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Stage fright: Internal reflection as a domain general enabling constraint on the emergence of explicit thought

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ABSTRACT

It has become increasingly clear over the last half century that there are multiple important changes in children's abilities taking place at around age 4. These changes span social, emotional, and cognitive domains. While some researchers have argued that a domain-general development explains some of the changes, such a position is a minority view. In the current article, we provide some evidence for the development of an age 4 domain-general enabling constraint on children's ability to reflect. In turn, the development of reflection is argued to enable the transitions that we see within and across developmental domains. The model of reflection being offered is part of a broader action-based model of cognition and mind – interactivism (Bickhard, 1973, 1978, 2009a,b). The empirical part of the article presents a new object reasoning task. This task was derived from theoretical constraints on the interactivist models of knowing and reflection. Results indicated that most children responded to the task incorrectly until age 4 which was interpreted as evidence that they lacked the ability to explicitly reason about relations between objects. Correlations between our new task and standard false-belief tasks were explored. Collectively, these results provide empirical support for the claim that children undergo a domain-general development in their ability for epistemic reflection at around age 4.

1. The transition in the room

It is increasingly clear that children's performance on multiple tasks, within and across different developmental domains, involve important changes at around age 4: social-cognitive abilities (Wellman, Cross, & Watson, 2001); executive functioning (Zelazo, Muller, Frye, & Marcovitch, 2003); appearance-reality understanding (Flavell, Flavell, & Green, 1983); language (de Villiers & Pyers, 2002); learning from informants (Harris et al., 2013); deception (Lee, 2013); autobiographical memory (Nelson & Fivush, 2004); meta-cognition (Woolley & Ghossainy, 2013); counterfactual and future thinking (Guajardo, Parker, & Turley-Ames, 2009; Atance, 2008); and, delay of gratification (Mischel, Shoda, & Rodriguez, 1989; Moore, Baressi, & Thompson, 1998).

The main thesis of the current paper is that the changes in performance across domains during the preschool years are a consequence of an underlying "stage-like" development in the ability for reflection. The development of reflection constitutes a domain-general transition, and that transition is itself a predicted consequence of a naturalized model of knowing. While the presence of performance changes within and across domains does not force a commitment to a stage transition in development, it does motivate and support the possibility of one. Conversely, the underlying naturalized model of knowing yields such a transition as a consequence, and the evidence of such transitions across domains supports that consequence: the empirical evidence supports the

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theoretical consequence.

The current paper begins by suggesting that a qualitative change in ToM development around age 4 is well motivated. We review two domain-general explanations for such qualitative change. The first is that of Perner and colleagues, followed by Zelazo and colleagues. The basic logic used by both groups of researchers to provide empirical support for their theoretical positions was applied to our own study. After introducing our general framework (i.e., interactivism) and some specific models of representation, implicit presupposition, and epistemic reflection, we explain the age 4 transition in terms of a domain-general enabling constraint on the emergence of explicit reasoning and thought. Similar to the empirical approach used by Perner and Zelazo, we designed a new task outside the social-cognitive domain (i.e., the physical domain), assessed age differences and possible relations with FB tasks. We present our study and its results followed by some discussion of the alternative proposals and implications for social-cognition research.

2. Stages: post-Piaget

Piaget was interested in the emergent origins and development of knowledge, and Piaget's stage model was a domain-general way to characterize qualitative transitions in children's development. Subsequent to serious critiques of Piagetian stages (Gelman & Baillargeon, 1983) developmental researchers have tended to avoid the use of stages as a theoretical construct. Neo-Piagetians are an exception to this tendency but, for some, their commitment to an information-processing framework made their use of stages problematic. See Bickhard (1993) for a specific response to Case's (1991) model and see Lourenço (2016) for a recent review of developmental stages. However, while not invoking the notion of stages per se, some researchers have argued for qualitative developments taking place between three and five years of age. For a well-known example, Theory of Mind (ToM) research has focused extensively on preschool age differences in performance as being theoretically important for understanding the nature of development. One prominent explanation has argued for changes in meta-representational abilities (Perner, 1991) while the second (starting-state nativism) advocated for the idea of a conceptual shift analogous to the conceptual advances in science (Gopnik & Wellman, 1992). These two approaches differ in that the first is domain general (the new knowledge-abilities apply across several domains) while the second is domain specific (the new knowledge is specific to ToM). More recently, in reaction to new empirical evidence for continuity accounts (Onishi & Baillargeon, 2005), other researchers have argued that early and later abilities are indicative of two qualitatively different systems (Apperly & Butterfill, 2009; Fenici, 2013; Low & Perner, 2012). In short, there is clear motivation from across the theoretical landscape for the idea that ToM developments undergo qualitative change. We will consider two lines of research that have argued that such change happens around age 4 and that such change is domain general.

