative task, they are unsuccessful. For example, presented with a drawing of a chimpanzee with one eye rather than two eyes, they do not complete the drawing whereas 2-year-olds readily produce such completions, often naming the missing feature before starting to draw. Saito et al. (2014) speculate that unlike chimpanzees, 2-year-olds use existing cues to conjure up a complete mental template, as shown by their naming of the missing part, and their accurate completions.

Given their proclivity toward figurative drawing, are young children also capable of drawing non-existent entities? Karmiloff-Smith (1990) asked children to draw a house, a man and an animal and then to draw a house, a man and an animal that do not exist, using several verbal formulae to help children understand these latter requests (e.g., "an X you invent" or "an X we have never seen before"). Many older children, aged 8-10 years succeeded by inserting an extra component, transposing components, or importing components from another category of entity. For example, in drawing a non-existent man, they might draw a man with an extra head, a man with a leg growing out of his shoulder, or a man's head and chest fused with the body of an animal. By contrast, few 4- to 6-year-olds (10% or less) produced these relatively complex solutions even if they sometimes produced simpler solutions, such as altering the shape of a component or omitting it altogether.

Karmiloff-Smith (1990) interpreted this age change in terms of older children's more flexible drawing skill – for example, in combining their routines for a man and an animal so as to

produce a centaur-like hybrid. However, subsequent research has shown that young children have problems in generating departures from everyday reality in their imagination, not in subsequently drawing them. Given external scaffolding for their imagination, they successfully re-configure their drawing routines. For example, Zhi, Thomas and Robinson (1997) gave children either a picture or a clay model of a woman with two heads and asked them to draw a man with two heads. Across four experiments, between a half and two-thirds of 3- to 5-year-olds succeeded. Berti and Freeman (1997) replicated the age change observed by Karmiloff-Smith (1990). More than half (55%) of 5-year-olds refused to draw a non-existent man or drew a normal man whereas none of the 9-year-olds refused, and few drew a normal man. Yet, when re-tested after a verbal prompt ("Do you know how a drawing of a man who doesn't exist could be done? It could be done with two heads."), most 5-year-olds (76%) drew an impossible man.

Leevers and Harris (1998) tested typically developing 4-year-olds, children with moderate learning difficulties, and children with autism. Rather than a free-drawing task, children were presented with incomplete drawing pairs – two incomplete drawings of a house and two incomplete drawings of a man – and asked to complete one member of each pair so that it looked real and the other so that it looked impossible. If children failed the latter task, they were given specific instructions, for example to draw an impossible house, they were told to draw "a door in the roof" and to draw an impossible man, they were told to draw "a man with two heads." Most children successfully completed the drawings to make them look like a real house or man, but they were much less successful in making them look impossible. However, after being given specific instructions about what to draw, the performance of all three groups improved sharply, with most children successfully producing an impossible house or man.

These findings for children's drawings are based on tasks in which children are prompted by an experimenter to draw something that does not exist. Arguably, children's spontaneous drawings would reveal greater inventiveness. However, the classic work of Luquet (1927), which inspired much subsequent research on children's drawings was based on more than 1700 drawings spontaneously produced by his daughter. On the basis of these drawings, Luquet concluded that children are figurative realists: they seek to depict real objects, often including features that they know belong to an object when those features cannot actually be seen from a given vantage point. Overall, the findings for figurative drawing echo those for innovation. When asked to extract a reward from a tube or to draw an impossible man, children face an ill-structured problem. It is up to them to generate the vehicle that will solve the problem – for example, to generate the idea of making a hook with a pipe cleaner or to generate the idea of drawing a man with two heads. If those ideas are externally prompted – for example, if children are shown a hooked pipe cleaner or a person with two heads – they readily execute the relevant steps: They can make a hook from a pipe cleaner or draw a man with two heads. Their difficulties arise at the initial stage of generation rather than the later stage of execution. More generally, the findings for tool innovation and drawing echo those in other domains – pretend play, thinking about the future, and making judgments of possibility. Children are imaginative in the sense that they are capable of conjuring up the familiar regularities of everyday reality – but not in the sense that they routinely generate novel or extraordinary possibilities.

