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Skill learning and conceptual thought: making a way through the wilderness

Often, when philosophers want to emphasize the *discontinuity* between human and animal cognition, they point to the fact that normal, mature, human adults have the capacity to think abstractly, conceptually, flexibly and in ways that are not bound to their immediate surroundings.[1] Notably, humans can contemplate the nature of justice, write a poem about a fictional character, plan a dinner party, and construct a 5-year plan. In a similar spirit, when trying to locate the *continuity* between the intelligence of human and non-human animals, natural-minded philosophers often avoid talking about abstract, conceptual thought, but rather, emphasize action, ability, and skill. It is supposed that it is in the practical realm that human animals and creatures lower on the evolutionary ladder might hold something in common. After all, birds build houses and humans build

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[1] For example, philosophers as diverse as Fodor (1983) and Millikan (2006) have emphasized the flexibility, agency, and non-situation-bound character of human thought. Fodor writes: "We have only the narrowest of options about how the objects of perception shall be represented, but we have all the leeway in the world as to how we shall represent the objects of *thought;* outside perception the way that one deploys one's cognitive resources, is, in general, rationally subservient to one's utilities. Here are some exercises that you can do if you choose: think of *Hamlet* as a revenge play; as a typical; product of Mannerist sensibility; as a pot-boiler ; as an unlikely vehicle for Great Garbo. Think of sixteen different ways of using a brick." (p. 55). Millikan writes, " The pushmi-pullyu animal solves only problems posed by immediate perception. It does so by deciding from among possibilities currently presented in perception, or as known extensions from current perception, as in knowingly moving from a known place toward another place known to afford what the animal currently needs. Human beings, on the other hand, spend a great deal of time collecting both skill and pure facts that no experience, either individual or the species, has yet shown any relevance to practical activity…They are curious about what will cause what and why, wholly apart form any envisioned practical applications for this knowledge" (p. 122).

houses. Squirrels can climb trees and humans can climb trees. It is thought that if there is any place where we might be able to locate the natural springs of human intelligence, it will be in the area of intentional action and ability.[2]

Contrary to received wisdom, in order to construct an adequate, naturalized theory of higher-order cognition, I suggest that we should look both to the continuity *and discontinuity* between human and non-human animal intelligence *in action*. That is, I claim that the discontinuity between human and non-human animal cognition is not simply realized in the distinction between action and conceptual thought, but rather, that there is important discontinuity between human and animal cognition in the realm of practical ability. Crucially, I claim that discontinuity in the realm of action can be explanatorily powerful in providing us with a naturalized account of human cognition. In what follows, I demonstrate how exploring uniquely human skills provide us with the opportunity to construct an intermediate stage of intelligence, which is both naturally grounded and sufficiently sophisticated to explain some basic features of conceptual thought.

My main claim is that the flexibility, creativity, agency, and deliberateness involved in skill refinement plays a key role in the development of human-style intelligence. Specifically, I claim that human skill learning occupies an intermediate territory between rote, fixed, procedural behaviors and fully abstract, conceptual thought. I suggest that it is through the process of skill learning that intentional actions break free from their domain-specific, instantiation environments and begin to exhibit increasing degrees of distinctness and abstractness. As such, it is through skill learning that action

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[2] See Millikan (2006); Dretske(1997; 2006); Hurley(2006) for examples of this kind of move.

elements acquire the capacity to show up, not fully independent of any context whatsoever, but in multiple contexts and multiple roles.

The following is a preliminary exploration of the relationship between skill learning and conceptual thought. It is a first attempt to present a theory that does justice to the role of skill learning in developing fully rational, higher-order, cognitive faculties. As such, naturally, many of the details will be impressionistic. Still, I hope that the general outlines and motivations of the theory will be clear enough to convince the reader that this approach is both promising and sound.

This paper will proceed as follows: in section one, I present three important features of human skill. In section two, I forward two distinctions: one between ability and skill and another between skill and conceptual thought. In section three, I present a framework where skill learning constitutes an intermediate cognitive category, which affords the development of several features characteristic of human thought. In section four, I review the hard-earned cognitive gains that follow from skill learning and, in section five, I respond to two objections.

1. The curious nature of human skills

1.1. Impractical skills—and so many of them

> One of the striking trends in human evolution, going back thousands of years, is the gradual diminution in the proportion of human effort devoted in any clearly discernable way to the achievements of the fundamental goals we share with animals: avoiding pain, hunger and predation, and seeking comfort, securing and mating opportunities. Even if the peculiar human desiderata of prestige, power, wealth, beautiful surroundings, recreation, music, toys, and so forth have discernable instrumental rational (improving one's contest for mates, enlarging one's harem, one's territory, one's margin or error) they have more or less detached themselves from these inaugural foundations and become ends in themselves. The young man bought the guitar in order to attract young women, but now he has become a guitarist who would rather make music than love (Dennett, 2006).

A strange and often overlooked fact about humans is that we spend vast amounts of time, energy, and resources pursuing a multitude of hobbies and skills that have no clear evolutionary advantage. As Millikan (2006) points out, "children practice hula hoops, Rubik's cubes, wiggling their ears, cracking their knuckles, standing on their hands, and turning around to make themselves dizzy." People not only learn to solve Rubik's Cube puzzles, but some even learn how to solve them using their feet. They play Tetris for hours on end, build enormous card houses that no one will ever see, knit booties for their pets, assemble and disassemble model cars, and reenact their favorite movie scenes in front of the mirror.

Some activities involve developing athletic skill, others nurturing artistic talent. Some appear to be ways of fighting boredom, and others more like compulsions. Some skills are performed in groups, some individually, some involve competitions or public displays while others never see the light of day. Some skills highlight strength and beauty, others point to oddness or idiosyncrasy. Some skills are big and bold, others small and quiet. Some skills are shared by most conspecifics and learned through formal education, others signal membership to a particular class or group, and still others never catch on beyond one lone individual. The skills we develop are manifold, multiple, and amazing. They are extraordinary and extraordinarily weird! Why in the world do we pursue so many practically useless skills?