2.1. Domain-general explanations of the age 4 transition

Two well-known groups of researchers have argued that changes in children's ToM performance around age 4 are not specific to ToM developments, though they differ in terms of the scope and content of that non-specificity (Frye, Zelazo, & Palfai, 1995; Iao et al., 2011; Perner, Mauer, & Hildenbrand, 2011; Perner et al., 2007; Zelazo, 2004; Zelazo et al., 2003). For both groups, the general experimental-design logic has been to show similar transitions in domains unrelated to social-cognition. The less conceptually related the domains in which a statistical relationship is shown on task performances, the more powerful the empirical demonstration of some sort of underlying domain-general development. Equally important as the "empirical argument" is the theoretical integration used to explain the statistical relationships. While both groups argue for domain-general developments to explain changes in ToM performance, they provide very different proposals about the nature of those developments.

2.1.1. Perner and colleagues

The research by Perner and his colleagues has involved varying degrees of distance between the new tasks from other domains and the original FB tasks. The False-Sign (FS) task (Parkin, 1994, unpublished doctoral dissertation, as cited by Iao et al., 2011) was an early attempt to design a task that was structurally similar to FB tasks but that did not involve mental-state content as part of its misrepresentation of the world (i.e., an object is moved to location B but the sign continues to point to location A). Statistical relationships between FS and FB tasks, as well as bi-directional training effects, have been found (Iao et al., 2011). These results have been interpreted as the consequence of a broader underlying development regarding children's understanding of the nature of (mis)representations. That is, FB and FS understanding are argued to be two manifestations of underlying qualitative developments in metarepresentational abilities.

Another manifestation of these metarepresentational abilities was explored through language. The alternative naming task (Perner, Stummer, Sprung, & Doherty, 2002) was designed to assess preschoolers understanding of the representational nature of language (e.g., that a 'bird' can also be called an 'animal'). Results indicated a strong relationship between performance on the alternative naming and FB tasks. In this case, metarepresentational knowledge about perspective is used to explain the statistical unity between the different knowledge domains. Most recently, dual-identity tasks (e.g., used to assess understanding that the same person can be both Superman and Clark Kent) have been used to further demonstrate the non-specificity of changes in ToM performance (Iao et al., 2011). Metarepresentational abilities concerning the distinction between sense (perspective) and reference are used to explain the unity between dual-identity and FB tasks. Perner's explanations go into much more detail but they are all united by the idea of a domain general development for new metarepresentational abilities that emerge at around age 4.

2.1.2. Zelazo and colleagues

The transition between 3 and 5 for Executive Functioning (EF) performance has been considered theoretically relevant in its own right as well as for its explanatory role regarding ToM development (Carlson, Moses, & Breton, 2002; Frye et al., 1995; Zelazo et al., 2003). EF is broader in scope than ToM and is not considered a domain (or subdomain) of knowledge. Instead EF is a domain general construct that is recruited for flexible functioning across and within domains. Further, EF is not a unitary process, but rather, refers to the variety of "...cognitive processes that are required for the conscious, top-down control of action, thought, and emotions..." (Müller & Kerns, 2015, p. 571).

Zelazo and colleagues (Frye et al., 1995; Zelazo et al., 2003) have explained preschool age changes in ToM performance as a consequence of changes in their reasoning ability on tasks that involve conflicting representations. For standard FB tasks children have difficulty integrating their own perspective with a conflicting one in order to answer task questions correctly. These researchers adopt a rule-based framework for thinking about perspectives and how they might conflict and how the integration of conflicting perspectives could be accomplished through embedded rules. In short, rules involve if-then contingencies in which all preschoolers are able to show competence. What changes around age 4 is the ability to integrate conflicting rules by embedding them into a higher-order rule. Applied to FB tasks, children can only reconcile how people can draw different inferences about the same thing (i.e., the location of the chocolate) if they can construct a higher-order rule that differentiates between the perspective of self and other.

Within their rule-framework, Zelazo and his colleagues sought to demonstrate connections between age-related changes in their embedded-rules task with both ToM performance and performance in a different domain (e.g., physical causality). All three tasks were intended to be analogous at the level of abstraction implied by the underlying explanation. That is, all three tasks were characterized as "...reasoning tasks with two conditions that share a conflicting judgment" (Frye et al., 1995, p. 487). Accordingly, the Dimensional Change Card Sort (DCCS) task was used to assess children's ability to construct embedded rules that require the integration of conflicting judgments. A similar switching task was designed to assess causal reasoning in the physical domain.

In contrast to Perner who was focused directly on ToM development, Zelazo's increasing-rule-complexity explanation for ToM was one of several extensions of his work on the planning aspects of EF more broadly (Zelazo et al., 2003). For Zelazo, it is the age-related changes in *reflection* that constitutes the domain-general development that then enables the qualitative performance transitions on various tasks (e.g., ToM, DCCS, & causal reasoning). In turn, reflection is explicated in terms of the Levels of Consciousness (LoC) model (Zelazo, 2004). LoC is broader than just the age 4 changes and attempts to account for multiple domain-general transitions that seem to take place around the end of the first, second, third, and fourth years of life in terms of new forms of reflections coming on line (Zelazo, 2004).