Three plausible objections might be raised against this characterization. First, young children are able to entertain patently false premises and reason from them. Second, the stories written for young children suggest that they have a preference for the fantastical and magical.

Finally, some children invent make-believe companions and even make-believe worlds. Each of these three objections is considered in turn.

Reasoning from false premises

Children and adults with little or no access to formal schooling routinely display an empirical bias in their approach to reasoning problems (Harris, 2000; Luria, 1971; 1976). Presented with a premise that does not fit, or lies outside, their everyday experience, they balk at accepting the premise as stated. For example, when told that fishes live in trees, and that Tot is a fish, and asked where Tot lives, preschool children resist accepting the initial premise which they know to be false. They affirm instead that Tot lives in the water and back up that claim by reference to empirical reality – ignoring the initial premise (Dias & Harris, 1988; 1990; Richards & Sanderson, 1999).

Nevertheless, when prompted to use their imagination, young children (Harris, 2000), and indeed adults with little exposure to formal education (Dias, Roazzi & Harris, 2005), do reason from premises conflicting with their empirical experience. Such findings appear to undermine the claim that young children's imagination is tethered by their knowledge of reality. Instead, they entertain the false premise that fishes live in trees, reason that, if Tot is a fish, he lives in a tree, and offer a so-called analytic rather than an empirical justification for their conclusion by referring back to the experimenter's assertion ('You said that fishes live in trees' 'Because we're pretending that fishes live in trees') (Harris, 2000). A clear implication is that young children can use their imagination to entertain possibilities inconsistent with their past observation of reality.

However, there is an important caveat. As noted above, when preschoolers are presented with premises outside their everyday experience, and asked to reason from them, they routinely

display an empirical bias, as measured by the frequency of their incorrect answers and empirically based justifications. Only when their interlocutor provides a relatively potent scaffold for their acceptance of an unexpected premise are children willing to entertain and reason from it. For example, in an initial study, Dias and Harris (1988) supported 4- and 6-year-olds' acceptance of premises such as 'All fishes live in trees', by asking them to look into a small, boxed diorama, where they could see toy trees with fishes dangling from them. Subsequent studies with 4-, 5- and 6-year-olds showed that verbal prompts could also be effective, if they included clear indications about how children should think about the supplied premises. Thus, when the experimenter stated the premises with a dramatic intonation as if telling a story, or explained that they described a far-away planet, or asked children to 'make a picture in their head' of the relevant premises, correct logical performance and the production of analytic justifications referring to the premises were frequent. By contrast, when the premises were stated with a minimal introduction and in a matter-of-fact fashion, children mostly drew logically incorrect conclusions and rarely offered analytic justifications (Dias & Harris, 1990).

Subsequent studies by Leevers and Harris (1999) confirmed this pattern. When 4-year-olds were presented with incongruent premises (e.g., 'All snow is black') and given systematic prompts to think about or construct a mental image of each premise – followed by relevant checks to assess whether they were doing as prompted – children often produced correct logical replies and analytic justifications. By contrast, when given only a brief preamble, in which they were told that the stories they were to hear might sound funny but to think about what things would be like if they were true, children rarely produced logical replies or analytic justifications.

Similar results were obtained with 2-, 3-, and 4-year-olds by Richards and Sanderson (1999). When the experimenter gave children a weak cue – notably asking them to pretend that

the stories they heard were true – children in all three age groups typically reasoned incorrectly. For example, having been told that: "All sheep ride bicycles" and that "Bill is a sheep" and then asked if Bill walked or rode a bicycle, children said that Bill walked and offered an empirical justification such as: "Because I know that sheep walk." By contrast, when children were given strong cues to use their imagination – either to pretend that they were on another planet where everything was different or to use mental imagery by making a picture in their head – they were likely to reason correctly from the premises, and to justify their conclusion by referring back to what the experimenter had said (e.g., "Because the story said that cats bark"). Moreover, the combination of correct conclusion plus analytic justification was mostly produced after the strong imagination cues whereas the combination of incorrect conclusion plus empirical justification was mostly produced after the weak imagination cues.