1.2. Impractical skills—over and over again

The oddness of human skill extends beyond the shear number of seemingly useless skills that we acquire to the amount of time and energy that we spend perfecting them. It should be clear that the energy that we expend refining skills is notably disproportionate

to any evolutionary advantage that they might hold. Think of the hours, days, months, and years that people spend practicing, training, drilling, and perfecting a sport, a musical instrument, a craft, or a hobby. We are not surprised when we hear about a person continuing to practice some skill after she is able to successfully perform it.[3] In fact, we are often inspired by the amount of dedication and discipline that it takes to push one's expertise to the next level. People refine and refine and train and train and, at their best, their goal is not to reach the bar, but to set a new one.[4]

Further, we should notice that developing skill often involves not only achieving a goal but achieving that goal in a particular manner or style. The fact is that attaining many high-level goals requires attention to and control over the way or fashion in which the skill, which aims at that goal, is instantiated. Even more surprisingly, however, we sometimes see that goal of the skill is irrelevant for some particular practice. Instead, it is the particular style or way in which one instantiates a skill that one seeks to refine— regardless of whether that refinement will make the goal more accessible. Think of the symphony, ballroom dancing, the Olympics, or the Venice Biennale—the goal isn't just to play a note, or dance a waltz, or finish a race, or paint a portrait, but to perform elegantly, precisely, powerfully, and harmoniously. This emphasis may have an integral connection to bettering performance, but it need not. Crucially, in either case, we must notice that in order to refine a skill, some feature of the skill itself, and not just some feature of the end at which the skill is aimed, must become an object of interest and

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[3] As Dennett writes "surprise is a wonderful dependent variable, and should be used more often in experiments; it is easy to measure and is a telling betrayal of the subject's *having expected something else*" (2001, p. 982).
[4] This does not, of course, require that all or even most of our skills are developed in this way. Such a claim would be blatantly false. The important point is not that all skills are developed to this extent, but that each individual has some skills, which she has developed beyond their mere utility.

concern. This means that we take interest in developing skills as ends in themselves. And this is too is weird!

1.3 Impractical is as impractical does: imitation

We should note that the impractical orientation that we have towards skills and the means by which they are performed can be identified in other uniquely human practices. For instance, our impractical orientation towards actions and their means can be gleaned from the strange human tendency towards imitation.

It is widely accepted that human children imitate far more frequently and in a far more detailed manner than any other organism.[5] For present purposes, it is important to notice that not only do human children prefer imitation as a learning strategy but often, human children will replicate an action or activity that is largely irrelevant for the goal at hand.[6] Curiously, this is kind of behavior is not seen in non-human primates.

For example, Horner and Whiten (2005) found that when both chimpanzees and children observed a causally irrelevant action in a series of movements that was required for retrieving a reward from a locked box, only human children replicated the causally useless movement. Once chimpanzees identified the movement as inessential to their goal, they dropped that movement from their behavioral repertoire. In contrast, children, even after identifying the movement as causally inefficacious,[7] continued to incorporate the movement into the sequence of behaviors they used to unlock the box. This indicates that while for primates the means by which goals are achieved derive their value

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[5] This does not mean that everyone agrees that only humans imitate. For instance, Byrne and Russon (1998); Byrne (2002); and Horner & Whiten (2005) disagree with Call, Carpenter & Tomasello (2005) by holding that non-human primates are capable of imitation. Regardless of this dispute, however, everyone agrees that imitation plays a special role in the learning and development of human children.
[6] See also Geregely & Csibra (2005); Schwier, et al. (2006); Byrne and Russon (1998), and Hobson and Lee (1999).
[7] Horner and Whiten (2005) conducted separate experiments establishing that children were able to discriminate between causally effective and ineffective actions.

exclusively from their instrumentality, for children, the means of goal attainment can have value that is detached from their role as a means for reaching some end. That is, for children, replicating a purposeful sequence of movements can hold value apart from that sequence's connection or efficacy for achieving some end. For children, the value of the activity need not be a practical, instrumental value.

The impractical orientation that children have towards the means by which goal-directed actions are instantiated is by no means isolated to a few clinical instances. In fact, the reproduction of the detailed style of an observed action is almost always irrelevant for accomplishing a particular task. But children regularly take interest in perfecting the detailed manner or style in which a model demonstrates a behavior. It's possible, then, that this "means-centric orientation" present in imitation may be the same orientation that drives children to refine and perfect their skills once they have acquired them. That is, the emphasis on and preoccupation with impractical actions may underwrite a number of human activities that are relevant for developing our peculiar kind of intellect.

1.4 Impractical skills and evolutionary considerations

Are skills and their refinements really evolutionarily valueless? Couldn't we find some story to tell where hula hooping, origami folding, terrarium building, video-game playing, memorizing baseball statistics, and popping one's thumb in and out of its socket all do something for us evolutionarily? Perhaps they make us more attractive to potential mates by highlighting our beauty, coordination, attention to detail, or sense of humor. Like peacock feathers or the nests of Bower birds, perhaps skills just make us stand out.[8] The problem with this kind of explanation, however, is that for every skill that we can

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[8] Thanks to Josep Call for pointing out this potential explanation of the utility of our skills.

think of that may show off some evolutionarily relevant feature, there are ten other skills that do not. The fact is that for every respectable, generalizable, evolutionary principle, which could explain the bizarreness of some one skill or other, there are countless other skills that do not naturally fit the bill.

Of course, such an explanation would also ignore the lack of proportionality between the time and energy invested in refining skills and their not-very-straightforward payoffs. This is not to say that skills never have or have had any evolutionary role,[9] but it is to say that whatever they do for us now, as Dennett (2006) put it, "they have more or less detached themselves from these inaugural foundations and become ends in themselves."

Additionally, it is important for us to note that just coming up with some evolutionary story for each odd or weird human endeavor is not enough for a selection story. For a non-contentious naturalist account, we would also have to show how pursuing that particular activity would be *more* effective than spending one's time pursuing some other more straightforward activity. That is, the bizarre activity couldn't just be attractive to someone in some way, but it would have to be shown to be more effective, in an evolutionarily significant way, than the countless other activities that one could alternatively pursue in order to reach that same end. The activity's ancestor, after all, would have had to have beaten out countless other endeavors in being selected for. So, one may claim that playing hours of Tetris on one's smartphone signals to a potential mate one's excellent hand-to-eye coordination, but then we'd have to ask if perhaps playing actual tennis with this potential mate wouldn't signal this more effectively.

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[9] Thanks to Richard Moore for highlighting this important point.