From our perspective, the literature reviewed above suggests the strong possibility of a general developmental transition in the functioning of mind around age 4 with implications for knowing across domains. Further, this literature provides a *modus operandi* for how to provide empirical support for theoretical claims about domain-general change around age 4. Specifically, both groups have created new tasks in areas that are outside of the social-cognitive domain and showed an age 4 transition for those tasks as well as relations to standard False-Belief (FB) tasks.

3. A new action-based model of "stages"

An action-based framework is an approach toward providing a naturalized explanation for the emergence of cognition and mind. Piaget's theory is a prominent example of such an approach and sensori-motor development was the core of Piaget's explication of the emergence of the representational mind from action. It is the action-basis that constitutes the qualitative difference between Piaget's approach and other major approaches in developmental psychology. For any action-based approach, interaction abilities *constitute* knowledge about the world. While for the infant, sensori-motor knowing is exhaustive for what it means to have knowledge about the world, through development, new forms of knowing emerge.

Interactivism is another action-based approach to cognition and mind (Bickhard, 1978, 2009a, 2009b). As a consequence of the shared commitment to an action framework, interactivism has similarities with Piagetian theory, but also important differences (Bickhard & Campbell, 1989; Campbell & Bickhard, 1986).

3.1. The interactivist model of representation

At its core, interactivism began as a model of representation (Bickhard, 2009a, 2009b; Bickhard & Terveen, 1995) that has been developed and expanded so as to provide a more global ontology for understanding "the whole person" (Bickhard, in preparation). Interactivism shares with Piagetian theory its concern for the origins of knowledge and both theories consider (inter)action as the necessary foundation for understanding mental phenomena in general. From the interactivist perspective, mental representation is emergent in action, and anticipations about potential interactions constitute the core of all representation. This anticipatory, action-based perspective on representation is in contrast to standard *encoding* models. Encoding models 'represent' in virtue some sort of *correspondence* relationship between the organism and the world (e.g., informational, causal, teleological, etc., for detailed discussions of the many intractable problems with encoding models see Bickhard (2009b) and Bickhard & Terveen (1995)).

3.1.1. Epistemic contact versus epistemic content

Encoding models are assumed to possess their content in virtue of a correspondence relationship with what they are taken to represent. These correspondences often take the form of a causal (or lawful or informational) relationship between the object in the

world and neural activity in the brain (e.g., via transduction). However, assuming that causal correspondences constitute representations of what those correspondences are with encounters multiple fatal problems. One of these problems is that such correspondence models conflate the causal capacity to *detect* with normative *knowledge* of what those detections are detecting: detection, or differentiation, is taken to constitute representation.

In contrast, it is widely accepted that the thermostat's sensitivity to temperature constitutes an ability to detect differences in temperature, but it is also widely accepted that the thermostat does *not* have representational knowledge regarding what those detections are of. That is, despite the thermostat's sensitivity to temperature, there is no representational knowledge involved. Thus, for the thermostat, it is generally agreed that detection does not constitute representational knowledge of what those detections are detections of. For humans, the potential to *also* have representational knowledge of what some detection is detecting is, of course, possible; but for encoding models, representational knowledge is assumed to be constituted by the detection itself. That is, encoding models inherently conflate a crucial distinction between epistemic contact (detection, differentiation) and epistemic content (knowledge, representation).

3.1.2. Interactive contact and content

The interactivist model of *interactive differentiation* captures our epistemic *contact* with the world (Bickhard & Terveen, 1995) — without conflating it with *content*, or representation. In more detail, consider that any interaction of a system with its environment will depend in part on the nature of the system and in part on the nature of the environment. As such, the internal outcome state of the system (after the interaction with the environment) will serve to categorize those types of environments that leave the system in that internal outcome state from those that leave it in some other internal outcome state. For simplicity, consider a system that has only two internal outcome states, A and B. Interactions with certain environments will leave the system in internal outcome state A while interactions with other environments will leave it in state B. Thus, internal outcome states A and B serve to differentiate A-type environments from B-type environments (e.g., “consider the category of things [environments] that causes a particular infant to develop an allergic rash or to smile...” (p. 64, Reznick, 2000)). Importantly, in terms of differentiations per se, the system has no knowledge/anticipations of the environments that it has differentiated, and, consequently, detection of A-type environments is not representation of those environments (i.e., epistemic contact is not epistemic content).

Epistemic contact with the world in terms of internal states of the systems has the crucial benefit that these internal states are system (functionally) accessible. Their accessibility means that they can be useful to the *further* functioning of the system and useful in such a way that is intrinsically sensitive to the current environment (for similarities and differences with enactivism, see Bickhard, 2016).