In summary, with explicit prompting from an adult interlocutor, children can represent and reason from premises outside their everyday experience. Absent that scaffolding, they are prone to an empirical bias. This pattern is consistent with the conclusions reached in earlier sections: when provided with external support – such as a demonstration of how to manufacture a tool or a verbal reference to a man with two heads, preschool children are receptive. They are able to entertain what their interlocutor intends and respond appropriately. However, when left to their own devices, children draw on their experience of everyday reality. They infer empirically plausible conclusions, ignoring the logical implications of the syllogisms as presented.

Children's fiction

Stories for children are often unrealistic. They include animals that talk, princes that turn into frogs, and carriages that turn into cabbages. By implication, children readily consume stories about unrealistic or magical possibilities. Note that even if this conclusion is true, it does not

undermine the claim that children's imagination is ordinarily guided by what they know of reality. It simply shows that children are receptive consumers of the stories supplied by adults. However, recent studies show that young children's supposed preference for stories with unrealistic content may not exist. When Barnes, Bernstein and Bloom (2015) presented children and adults with a choice between realistic and fantastical stories, 4-5-year-olds – unlike 6-8-year-olds and adults – expressed no preference for the fantastical stories. Moreover, when children aged 4-7 years were asked to choose stories alleged to be true versus make-believe, they expressed a systematic preference for the true stories.

Children also display a bias toward realism when they are asked to say how a given story should be elaborated. Weisberg, Sobel, Goldstein and Bloom (2013) presented 4-year-olds with either a realistic or a fantastical story and asked them to fill in missing parts of the stories. Both the realistic and the fantastical story had the same overall event structure (a boy and his dog got ice cream, went to a petting zoo, and came home for dinner) but, unlike the realistic story, the fantastical story included reality violations such as a child who could fly, and animals that could talk. When each story was read to children, the experimenter asked for children's help with the missing parts, in each case offering them a choice between a realistic continuation and a fantastical continuation, with each alternative illustrated appropriately. Irrespective of which story they heard, children mostly opted for realistic continuations. A comparison group of adults, by contrast, tailored their choices to the story presented by selecting mostly realistic continuations for the realistic story and mostly fantastical conditions for the fantastical story. Similar results emerged in a follow-up study in which 4-year-olds were given more extensive exposure to a fantastical story before being invited to say how it should continue. Again, they mainly opted for realistic continuations.

Nancekivell and Friedman (2017) examined the explanatory framework that young children aged 6 and 7 years adopt towards remarkable, quasi-fictional episodes, such as a man having a beard down to his toes, a woman having a unicorn for a pet, or a man having a house made of clouds. Children frequently judged such episodes to be impossible but went on to volunteer naturalistic rather than magical explanations for their occurrence. For example, most children judged owning a unicorn to be impossible but offered non-magical explanations, such as: "Well, well probably from the pet store" or "Maybe she won at the farm in like a different country." A similar pattern emerged in a follow-up study. When 6- and 7-year-olds were asked to explain impossible episodes, they typically volunteered naturalistic explanations even when the protagonist was a magic being – a fairy or witch – rather than an ordinary person.

Taken together, these findings indicate that young children do not readily construe fantastical episodes as belonging to an exotic, reality-defying environment. When presented with a story that includes such episodes, they opt for realistic rather than magical continuations and when asked to say how the episodes came about children mostly offer naturalistic rather than magical explanations. Admittedly, these findings do not show that young children are unreceptive to the departures from everyday reality that they encounter in children's fiction, especially in fairy tales, but they do show that it may be misleading to draw conclusions about children's own imaginative dispositions and capacities from the fictional materials that adults create for them.