At this stage, I recommend revisiting our unreflective assumption that every activity must have a proprietary purpose for its existence. We should notice that a naturalistic story does not require that each activity on its own conform to the requirement of having practical advantage. It is consistent with evolutionary theory that selection may be for an entire class of abilities taken together. It follows that instead of thinking of the evolutionary payoff of, e.g., learning the River Dance, and then for clicking one's tongue, and then again for embroidering doll's clothes, we ought to look at this group of activities as a whole, as a group of individually, more or less valueless activities. When we take the category of "practically valueless skills," it becomes possible to consider the evolutionary payoff at a more abstract level of individuation.

In short, only after we accept the fact that we pursue impractical skills will we be in a position to ask, "For what reason might we pursue evolutionarily impractical skills when there seems to be no such parallel in the animal world?" That is, only if we accept that there *are* valueless activities can we then ask about the value of these valueless things. In the remainder of this paper, I will argue that though, individually, most human skills have no evolutionary advantage, taken together, the class of individually, valueless activities plays a crucial role in setting the stage for intellectual growth at the intermediate level of cognitive development.

2. Two distinctions: ability and skill & skill and concepts

For the sake of terminological clarity, in the remainder of this paper, I will refer to abilities as the general class of capacities that reliably achieve practical success. In contrast, I will refer to skills as the sub-class of abilities, which are characterized by the fact that they are refined or developed as a result of effortful attention and control to the

skill itself. As such, only if a subject develops an ability with explicit attention to that

ability itself and not merely to the goal at which that ability is aimed, will I call it a skill.

I will also insist that there is an important feature of full-fledged conceptual

thought that skills are incapable of expressing. Specifically, I claim that skills are

incapable of meeting the context-independence criterion (CIC). We can think of CIC in

contrast to another important characteristic of conceptual thought: namely, the generality

constraint. To understand these two features of conceptual thought, I suggest we turn to

Gareth Evans (1982).

As Evans writes:

> It is a feature of the thought-content *that John is happy* that to grasp it requires
> distinguishable skills. In particular, it requires possession of the concept
> happiness—knowledge of what it is for a person to be happy; and that is something
> not tied to this or that particular person's happiness. There simply could not be a
> person who could entertain the thought that John is happy and the thought Harry is
> friendly, but who could not entertain—who was conceptually debarred from
> entertaining—the thought that John is friendly or Harry is happy (p.102-3).

For Evans, being a concept requires meeting two independent criteria. It requires that if

one possesses a concept, one must have the capacity to both apply that concept in various

situations (the generality constraint), and also, to entertain that concept without applying

it in any situation in particular (CIC). That is, one must be able to think of that concept

"as such. " Accordingly, to meet the generality constraint (GC), a subject *S* who

possesses the concept *c*, must be able to think of *c* in context *a*, and also in context *b*. To

meet the context-independence criterion (CIC), a subject *S* who possesses concept *c*, must

be able to think of *c* independent of all contexts; *S* must be able to think of *c* "as such".[10]

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[10] Fodor LOT2, 138) writes that "[A] sufficient condition for having the concept C is: being able to think
about something *as* a C (being able to bring the property C before the mind as such, as I'll sometimes put
it." Notably, McDowell (1994) has argued that concepts can be non-general or, as he calls them,
demonstrative. What's important is that generality and context-independence are distinct properties and we
should be able to distinguish when these two independent constraints are met. The importance is not in the
name, but in the distinction. I'm pretty sure all would agree that the CIC is often, but not always, satisfied

It is the inability of skill to meet CIC that prevents us from identifying skills with full-fledged, higher-order concepts.[11] The reason that skills cannot meet CIC is fairly simple: context-independence requires abstraction from the particular instantiation situation but such abstraction is devastating to the successful performance of a skill. After all, in order for a skill to be successfully instantiated one must adjust, shift and respond to the very particular features of the environment in which the skill is being performed. Lacking sensitivity to the particular conditions in which a skill is instantiated sabotages the possibility of that skill's success.

For example, if one rides a bike without being responsive to the very material, the very incline, and the very uniformity of the surface on which one is riding (e.g., a flat paved road, a grassy uphill, or a rocky mountain descent) one will not be able to perform the micromillimeter, microsecond bodily adjustments required for staying on one's bike. The crucial point is this: while full-fledged concepts can be abstracted away from their environments, skills develop by becoming more and more attuned to their particular circumstances. While concepts move towards context-*independent*, the elements, which constitute skill, as they become more and more refined, become more and more sensitive to context.

3. A proposal: skill refinement as an intermediate developmental stage

Distinguishing between abilities, skills, and concepts opens up a way to ground higher order cognition in more basic, but still intelligent, bodily action. Specifically, in what follows, I argue that it is through skill learning that actions, properties, and mental states

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in mature, human thought and that generality is a more minimal requirement. Everyone should agree that meeting one constraint but not both is different from meeting both.
[11] This is relevant to the knowledge-how/knowledge-that debate (stemming back to Ryle (1949) and recently made popular by Stanley and Williamson (2001) and Stanley (2011a; 2011b). See Fridland (forthcoming) for more about how the problem of particularity presents a challenge for Intellectualism.

first acquire the ability to break free from their particular, immediate, instantiation environments in order to show up in different environments and situations. In what follows, I shall propose that skill learning can provide us with an account of the flexibility, manipulability, and agency required for satisfying something like the generality constraint in action.

Importantly, on my account, the generality constraint (GC) and the context-independence criterion (CIC) are neither identical nor developed simultaneously. This means that a further developmental stage is required in order for human reasoning to become fully abstract. Still, before one can run, one must walk. As such, I think that achieving the more basic kind of flexibility needed for recombination into multiple action contexts is a huge step in cognitive development. In what follows, I will show why skills are a prime candidate for driving the flexibility and agency of recombination. As such, I will propose a naturalized explanation of this essential feature of human cognition.

3.1. General relations

To begin, we should notice that we have roughly four options for laying out the logical relationship between skill learning and conceptual thought. Either (a) skill learning is a prerequisite for conceptual thought, (b) skill learning and conceptual thought are both the results of same-level cognitive mechanisms, (c) skill learning is the result of conceptual thought, or (d) they bear no relation to one another.[12] I will present several reasons suggesting that (a) is the most convincing of these four options. To clarify, I will not claim that (a) must be true for purely logical or conceptual reasons. Rather, I propose that this particular way of framing the relationship between skill learning and conceptual

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[12] Not having a relation is, of course, not a relation, but it is a conceptual possibility. After all, it might be that skill learning and conceptual thought simply have no interesting connection to one another.

thought allows us to account for human cognition in the natural world while simultaneously doing justice to a whole host of empirical research. This means that the truth of (a) is not conceptual or *a priori* but rather the result of abduction.