It is in *indications for potential further functioning* of the system that representational *truth value* is emergent: such indications can be true or false. Bickhard (2009b) elaborates on the emergence of representation based on differentiated contact:

It might be learned, or hard-wired, for example, that, if state A is encountered, then an indication [for a frog] of the possibility of tongue flicking and eating of a particular sort can be set up. Such an indication is future oriented, anticipatory, and, therefore, involves content: it is about the current environment, and it could be true or false. But, to reiterate, setting such an indication up should be contingent on having engaged in a prior differentiating interaction with the right kind of internal outcome (p. 574).

3.1.3. Implicit presuppositions

So, complex agents must select which potential interactions they will engage in, and such selection requires a functional indication, or anticipation, of what interactions are possible in a given situation. Such anticipations about potential future interactions, if in fact selected, can proceed as expected or not – anticipations can succeed or they can fail; they can be true or false. This is the sense in which the interactivist model of representation accounts for truth-value (i.e., that representations can be true or false).

Importantly, anticipated interactions are, in general, premised on prior interactive differentiation/detections of the environment (epistemic contact). Actually engaging in one of the anticipated potentials *implicitly presupposes* that the environment is appropriate to support the interaction. Similarly, an indication *per se* (whether or not it is actually engaged) involves the presupposition that ‘this’ is an appropriate environment to support the indicated interaction. Such presuppositions are *about* the environment— that it is an appropriate kind of environment for supporting the indicated interaction. It is such *presuppositions about the environment* that constitute *content* of the anticipatory indications: it is the correctness of these presuppositions that grounds whether or not the indications are true or false. If that anticipation is in error and the interaction fails, then the implicit presupposition is false. For example, when a frog differentiates its environment as indicating an opportunity to flick its tongue and eat, actually engaging in the tongue flicking implicitly presupposes that the differentiated environment affords an opportunity to eat (i.e., there is a fly or a worm). If instead the environment was one in which, for example, there was an experimenter throwing pebbles, then the anticipation is in error, the interaction fails, and the presupposition is falsified. That frogs do in fact eat pebbles in these situations suggests that they do not differentiate between fly-type environments and pebble-type environments. Instead, the implicitly defined ‘opportunity-to-eat environments’ (Campbell, 2011) are differentiated at something like the level of small-object-moving-across-the-retina.

Importantly, note again that these presuppositions are *implicit*. There are no explicit representations of them, instead there are implicit presuppositions of them in the functional anticipatory activity of the organism. The organism has no explicit knowledge of them, but does engage the world in ways that presuppose them. Toddlers know nothing explicitly about atoms and molecules and the forces that bind them, but they do interact with the world in ways that atoms and molecules and their forces support. This is the case for all species but humans can learn more about what supports various kinds of interactions with the world via, e.g., science.

3.1.4. Implicit knowledge

The interactivist model of representation, thus, models implicit representational content as implicit functional presupposition. While there are multiple consequences of the interactivist model related to issues of implicitness (Bickhard, 1989, 2001, 2005), we will focus on two aspects related specifically to the model of representation. This contrasts with most approaches in the literature. Issues related to implicit knowing have been discussed in a multitude of ways (e.g., as tacit knowledge, sub-personal representations, procedural know-how, unconscious heuristics, system one processing, etc.). However, for all of these approaches, if representations are discussed, they still involve some type of explicit content. Accordingly, it tends to be the nature of the processes that *operate on* the explicit contents that make the knowledge “implicit” versus “explicit” (e.g., heuristic vs. rule-based; intuitive vs. rationale, conscious vs. unconscious, fast and automatic vs. slow and flexible, etc.).

Fodor (1998) captures the point succinctly in his response to Karmiloff-Smith (1992) when he says that “all representations are explicit about something” (p. 134). We agree with Fodor concerning this particular point—if it is assumed that all representations must be accounted for in terms of some form of an encoding model: encodings only exist in so far as they have explicitly specified contents. However, action-based approaches in general, and the interactivist model in particular, present an alternative foundation for representation – action and interaction—and, thus, an alternative framework for modeling implicit knowledge. Thus, the *possibility* of implicit knowledge is a consequence of our action-based approach to representation—and, in fact, implicit knowing is ubiquitous (Bickhard, 1998).

The notion of implicit content constituted as implicit presupposition is powerful for several reasons. Here we will mention that it enables researchers to model implicit knowledge without that knowledge having to be explicitly *represented*. Further, it resonates with research observations about human behavior that accord with some rule or principle, but with a rule or principle that seems unlikely to be known or represented by the infant or young child.