Imaginary beings

Some young children invent an invisible companion, project animate characteristics onto a doll or stuffed animal, or impersonate a person – or animal – for extended periods (Taylor, 1999). It is hard to be sure how many young children engage in such activities but in a careful

assessment, involving two interviews with 3- and 4-year-olds as well as two parallel interviews with their parents, Taylor and Carlson (1997) concluded that almost 40% had an imaginary companion, or engaged in impersonation, or both. Moreover, it is quite common for children who lack an imaginary companion at 3 or 4 years to invent one after the age of 4 years (Taylor, 1999). By implication, the tendency to imagine a living being is not rare among young children.

Do these forms of make-believe undermine the current thesis, namely that young children's imagination is closely tied to reality? Some of their inventions do include notable departures from verisimilitude. For example, a 3-year-old boy imagined a female companion with long yellow braids that dragged behind her; a 4-year-old imagined a pair of brightly colored birds that talked incessantly; a 5-year-old imagined a dolphin called Dipper who had sparkles and stripes and lived on a star (Taylor, 1999). In future research, it would be valuable to obtain, more systematic information about the frequency of such departures from ordinary reality as well as information about potential sources of inspiration in the stories or picture books supplied to children by adults. Miller, Hengst, Alexander and Sperry (2000) offer compelling evidence of such inspiration in a case study of how a child's early make-believe can be infused by fiction. They explain how 2-year-old Kurt drew on his exposure to gardens and plants and on frequent retellings of *The Tale of Peter Rabbit* to generate his own stories. Gazing at his grandparents' garden, he imagined Peter Rabbit engaging in various transgressions: "Peter Rabbit ate the iris…ate them *all* up!" In later stories, he coordinated fictional protagonists (e.g., the mother of Peter Rabbit) and real people (e.g., his grandmother), for example: "…Mother says, 'don't go there'…Grandma planted some flowers in there."

Whatever the original source for children's choice of an imaginary companion, one notable characteristic recurs across them. Many of the attributes that children ascribe to such

beings are grounded in reality. Thus, an imaginary companion is typically invested with the psychological characteristics of an ordinary person – he or she interacts as a playmate or confidant, expresses thoughts and emotions, eats and sleeps, is a source of reassurance and sometimes of frustration – by arguing or failing to show up. Similarly, the impersonation of animals often involves a faithful reenactment of the creature's repertoire, whether to go on all fours, to bark, to rub against the legs of guests, or to cock a hind leg.

Finally, the tendency to engage in role-play and to invent an imaginary companion is correlated with the ability to think accurately about other people' mental states. Indeed, young children with an imaginary companion perform relatively well when asked to engage in a pretend phone conversation (Astington & Jenkins, 1995; Taylor & Carlson 1997). By implication, children who invent or impersonate pretend beings draw on a realistic rather than a fantastical understanding of other people.

Conclusions

Early accounts of the development of the imagination portrayed young children as fantasy prone. For example, echoing Freudian claims, Piaget emphasized the early dominance of fantasy over reality-based thinking (Harris, 1997; 2000; Piaget, 1923). On that classic account, a more objective and reality-oriented stance emerges slowly in the course of development, displacing children's tendency toward unrealistic fantasy. As described in the introduction, more recent studies of pretend play have analyzed the intriguing individual differences among young children in their disposition to become engaged in a make-believe world where they invent imaginary companions or indeed whole communities. Neither of these accounts has focused on the connections between children's understanding of reality and their imaginative activities. Yet those connections are apparent from an early age in children's pretend play. Moreover, such

connections persist into adulthood because the recall of past reality is likely to impact the way in which the future is envisioned. Indeed, to the extent that older children and adults must plan a variety of short and long-terms activities, the intimate connection between knowledge of reality and the contemplation of future possibilities is likely to be a stable feature of mature thinking.