3.2. Representational Redescription

In order to advance the case that skill learning functions as a prerequisite for conceptual thought, I will rely on Annette Karmiloff-Smith's (1992) model of Representational Redescription (RR, from hereon). Though I will not commit myself to every letter of this doctrine, I will use the general framework of RR as a tool for elucidating the relationship, which I submit attains between skill learning and conceptual thought. Essentially, I will forward the claim that the intermediate stage of the RR model is best understood as a stage of skill learning where a child shifts her concern from success at a given task towards attempts to refine the style or manner in which that task is instantiated. In contrast to Karmiloff-Smith's own model, I claim that this intermediate stage of RR in not characterized by an interest in internal representations, but rather, by a focus on action manipulation.

The RR model individuates human intellectual development into three basic stages. Roughly, according to RR, a mental state at the first stage of human cognitive development is best understood as "implicit, not representational, procedural and must be run in its totality. It cannot be accessed or operated on" (Karmiloff-Smith (1986), p. 102). This first level of procedural knowledge is fully embedded in a context and tied to particular situations and circumstances. Such cognitive states have practical value but lack flexibility. They are not composed of atomic or compositional parts, but rather, of whole sequences which are difficult to interrupt and individuate.

Importantly, "behavioral mastery is a prerequisite for subsequent representational change" (Karmiloff-Smith (1990), p. 60) into the second level of redescription. This means that redescription's purpose in not simply geared towards practical success, since practical success is a prerequisite for redescription.

At the second stage of cognitive development, the implicit procedures from the first level of representation are redescribed into the same representational code "i.e., kinaesthetic, spatial, linguistic, etc." (Karmiloff-Smith(1986), p.102) and begin to exhibit a limited kind of flexibility. Karmiloff-Smith (1992) breaks this intermediate stage into two levels where first Ei representations are worked over by metaprocedures that remain unconcious, and then, those procedures are again redescribed into the same representational code in Eii. Importantly, at the Eii stage, a child has conscious access to these procedures and, as such, begins to "gain some control over the organization of her internal representations" (Karmiloff-Smith (1990). The middle or intermediate stage of cognitive development allows for limited flexibility and variability. At this stage, procedures are broken up into parts and begin to acquire a degree of manipulability and control. At the second level of redescription procedures become a "problem-space" for children. As such, these procedures can be acted on, and attended to.

Importantly, in contrast to the standard RR model, I claim that the procedures at the intermediate stage of redescription should not be thought of as primarily internal represenations, but rather, as actions that children regularly instantiate and thereby develop into skills. That is, the problem space for children at the intermediate level of RR is not one of internal representations, but rather, of intentional action. The child is not primarily focused on the way the procedures underlying a task are internally represented,

but rather, on refining the manner in which she is able to execute her actions.[13] I will provide arguments for this proposed change below.

To return to the RR model, we should notice that after recurrent cycles at the intermediate level of redescription, representations are again translated or redescribed. This time, however, they are translated into a different representational code than that which was used at the two previous stages. This code is abstract and allows for the generality, flexibility, and objectivity of fully mature, conceptual thought. This last level of RR grounds higher order reflection, abstract thought, and theoretical reasoning. Also, the third stage of RR it is notable for allowing connections between various unrelated spheres of action and thought to be established. In this way, expertise or knowledge from distinct domains may be transferred to others. As Clark and Karmiloff-Smith (1993) write, "RR frees knowledge from spatial, temporal and causal constraints and enables new links to be noticed across originally different representational formats" (p. 575). We should also note that at each stage of redescription, there is a trade-off between the fineness of grain of the information contained in the representation and conscious accessibility to that representation.

For the purposes of my argument, it is not vital that I take a stance on the exact nature of the underlying code at the third level of redescription. Lawrence Barsalou (2003; 2008) claims that modal, grounded concepts can instantiate symbolic representations while Sun et al. (2001) have claimed that redescription into a wholly different type of code elegantly accounts for the difference between the accessibility of concepts to conscious thought and the inaccessibility of procedures at lower levels. I

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[13] Though I will focus on embodied activities such as dance or sport, I also consider social skills to be developed much in the same way. I will not give an account of social cognition here, but I do think that it can be integrated into an amended model of RR rather easily.

would like to stay neutral on the exact nature of the code of conceptual thought, while remaining fully committed to the idea that at this third level of rational development, concepts become fully abstract and context-independent. For the remainder of this paper, I will not say much about either the first or third level of RR. Before moving on, however, I'd like to point out one further feature of the RR framework: moves from one stage of description to another are not discrete changes that occur at one particular moment or age, but rather, are the result of recurrent cycles. As such, moving from the first to the second stage and then to the third requires regular and recurrent application.

3.3. Evidence in favor of a tripartite model of cognitive development

As Karmiloff-Smith (1986) has argued, the standard dichotomies between conceptual and procedural knowledge (conscious/unconscious; implicit/explicit; first-order/second-order) are insufficient to capture the intermediate levels of flexibility and variation present in human cognitive development. In short, there are systematic differences between various stages of cognitive development that are largely overlooked when one conceives of cognition as bivalent. Many features of cognition, such as flexibility, generality, transferability, and consciousness, are not all or nothing. [14]

Here, I will limit myself to reviewing one particular study in order to demonstrate this point. When asked to draw "an impossible person," 4-6-year-olds created drawings that differed significantly from 8-10-year-olds who were asked to complete the same task. In particular, there were striking differences in the type and timing of changes and variations that each group was able to produce. Importantly, younger children made deletions at the end of their drawings, which involved no interruption of the sequential order of their drawing procedure. Younger children also produced changes in size and

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[14] Philips et al. (1985); Hormelin et al.(1989); Shankweiler (forthcoming); Hurley (2001).

shape but did not introduce objects or features from different conceptual categories. 4-6-year-olds showed some flexibility, but this flexibility was limited in both type and sequential order. In contrast, 8-10-year-olds who were asked to complete the same task, changed orientation, added elements from various unrelated conceptual categories and made changes at several points in their drawing sequence indicating that their drawing pattern could be interrupted more freely than that of the 4-6-year-olds. The older children also followed a sequence "but they do not have to rigidly stick to it" (Karmiloff-Smith (1990) p. 57 & 72).