Conversely, *not* having some way to model implicit knowledge has contributed to the spread of claims about what infants and young child “know” (explicitly represent). For a classic example, researchers have argued that, because an infants’ looking behavior differentiates two displays that are consistent with the “principle of solidity”, that they have knowledge of that principle as part of their innate core knowledge (Spelke, Breinlinger, Macomber, & Jacobson, 1992). For an everyday example, consider the performances of professional soccer players who, presumably, do not possess corresponding knowledge about Newtonian mechanics. More recently, claims about “impressive” infant abilities have also been made in the area of ToM (Onishi & Baillargeon, 2005; Scott, Richman, & Baillargeon, 2015). In response, researchers have attempted to determine what it means for infants to have “implicit” ToM knowledge (Fenici, 2015; Low & Perner, 2012). Our claim would be that an action-based framework can provide an adequate ontology for modeling implicit knowledge in general (Allen & Bickhard, 2016; see Bickhard (1998) for a detailed explication of the multiple types and forms of implicit knowing).

3.1.5. Object representation

Much of contemporary developmental psychology has accepted the nativist stance that the object “concept” is an innate primitive – part of the innate foundation for the rest of knowledge (For a detailed critique of nativist methodology and theoretical framework, see Allen & Bickhard, 2013). From an action-based perspective, object representation must be emergently constructed and therefore must involve genuine learning and development. The interactivist perspective borrows heavily from Piaget’s action-based model of object representation as an invariant organization of interaction potentialities. That is, object representation is *constituted* by a web of interactive potentialities that remains invariant under some class of further transformations (Bickhard, 2009b). Thus, the general organization of anticipations that constitutes the representation of objects remains invariant under certain transformations (e.g., displacement) but not others (e.g., burning), and it is this functional invariance of the organization of anticipations that presupposes the permanence of the objects represented. Crucially, which transformations are deemed relevant is going to be discovered through children’s own exploration and through observational learning. In general, learning will exist both with respect to the invariant web itself as well as for the relevant transformations.

Thus, the “striking” decalages demonstrated for infant performances on visual displays that involve *occlusion*, *containment*, *covering*, etc. (Baillargeon, 2008) make good sense in terms of infants learning about how these transformations *do not* change the web of potentialities related to visual scans (Allen & Bickhard, 2013). Further, the visible and invisible displacements involved with the original A-not-B tasks were attempting to capture developments concerning the relevance (or irrelevance) of spatial transformations for a more developed web of potentialities. Such advances culminate around age two in terms of iterations of indication of potential interaction such that a sub-web of potentialities could be recovered through intervening steps. For example, before the sub-web of potentialities that constitutes my object representation is interactively available, I may need to walk into the other room and open the toy box. This developmental accomplishment constitutes a functional understanding that an environment exists beyond the child’s current perceptual access.

In turn, object permanence is not so much about knowing that objects continue to exist when out of sight as it is an emergent property of the new type of internal organization for engaging with the world. Accordingly, object representation ability is more appropriately characterized as the infant’s presuppositional understanding that the world exists independent of his/her activity. This understanding is implicit in the differentiation of self from the world. Once developed, object representational abilities are foundational in the sense of providing anchor points (invariances) from which to explore and learn about the world. Such learning and knowledge creates a sort of cognitive distance between the toddler’s perceptions and subsequent goal-oriented behavior, but this is not symbolically mediated thought.

It is important to note that the distinction between explicit versus implicit knowledge of objects does not exist without assuming an action-based approach to representation in the first place. For standard frameworks, if you know about an object, then you

represent it as such and have procedures that can operate on it. In contrast, interactively knowing an object means anticipating possible interactions with it. The anticipations are functional indications of what further activity could follow. The anticipations are *not* indications between representations. Instead, the anticipations *are* the representations. This means that the explicit content of an object representation is not the object per se, instead the object per se is part of the implicit content of the representation – i.e., the presuppositions of the anticipations.

3.1.6. Knowing levels: reflecting on what is interactively known

From the interactivist perspective, knowing is competent interaction and knowledge is the ability to engage the world successfully for some purpose. However, knowing about the mental states of other people poses a general problem in that the organism has nothing to directly interact with. Minds (as well as hidden causes, motivations, essences, grammar, necessity, numbers, relations, etc.) are not available for direct interaction and so representing these properties is not possible for an organism that is only able to interact with the external environment. Thought is only possible in terms of interaction potentialities (however complex the anticipated interactions become) and so an action-based framework faces a “thought-in-(inter)action” constraint on knowing. That is, knowing is restricted to what the organism can interact with – the “concrete” world. This constraint means that action-based frameworks need to explain the developmental emergence of more abstract knowledge. However, even for object representation, the knowledge of the organism is in terms of the interactive potentialities and not in terms of the object-as-object per se. The *aboutness* of interactive representation of objects is in terms of the implicit presupposition that the environment (object) is appropriate to support the indicated interaction as a potentiality, but that implicit presupposition is not itself known – explicitly represented. As a consequence, before a certain age children are only able to interact with the world in ways that correctly presuppose objects and object permanence, but are not able to represent object properties that are not “perceptually” available and this includes their relationship to other objects qua objects.