Besides this enduring connection, the present review has also pointed to plausible developmental changes. Commensurate with their developing recall of the past, children should be increasingly able to envisage what might happen in the future and to plan appropriately for contingencies that might arise. In addition, insofar as children critically appraise the products of their imagination, they can increasingly differentiate between what cannot possibly happen and what might conceivably happen even if it is improbable. Moreover, in the course of development, children show signs of greater inventiveness. Faced with a problem whose solution is specified in an ill-structured fashion, older children are more adroit than younger children at identifying a workable solution from among the range of possibilities. They are able to entertain a solution in their imagination and to set about executing that solution, whether it involves the manufacture of a tool or the drawing of a non-existent entity. In each of these cases, there is a striking gap between the difficulties that young children display when left to their own devices – i.e., when left to decide what tool to make or what novel entity to draw – and the relatively successful performance they display when given an external prompt. Thus, in each case, young children's difficulties lie in the autonomous generation of a mental template or plan of action but if that is supplied externally, they succeed.

This account of the imagination opens up several potentially fruitful avenues for developmental research. First, it invites further analysis of the extent to which reality-based constraints continue to guide children's imagination in the course of development. Consider, for

example, the development of counterfactual thinking (Nyhout & Ganea, 2019). According to the

present account, children should typically generate counterfactual alternatives that are closely

tied to realistic possibilities even if they are receptive to more exotic possibilities when those are

presented to them. Consistent with these prediction, when 6-11-year-olds were invited to

generate counterfactual thoughts in the wake of a negative outcome (e.g., a farmer's poor

harvest), almost all of their proposals involved naturalistic alternatives (e.g., "If only he had

watered them more") (Botsolis, De La Vina Simon, Payir, Harris & Corriveau, 2019). Thus,

non-naturalistic alternatives (e.g., "He could have prayed") were rarely proposed. Nevertheless,

children who were receiving a religious education systematically endorsed the plausibility of

such alternatives when explicitly presented with them.

Second, this account invites further consideration of the ways in which children's

imagination can be used in the classroom. As noted in the discussion of thought experiments,

children's reality-based imagination is a positive advantage if they deploy it to contemplate the

way that reality operates. In particular, prompting children to entertain various physical or social

scenarios, and to contemplate how they might play out, may help them to overcome naïve or

unreflecting intuitions. Thought experiments have played a major role in the history of

philosophy and science, but their pedagogic benefits have rarely been explored in the classroom.

Finally, this account invites more research on how cultural input can scaffold and

ultimately shape the development of the imagination. Young children learn about the world from

direct observation and, as argued in this paper, that empirical observation of reality guides their

early imaginative activities. Nevertheless, the evidence also shows that children are often

receptive to imagining possibilities introduced by other people. For example, when it is enacted

by a play partner, they readily imagine a pig squirted with ketchup; when explicitly prompted to

do so, they can imagine the non-vertical trajectory of a ball rolling down a sloping tube; and when cued by an adult, they can imagine a tool or non-existent entity that they proceed to make or draw. More generally, children also learn about the world and its possibilities from cultural input in the form of toys, stories, explanations, drawings, films and cartoons, typically created and supplied by adults (Harris & Koenig, 2006; Singer & Singer, 1990; Woolley & Cornelius, 2013). Some of that cultural input can expand children's understanding of reality. Thus, on the basis of stories and films, they can contemplate in their imagination remote places and events that they cannot easily observe first-hand. Other forms of cultural input are likely to override rather than simply expand children's conception of reality. Thus, the supernatural powers described in religious narratives, the unobservable entities invoked in science, and the alternative possibilities represented in fiction, will also feed children's imagination, leading them to set aside the known constraints of everyday reality. By implication, the direction that children's imagination takes in the course of development is likely to be strongly inflected by the representations – in religion, science and fiction – that they encounter in the surrounding culture.

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