These findings indicate that accounting for older children's superior flexibility is not simply a matter of paying attention to the *number* of changes they make, but rather considering the *kinds* of changes that they are able to make. In short, there are qualitative differences in the kinds of variations that each group of children is able to produce when given the same task. It is exactly this contrast, however, that cannot be captured by a cognitive model that only has the resources to classify knowledge dichotomously as procedural or conceptual, flexible or inflexible. After all, if one only had the resources to label 4-6-year-old knowledge as implicit or explicit, as procedural or conceptual, then 4-6-year-old capacities would have to be classified alongside those of 8-10-year-olds. However, the behavior of these two groups exhibited clear, systematic differences. As such, these differences must be captured by a cognitive model and this necessitates distinguishing an intermediate stage of cognitive development where variation and flexibility is present, but limited in type and kind from both procedural and conceptual stages of development.

3.4 An amendment to RR: swapping skills for internal representations

As I stated above, I suggest that we move from an understanding of the intermediate level of RR as a stage that is primarily concerned with internal representations, towards an understanding of this stage as primarily concerned with the manipulation and control of external actions or abilities. The intermediate stage of RR, I claim, is neither simply concerned with the ends of intentional actions, nor with the decontextualized internal representations of such actions. Instead, we ought to consider the intermediate stage as a place where attention is focused on actions themselves—it is a stage where a child begins attempting to exert control over the style, manner or way in which her abilities are instantiated.

The fact is that all empirical evidence seems consistent with the view that children's efforts at the intermediate stage of cognitive development are largely directed towards their own actions. As such, it seems likely that internal representations find their way into the discussion of the intermediate stage of RR as a result of a conflation. The conflation is between procedures as mental patterns that represent embodied actions and procedures as the patterns of instantiated action themselves.

We ought to note that this conflation is similar in structure to a common mistake that occurs in the consciousness literature. There, people often confuse the content of a conscious state with the content of an introspective state.[15] As such, one will claim that the content of a conscious state of believing that there is a tree in the yard is "that I believe that there is a tree in the yard." However, this is a mistake because this is the content of an introspective state about the belief and not the content of the conscious state about the tree. The content of the conscious state is just "that there is a tree in the yard."

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[15] See Rosenthal (1991; 1994; 2004) for more on this kind of mistake.

Likewise, we must differentiate between a concern with the representation of an action and concern with the action itself.

The fact is that a much more minimal and justifiable interpretation of the evidence is to understand children, at this intermediate stage of development, as developing the capacity to shift from an exclusive concern with the goals of their actions to a concern for the way in which those goals are attained—that is, to shift their concern from ends to means. At the intermediate stage of cognitive development, children develop the capacity to attend to the way, manner, or style in which they reach their goals. As such, children begin to take abilities, or the means of goal attainment, as objects of interest and concern in and of themselves. On my amended model, at the Ei/Eii stage, children do not go from concern with the external world to concern with internal representations, but rather, shift concern from ends to means.

I should add that this amendment is not simply advancing a semantic distinction.[16] That is, even if the skills that children are attending to are in fact internal representations, it is not the case that children attend to those skills *as* representations. That is, from the point of view of the child, the child is attending to her own actions. In Fregean (1980) terms, we are on the sense side of the sense/reference distinction. Therefore, the underlying, functional, representational nature of the skill is irrelevant for understanding what the child, from her perspective, attends to and manipulates at the intermediate stage of RR. And it is exactly from the perspective of the child that we need to understand this developmental stage.

3.5 How does it work?

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[16] Thanks to Austen Clark for drawing my attention to this issue.

My claim is that when children develop the capacity to take means as ends in themselves, they also develop the resources to inject variation into the sequences or patterns of action, which were fixed at the first level of RR. In this way, children begin to express limited degrees of creativity, flexibility, and organizational control over their own abilities. At the intermediate level of RR, because a child becomes interested in improving the means by which she achieves her ends, she becomes able to break up, shuffle, and reorganize the fixed procedures that accounted for her success at the first stage of RR.

As a result of a child's attempts to refine her own abilities, the mutually reinforcing features of agency, flexibility, object/action individuation, and recombination enter onto the human cognitive scene. As intentional actions themselves become the objects of concern, through recurrent and regular cycles of purposeful instantiation, action patterns begin to break free from their bounded sequences. Activities gain flexibility, become proto-compositional, recombinable and emerge in various contexts to fulfill multiple roles.

Importantly, improvement efforts directed at abilities produce the individuation of action parts and this individuation provides the grounds for further flexibility, recombination, and control, which, in turn, leads to finer-grained individuation and increased opportunities for recombination, and so on. Action elements, thus individuated, are then capable of occupying multiple roles in multiple situations. That is, individuation provides action-elements with criteria for identification and reidentification, and this then makes it possible for the same action element to be used in various circumstances. In this way, skill learning breaks up procedures and makes them both flexible and compositional. The process of skill refinement also naturally leads to

the development of a sense of agency because it is through intentionally performing

actions that flexibility, manipulability, and transferability develop.

3.5.1 Trial, error, and flexibility

At the intermediate level of RR, the child's goal becomes to instantiate abilities in

particular ways, manners, or styles. At this stage of RR, a child begins to attend to her

own actions as ends in themselves and not merely as instrumental for achieving the goal

at which they are directed. This shift from attending to goals to attending to the means

through which those goals are attained is a major achievement in cognitive development.

At this stage, a child can apply effort to working on the way in which she achieves her

desired ends. In attempting to manipulate the manner or style of ability instantiations,

these abilities become a "problem space" for the child. The child becomes concerned

with guiding and controlling her actions in order to figure out how to perform those

abilities in particular ways. In order to do this, she applies effort and attention.

As the child becomes interested in performing an ability in a particular fashion,

she must find a way to introduce variation into the sequence that she ordinarily follows.

This should be obvious since there can be no change or improvement without the

possibility of variation. So, the child must experiment with her actions in order to figure

out how to change them, how to control them, and how to get them right. This

experimentation takes place through a kind of practical trial and error, which naturally

introduces the first seeds of flexibility into a fixed action pattern or ability sequence.