However, if a second level knowing system is able to interact with (reflect on) the first level system in a way that is similar to how the first level system interacts with the environment, then those implicit properties of the first level system can become known. That is, a second level knowing system could represent properties and relations that are only implicit in the organizational functioning of the first level system. Accordingly, the interactivist model proposes a hierarchy of knowing levels (Campbell & Bickhard, 1986) in which each higher level interacts with (represents) properties implicit in, realized in, the level below it. This forces a strict sequencing of developmental “stages” in which no higher level of organization can be constructed prior to the development of some organization at the level below it (level n cannot be constructed prior to the presence of level $n-1$) because a level of knowing with nothing immediately below it would have nothing to interact with (Bickhard, 1978). Note however that there are other instances of the system interacting with aspects of itself that do not constitute forms of epistemic reflection. The interactivist model of knowing levels is actually the final extension of a macro evolutionary ratchet in which prior forms of internal interaction systems enable the emergence of learning and emotions (Bickhard, 1980, 2006).

The relationships between a level of knowing and adjacent levels is functional, not architectural. It is a relationship of an organization of processes at one functional level interacting with an organization of processes at a lower level. Such relationships can be more or less specific to sub-organizations or domains or properties within a lower level, so development through levels can be *asynchronous* across sub-organizations and domains. However, the initial transition from level 1 to level 2 requires an architectural change – brain maturation (for a discussion of the reasons for this, see Bickhard, 1992). As a consequence, the initial transition from level 1 to level 2 will involve a generally age *synchronous* transition with respect to the new potentialities enabled by the second level system. The major emergence constitutive of second level knowing is the “initial ability for genuine epistemic reflection, and should make possible the development of many specific forms and instances and consequences of such reflection” (Bickhard, 1992). Chief among these consequences is the general ability to think internally, to transcend the “thought-in-(inter)action” constraint of first level knowing.

The distinction between thought-in-action and internal thought is a natural distinction for any model of cognition and representation as emergent in interaction—it derives from a basic distinction concerning what is being interacted with (Piaget, 1952). In particular, for an organism with only one level of interactive system, the only realm to be interacted with is the environment.¹ In such a case, any ‘thought’ *must* be ‘thought in action’. However, if the organism has a functional second level of interactive processes, then that second level can interact with processes and organizations in the first level, and thus have internal thought—thought that does not (necessarily) involve interaction with the environment; thought as ‘internal’ action. This involves one part of the CNS interacting with processes in other parts of the CNS (Bickhard, 2015a, 2015b). In turn, the possibility of internal thought enables abilities such as rehearsal, planning, transformational imagery, and the explicit consideration of hidden causes and relations – for both objects and agents (Campbell & Bickhard, 1986).

The interactivist model of knowing levels has some affinities with the LoC model discussed in the introduction but also, we believe, some relevant differences centered on the nature of reflection and the emergence of new representational content. For both approaches, the function of epistemic reflection is to take what is known at one level of knowing as the content for a higher level of knowing. This higher level is intended to constitute a qualitative emergence of new forms of knowing. With regard to recursive processes, they enable systems to benefit from the results of prior processing; but it is unclear how recursion alone will constitute a qualitatively new form of consciousness/knowing/process (Müller & Kerns, 2015). That is, it is unclear how recursively processing

¹ Note that for the neonate, the environment that is being interacted with and learned about is, for example, the proprioceptive-kinesthetic body — e.g., in primary circular reactions.

old content will result in novel representations, rather than, for example, “new” complexes of already available (‘old’) representations—perhaps available in some innate base of atomic representations (Fodor, 1998).

From our perspective, it is the underlying organization of representation, with the various types of implicit content, that becomes known through reflection and constitutes the new representations. Accordingly, we wonder if *recursion is enough* to enable epistemic reflection (i.e., the emergence of qualitatively new representations). Further, we wonder if, in addition to experience-dependent growth, intrinsic constraints on the knowing/reflection processes are needed to explain how and why the forms of reflection come on line when they do? We would like to suggest then, that adequate answers to both questions are important to provide an explanation for an ontological sequencing of qualitatively new forms of knowing. Our analysis is not intended to be definitive about any difference between LoC and interactivism. Instead, a proper treatment of these issues and the relationship between the two models, while potentially fruitful, is beyond the scope of the current article.

4. The current study

The implication of level-two reflection for mindreading abilities is fairly straight-forward: perceptually inaccessible mental states cannot be interacted with directly and therefore level-two reflection is required for any task that necessarily involves reasoning about such states. Because the capacity for reflection appears to develop around age 3.5-4, children prior to this age should not be able to engage in explicit mindreading activities. Less straight forward is the sense in which reflection applies to reasoning that involves objects.