In learning to perform an ability in a particular manner, a child must make various

attempts or trials. Some of these trials will work, but many will not. As such, interfering

with an action pattern produces flexibility, but it does so at a cost: failure. As such, the

first signs of an action-patterns breaking apart at the intermediate stages of RR can be observed in the mistakes that children begin to make after they have attained practical mastery at the first level of RR. Empirically, there is clear evidence that children begin to make mistakes after achieving mastery of a particular task.[17]

This kind of trade-off between success and flexibility is easy to understand. To improve the way one performs some task requires shuffling, shifting, adjusting and altering the way in which that task is instantiated. The once fixed but successful sequence is tweaked through trial and error and, as a result, the child makes various mistakes or errors when instantiating it.

Counter-intuitively, then, before a child can gain full control over her actions, she must reject the automatic control which already guides her abilities. That is, the natural, thoughtless, procedural control that a child has over her abilities at the first stage of RR must be replaced by an agent-directed control that is more responsive and flexible to the specific goals of the child. In this process, long-term expertise and improvement requires short-term sacrifice. Trial and error thus produces flexibility at the cost of automatic success. This flexibility is responsible for breaking up action sequences into constitutive elements, which then allows for finer-grained manipulability and control and, thus, provides the foundation for higher levels of expertise.

3.5.2 Recombination and individuation

As skill refinement progresses, two mutually reinforcing characteristics emerge. These are the very characteristics, which underwrite the capacity for the improvement and

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[17] Karmiloff-Smith (1986), p. 107.

refinement of a skill but they are also the features, which account for the satisfaction of the generality constraint. They are individuation and recombination.

As the action sequence, which constitutes ability becomes the object of trial and error, the sequence that has up to now followed a fixed pattern, relaxes in various limited ways. This relaxation allows for, at first, limited degrees of combination and recombination to emerge. What this means is that trial and error allows for variations in the pattern and execution of a sequence. This limited recombination, in turn, allows for a coarse kind of individuation of the parts of a sequence. The recombined parts begin to develop boundaries of individuation and identification. Such individuation, then allows for more effortful attention and control to be focused on the individuated parts and, in turn, further combination and recombination can develop. And then further individuation, and so on.

Through effortful trial and error, I suggest that activity sequences break up into action-parts. As a child learns to manipulate and control various parts of an action sequence, she develops the capacity to attend to and control not simply the sequence in its entirety, but finer and finer-grained portions of the sequence. A child becomes able not only to consider a sequence as a whole, but begins to think of it as having a beginning, and an end, and then later as having a beginning and a middle and an end, and later, as a beginning part I, beginning part II and beginning part III, middle, and end, etc.

Importantly, as these elements become individuated they also acquire the capacity to show up at different stages of a sequence or in different sequences altogether. These elements develop boundaries of identification and those identifiable parts are then capable of entering into other sequences, situations, and scenarios. They develop the

capacity to occupy not just one role, but many. They are able to show up not just in one environment or set of circumstances, but in several. The same element acquires the capacity to play multiple roles. The kick before a cartwheel can show up as the preface to a front walkover and the sequence of notes that ends a particular piece of music can be played in the middle of another.

In short, action elements break free from one environment and show up in others. And this is exactly what is required for the satisfaction of the generality constraint: that some element can be identified and reidentified, applied and reapplied, used and reused in various, novel circumstances. To possess the concept GREEN, I must be able to think of the couch as green and the chair as green. If I can think that John loves Mary, I must also be able to think that Mary loves John. My claim is that in the realm of action, we can meet GC through skill refinement. For example, a swing *s* can show up in context *a* and also in context *b*. We can execute swing *s* followed by turn *t,* and we can also execute turn *t* followed by swing *s.* We can reverse the relations of *s* to *t* and *t* to *s.* We can do all of this in action and, in fact, this is precisely what we need to learn in order to execute complex skills at any level of expertise.

Without the capacity to manipulate (combine/recombine/adjust) the parts (individuated elements) of a skill, a skill simply could not improve. This becomes a practical requirement for refining the way or the manner in which a skill is performed.[18] As such, the recombination and individuation that takes place in skill learning assures us of the satisfaction of GC. The more a skill is improved and refined, the more attention to

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[18] Notice, that this is not a requirement of abilities since their sequences are not compositional. However, in order to develop skills, which are under the control of an agent, it is precisely this kind of individuation and flexibility that is required since one must take the skill as an object of effort and attention. Unless the action parts are sufficiently fine-grained, they will not be susceptible to the kind of control that is required for high-level expertise.

finer-grained elements of the sequence is required, and the more these elements become refined, the more they are able to be abstracted, controlled, manipulated, and transferred into various circumstances.[19] As such, skill learning both spawns and requires the flexibility, agency, control, individuation, and recombination, which is at the heart of GC.

3.6 An example

In choosing an example, I want to remain as gender-neutral and culturally universal as possible. It is hard to do this, but here's my best shot: it seems that no matter whether a child is a boy or girl, rich or poor, almost in all cultures and locations, it will learn to kick a ball.[20]

As a preface to this example, I should make two points: (1) it *would not* be a counterexample to my theory if all children did not learn some one particular skill. It *would* be a counterexample, if there were cultures where children did not develop and refine skills beyond the level required for practical survival. As long as all children learn some skill or other, which is developed and refined beyond its usefulness for immediate success, that is, that is learned not only as a means to some other goal but as an end in itself, then my theory is in good shape. (2) It is also important to notice that I am not claiming that the content of conceptual thought is directly extracted through skill learning. Rather, skill learning constitutes a necessary stage of cognitive development, which precedes the development of conceptual thought. My claim is that the function of skill learning is to develop a conceptual capacity but it is not my claim that it is skill learning's function to furnish that conceptual capacity with content.[21]

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[19] See Phillips et al. (1985) for more on the nontransferability of skills at primitive levels of representation.
[20] Or, at the very least, a can.
[21] Some skill learning will undoubtedly be the content of conceptual thought. My only point is that being involved in skill learning is not necessary for developing into a concept.

Back to kicking a ball: first off, it is important to notice that at the intermediate stage of RR, the kind of ball kicking that we are considering is not oriented towards simple success (i.e., contact of foot with ball resulting in ball moving). In fact, the intermediate level of cognitive development only proceeds after procedural success has been sustained at first level of representation. As such, we must imagine a child who can successfully kick a ball, but who is attempting to kick the ball in a particular way.