Pre-reflective object knowledge is constituted by a web of interactive potentialities that remain invariant under some other class of further transformations; this organization, however, is not itself known. That is, while the child is able to act in accordance with the presupposed properties of the organization that constitutes the invariance of objects, he/she cannot reason explicitly in terms of those presupposed properties. Therefore, it should (in principle) be possible to devise a task involving object reasoning that can differentiate between the implicit presuppositions (the implicit content) about the object properties and explicitly represented knowledge of those properties. An additional difficulty for devising a test of reflection is that an interactive knowing system *without* reflection can (in-principle) learn any particular procedure with enough practice or training. Consequently, the task must also involve sufficient novelty such that children cannot respond correctly on the basis of prior interactive learning.

Accordingly, an object reasoning task (called Leaning Blocks, LB) was developed by one of the authors some time ago (Bickhard, 1978). This task required children to verbally predict what would happen to a block being held on edge when released (i.e., “fall” or “stay up”). After a similar introduction for a second block placed opposite the first, the two blocks were placed leaning against each other and the same prediction question was asked. Those children incapable of reflection were expected to assume that the blocks would fall because they were unable to reason explicitly about the relationship between them and therefore could not anticipate the consequences of what would happen given the novelty of the situation. For testing, the canonical task described above included three perceptual variants (LB-perceptual) and a modified version of the task included two additional variants (LB-structural). The canonical (perceptual) and modified (structural) versions of the task, and the variants within each, are described in detail in the methods section.

The LB tasks are expected to be a relatively “pure” measure of reflection in that there are few extraneous task demands. Linguistically, children need to be able to understand the question and responds with one of the words but there is no narrative comprehension required. Further, the duration of the task is short, only involves two concrete objects, and a single judgment which suggests minimal working memory demands. In contrast, FB tasks involve both narrative and working memory demands. As such, we would expect the LB task to be easier than the FB tasks.

The primary purpose of the current study is to provide evidence for a theoretical implication of the interactivist model which predicts that a domain-general transition takes place during early development (Bickhard, 1978). The LB task was devised to test this prediction. Positive results for the LB tasks would be confirmatory in that the predictions are both novel and seemingly inexplicable from extant perspectives about the development of children’s physical reasoning abilities (Hespos & Baillargeon, 2008; Needham & Baillargeon, 1993; Piaget, 1954). Given its commitment to an action-based framework for knowing about the world, interactivism makes the strong claim that reasoning in terms of hidden mental states is not possible without reflection (i.e., until around 4-years of age). Further, from the interactivist perspective, there is a fundamental similarity between being able to reason explicitly in terms of object properties and being able to reason in terms of an agent’s mental states – both require explicit representations of hidden contents and therefore require reflection. While the idea that children before age 4 cannot reason about any mental states is uncommon, the possibility that they cannot reason about objects per se is difficult to understand from extant perspectives because they are unable to draw a distinction between implicit and explicit content.² Therefore, if it can be demonstrated that thinking explicitly *about* objects requires reflection, then that would strengthen the claim that all forms of mental-state attribution also require reflection.

4.1. Research questions

Does performance on the LB tasks involve an age 4 transition?

² In correspondence models of representation, a representation of an object is *explicitly* a representation of that object, and a representation of a mental state is *explicitly* a representation of that mental state: for a pure correspondence model, there is no alternative — contact and content are identified.

Hypothesis 1. Without the capacity for internal reflection, children will not be able to reason explicitly about object properties/relations and therefore about the consequences for objects in a type of novel situation.

Prediction 1. Children younger than 4 will fail to understand that two objects leaning against each other will be mutually supportive.

Is LB performance an earlier example of the age 4 transition than FB performance?

Hypothesis 2. Although reflection is a domain general development, it is an enabling constraint that should manifest differences in accordance with task demands.

Prediction 2. We expect an asymmetry in performance on the LB-perceptual tasks and the FB tasks such that children will not do well on the latter unless they do well on the former.

Is performance on LB tasks related to performance on FB tasks?

Hypothesis 3. As a domain general development, we should expect some degree of synchrony in performance across tasks with similar task demands.

Prediction 3. The LB tasks will be correlated with the FB tasks before and after controlling for age.

4.2. Methods

4.2.1. Participants

Seventy-four (47 male, 27 female) predominantly white middle class children (aged 3–5, $M = 48$ months, $SD = 10$) participated in the current study. Children were recruited through published birth announcements and the university daycare. Of the seventy-four children, three were excluded from all analyses for not providing data on the tasks (i.e., they did not want to play the games).

4.2.2. Materials

Materials for the perceptual version of the leaning blocks task included two smaller toy blocks of different colors, two larger toy blocks, two larger rectangular cardboard cards. For the structural version of the leaning blocks task two additional blocks were used. Materials for the false-belief tasks included pictures, vignettes, figurines, a crayon box, and a portable sandbox.

4.2.3. Procedure

All children received a warm up with two experimenters. Following this, all children were given the leaning blocks tasks (with 5 variants – 3 perceptual and 2 structural) followed by three theory of mind tasks (unexpected contents, change of location, and active deception).