So, let's call our kicker, little Sally. Sally can already kick a ball. Let's even posit that she has some minimal control over where the ball goes when she kicks it. Now, however, she wants the ball not just to go in a particular direction, but she wants to kick it forcefully, gracefully, like that player on TV, or like her older sister.[22] In order to do this, she has to attend not only to the goal post, but also to the position of her leg. She has to begin to differentiate between kicking forcefully, and kicking gently. She has to pay attention to how high she lifts her leg, how fast she can run, and how many steps she can take before kicking the ball. She has to attend to the amount of effort that kicking requires and the exact spot on the ball that she has to kick.

Also, let's imagine that Sally begins experimenting by kicking the ball with different parts of her foot. She uses her toe, and then the inside of her foot, and then learns to switch back and forth between kicking with the inside of her right foot and next with the left, and then she learns to vary the number of steps in between the alternating kicks. In learning to kick in different ways, she feels that kicking with the inside of her

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[22] It's essential to note that skill learning often proceeds by imitation. That is, we do not learn skills in isolation but often mimic what others do. Further, others often exaggerate how they do something in order to demonstrate the way they do it so that someone can learn from them. This kind of social skill learning is a special feature of human interaction and though I am not developing this aspect of human learning here, I do take it as an important feature of skill to be developed elsewhere.

foot and kicking with her toe create different feelings of control, they create different results, and they require different degrees of effort.

All of these variations: the run, the angle, height and bend of the leg, the inside of the left and the inside of the right foot, the toe, the number of steps in between the kicks, the feelings of tension and effort associated with them, the proprioceptive sensations, the visual and auditory sensations (look here, it sounds like this), all change and become relevant in developing kicking expertise; they all become intentional objects that Sally will try to guide and control. After all, she has to learn how to attend to and control all of these elements, if there is any hope that she will learn to kick like an expert.

In order to master the appropriate variations for kicking a ball, Sally must begin to treat her once entire kicking sequence as individuated kicking parts. To achieve expertise, she must learn to take action parts as objects of attention and control. Kicking with the inside of the foot becomes individuated from kicking with the toe, a kick to pass becomes different from a kick to score, running and kicking becomes different from running, stopping, and kicking. Kicking along the ground and kicking through the air are different kicks and require different bodily adjustments. As one develops the manner or style of the kick, one has to break up the parts of the action in order to perfect and perform them appropriately. As one individuates the parts, one can recombine and refine them in various ways; a running pass through the air; kicking gently with the toe, a running pass on the ground with the toe, etc.

Each of the hard earned variations in flexibility and recombination lead to further fined-grained distinctions and further possibilities for recombination and individuation. The entire kick sequence breaks into elements and those elements, in being individuated,

are no longer necessarily bound to their immediate action-environment. They break free from a particular environment, but they are not directly abstracted away from any and all contexts. Rather, first, they show up in multiple contexts. Sally can use the same leg angle to pass far downfield and to score a goal from a distance. But she might use a different part of her foot, or a different amount of force. In creating these variations, each of the parts of the action-sequence become elements ripe for control, reapplication, and recombination. It is in such skill refinement, I claim, that the first agent-controlled abstraction from the immediate environment occurs. This "breaking free" is essential for recombination. It is important to the identification and reidentification of action elements, but even more importantly, it is essential for the volitional application and reapplication of those individuated elements into various action sequences and situations. And, of course, it is also essential for skill learning and skill refinement.

4. Some further hard-earned benefits

In this section, I will review two further benefits of skill refinement. It is probable that these cognitive products of the intermediate level of RR work in concert with the flexibility and recombination that I discussed above in order to propel development into the third stage of RR. For reasons of brevity, however, I will not endeavor to give an account of how these characteristics of cognition are related to one-another and how they function together in development, generally.

4.1 Meta-representation

We should notice that not only do mental states accompany actions, but that paying attention to one's own internal states is an integral aspect of skill learning.[23] In the

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[23] As Pezzulo (2011) states, "simulation is not limited to effects of possible actions, [but it] also informs one's idiosyncratic performance and one's own mental states" (p.99).

process of skill learning, one must learn not only about how things in the external world should be ordered, but how things internal to oneself should proceed as well. To learn a skill, the idiosyncratic internal features of a task must be taken as markers for the proper performance of an activity; one must learn what the right amount of, e.g., force, effort, and attention feel like. One has to attend to action elements both as public sequences that can be performed by various persons and as proprioceptive sequences that can only be accessed from the first-person perspective. To learn a skill, then, one must attend to and control internal as well as external features of a skill.

As such, we have an elegant way to account for how internal mental states become intentional objects. It is in skill learning that the first crucial inversion of attention onto one's own internal states is born. It is here that reflection and introspection can first be genuinely identified. After all, because internal states necessarily accompany actions, which in the process of skill learning become the objects of effort, attention and control, those internal states slip their way into becoming intentional objects. Clearly, there is no sense in thinking of guiding or controlling an action simply by thinking of it from a the outside. We learn to refine skills in the first-person and that requires attention to the subjective or qualitative aspects of an activity. Since attention to many of these elements is required for the refinement of skill, it is no wonder that internal states as well as external ones end up as the intentional objects of thought and effort.

As such, our capacity to reflect on our own mental states can be traced back to skill learning. This is because skill learning requires that we take as objects the features that are relevant for the improvement of our skills and since the relevant aspects for such learning are both internal and external, it only makes sense that we would to attend to

both. There is no great leap here: actions change our perspective on the outside world, but they also transform our internal landscapes. Turning one's attention to the feeling of force required for kicking a ball, is no harder than turning one's attention to the angle that one must hold one's foot in order to kick the ball, or to the spot on the ball at which one should aim. These different features are equally relevant for skill learning and, as such, become equally prominent as objects of attention.

4.2 Agency

A further virtue of this particular account of cognitive development is that the relationship between a sense of agency and conceptual thought becomes easy to locate and explain. We should notice that agency is not simply a trivial or peripheral feature of cognition. As Andy Clark (2002) describes Dennett's view, agency and personhood are crucial elements of full-fledged, conceptual thought.

> Consciousness, personhood, moral responsibility, free will, and even real thinking (see e.g. Dennett (1996) p.130, (in press) p.4) are thus all tied together…human thought is thus marked out as deeply different from the cognitive capacities of other animals. It is different courtesy largely of the culturally incubated mind-tools whose transformative powers open up the space within which we actively construct the experiencing and responsible self.

 If Clark (2002) is right about Dennett, and Dennett is right about agency, then any account of cognition will only be adequate insofar as it can explain the intimate connection between agency and florid, reflective, conceptual thought.

On the version of cognitive development that I am forwarding, since full-fledged conceptual thought is necessarily preceded by a stage of skill learning, the connection between agency and conceptual thought becomes easy to explain. After all, skill learning requires pronounced effort, control, attention and a deliberate manipulation of actions, which can itself foster a sense of agency as it proceeds. As Vittorio Gallese and Thomas Metzinger (2003) have argued, "in selecting paths to a goal, an organism develops into an

agent, the agent actually creates a self in the act of intending" (p.373). It seems clear that in the process of choosing a means and pursuing a goal, a child begins to feel how her intentions dictate her actions and thereby change the world. She begins to sense that she is not just a passive consumer of information, but a transformer and reorganizer of this information. It is thus, through acting, that she becomes an agent. As such, being an agent is not a prerequisite of intentional action, but rather, a characteristic that emerges as a result of making deliberate, directed choices. It is not that one chooses in order to become an agent, but in choosing and acting, one simply cannot help but developing a sense of oneself as an agent.

I claim that in being an intentional actor, a manipulator, controller and transformer of one's own actions a subject becomes an agent. The more a child does, the more she feels like a doer. Therefore, practicing, manipulating, shifting, altering, varying, and combining action elements in skill refinement spawns a sense of agency. What's nice is that this feeling is rooted in the body. One has particular corporal, proprioceptive, and kinaesthetic feelings of control that produce very real physical and detectable changes as one attempts to manipulate one's own actions. The bodily feelings of, e.g., force, tension, balance, effort can thus provide the foundation for a robust sense not only of ownership, but of a robust sense of agency as well.[24]

Crucially, on the account that I am offering, a sense of agency emerges not only as a direct result of choosing a goal, but from the continuous, deliberate guidance of one's actions throughout the process of ability instantiation and refinement.[25] It follows that agency is not the direct result of intentional action alone, but of an intentional action

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[24] See Gallagher (2005) for more on this distinction.
[25] See Frankfurt (1978) for the distinction between intention causing an action and guidance or control throughout action.

plus the purposeful and deliberate control that one exerts over the instantiation of an entire action sequence. This kind of continuous control explains agency not only in terms of mental volition, but extends agency into the world. Guidance throughout action instantiation distributes agency from the moment of choice into the process of action. This explains why it is not simply that we feel some flicker of agency as a mental act impacts the world, but rather, feel a robust and diachronic agency pervasive throughout our actions.

We should note that often, when we think of full-fledged, reflective, mental representations and higher order reasoning the connection to behavior and thus agency appears tenuous or contingent. After all, much of our thinking is done offline and some of it will never have any direct impact on our behavior. Such a perspective, of course, leaves open the question of why agency and conceptual thought are intimately connected. It becomes a further question to answer why normal, mature, higher-order cognitive function is never present in the absence of a sense of agency.[26] This is not the case on the account I have presented. Since on my account the development of the conceptual stage of representation requires prior experience with skill learning and ability refinement, we can see easily why agency is presupposed by full-fledged cognitive capacities. The type of attention and control that is required for skill learning provides us a threshold with a high degree of sustained, determined, active contribution to and responsibility over one's actions. The subject must become an agent if she hopes to learn skills and so she must also be an agent in order to be a real thinker. Agency emerges in the process of skill learning and skill learning is a necessary stage in the development of conceptual thought.

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[26] Of course, pathologies of agency are important to consider here (e.g., thought insertion). See Campbell (1999) for an interesting account of thought insertion, agency, and embodiment deficits.

As such, this intermediate stage of intellectual development assures that a sense of agency is present in the later stages of RR. The connection is that simple.

5. Concluding thoughts (or two objections)

Before ending, I should make note of some potentially problematic areas for the above theory. I will not go into detail as to how to address these objections, but I will gesture to some potential responses.

One relevant objection to consider in light of the above claims is whether, in fact, skill refinement is necessary for the development of full-fledged conceptual thought.[27] That is, one may wonder whether some children, for example, children with severe physical handicaps, who are incapable of the fine-grained physical control required for skill refinement but capable of higher-order cognition, may serve as counterexamples to my theory.[28] The way to deal with these cases, I think, is to look into exactly what kinds of skill development these young children engage in. The prediction that this theory makes is that in cases of severe disability, some sort of compensatory strategy will be required in order to play the role of skill refinement at the intermediate stage of cognitive development. If this prediction is not born out, it will be a problem for my theory.

Another problem that this theory will need to address follows from the fact that the behavior of many non-human animals expresses various degrees of flexibility, as well as a capacity for identification and reidentification. As such, if non-human animals are incapable of skill-refinement, but are capable of limited kinds of abstraction and recombination, then the above account should have something to say about this.[29]

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[27] Thanks also to Paul Davies for raising this objection.
[28] Thanks to Ruth Millikan for drawing my attention to the case of Alice, a girl with severe cerebral palsy who nonetheless developed higher-order cognitive capacities.
[29] Thanks to Marc Borner, Kati Hennig and Michael Tomasello for flagging this as an issue.

In response to this objection, I think the most reasonable thing to say is that non-human animals can develop degrees of flexibility and limited recombinatorial capacities at the first-order level of RR. Further, this kind of first-order flexibility could be rooted in a creature's use of various objects in various environments and in having various situation-bound goals that can arise in different contexts. As such, the kind of discrimination and reidentification that comes with encountering and using the same object at different times, locations, and for different purposes should be enough to underwrite the kind of flexibility evident in non-human animals. However, this degree of flexibility, manipulability, and recombination will not be identical to the flexibility that is produced as a result of skill refinement.

The fact is that it should not be a problem for the above theory that it is possible to develop limited kinds of proto-cognitive behaviors without skill refinement. Such a possibility does not undermine the above theory since I do not claim that all and every kind of flexibility is explained by skill refinement. If animals develop something resembling this feature of conceptual thought via a different means, this is compatible with the fact the cognitive products of the intermediate stage of human cognition, because they are developed via skill refinement, are characterized by distinct qualities, which carry importantly different potentials for further development. That is, it is wholly compatible with the above theory to say that humans develop a kind of flexibility through the particular route of skill refinement and this route carries with it a certain kind of explanatory power that is missing from the distinct way that non-human animals develop their own kind of limited flexibility.

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