4.2.3.1. Leaning blocks (LB) tasks. To test for internal reflection, new tasks were created. The original leaning blocks task was conceived to involve a demonstration using small wooden blocks (see, for example, the plan/image distinction in Bickhard, 1978). This task involved two control questions and one target question. First, the experimenter placed a smaller toy block on edge (holding it in a pincer grip at the top) and asked the child: “What will the block do if I let go? Will it fall or stay-up”. After the block was released and fell, it was removed from sight and the experimenter placed a second toy block (opposite the location of the first one) on edge and asked the child: “What will the block do if I let go? Will it fall or stay-up”. Finally, the experimenter leaned the two wooden blocks against each other (holding them near the top) and asked the child the target question: “What will the blocks do if I let go? Will they fall or stay-up”. If children failed to provide an answer for a question they were prompted by the experimenter by saying “When I let go, will it/they fall or stay-up”.

LB-perceptual: Two additional variants on the original task were included that only differed in terms of the perceptual appearance of the objects that were used. For the first variant, two larger toy blocks were used. For the second variant, two large rectangular cardboard cards were used. In total, there were three perceptual versions of the task. For each variant, any children who failed to answer either of the control questions were scored with a 0. For example, if the child could not correctly answer what would happen to the single block when released, then they were given a 0 for that trial. Responses on the target questions were summed for an LB-perceptual score from 0 to 3.

LB-structural: For the structural version of the task there were two variants. For the first one, the two smaller blocks were held together (side by side) in a pincer grip and then placed such that one of them was leaning against a third medium size block but the other one was free to fall once the pincer grip was released. Children were then asked what would happen to each block when released (i.e., “What will the white/brown block do if I let go? Will it fall or stay-up”). The second structural variant was the same as the first except that the two small blocks were glued together and children were given a chance to see that they did not separate by pulling on them. For both of the structural variants, any children who did not answer both sub-questions correctly were score with a 0. For example, if the child correctly answered what would happen to the white block (i.e., “stay up”) but was incorrect for the brown block (i.e., “stay up”), then they were scored as 0. For both of the structural variants, if children answered the two sub-questions correctly, they received a 1. Children’s responses on the two variants were summed to create an LB-structural score from 0 to 2.

4.2.3.2. Theory of mind tasks. Three separate ToM tasks were used to test children’s explicit false-belief understanding. First, children were tested on an unexpected contents task (Perner, Leekam, & Wimmer, 1987) using a crayon box with a plastic horse inside. The

task involved two control questions and one target question. The experimenter began by asking the child “What is in the box?”. After answering that there were crayons in the box, the experimenter asked the child to open the box and empty its contents. After discovering its contents, the experimenter and child put the toy horse back inside the box and closed the lid. Children were then asked two control questions: 1.) “Before you opened the box, what did you first think was in it?”, and, if they correctly answered crayons, they were asked 2.) “But what is really in the box?”. This was followed by the target question: “Your friend [Tommy] has not seen this box yet, what will [Tommy] *think* is inside the box before he opens it?” Children received a score of 1 if they answered all of the questions correctly and a score of 0 otherwise.

Second, children were tested on a change of location task (Wimmer & Perner, 1983) using a 5-step picture story narrative. In this narrative Johnny and his mom made a cake that was moved to the fridge when Johnny was outside. After the story had been presented, children were asked two control questions: 1.) “Where did Johnny put the cake before he went outside to play?”, and, if they answered correctly, 2.) “Where is the cake now?”. Next, the experimenter asked the target question: “When Johnny comes inside for some cake, where will Johnny look *first* for the cake?”. Finally, children were asked: “Will he find the cake when he looks there?”. Children received a score of 1 if they answered all of the questions correctly and a score of 0 otherwise.

Third, children were tested on an active deception task (Chandler, Fritz, & Hala, 1989) involving two toy characters who were playing a hide and seek game in a small sand box. Children were asked to select either “Mark” or “Sue” to be on their team. If, for example, Mark was selected, then Sue was placed behind the experimenter and the child was told that she could no longer hear or see us. The experimenter then demonstrated to the child how the game was played. Mark was used to hide a sticker under one (of three) cups laying at one end of the sand box. However, to hide the sticker, Mark had to walk in the sand leaving footprints behind. Children were asked if they knew what to call the “foot prints” that Mark left in the sand and were then told explicitly “That’s right! You can see Mark’s footprints. So Sue will know where Mark has been walking to hide the sticker. Hmm, we don’t want that!”. The sand box was then reset and children were given their turn to hide the sticker just like the experimenter had shown them. After walking to one of the cups and hiding the sticker, children were asked: “Okay, now before Sue comes back, what can you do to make her look under the wrong cup?” If needed, children were prompted: “Can you do anything else to the sand or can you do something with Mark to make Sue look under the wrong cup?”. Finally, just before bringing Sue back, children were reminded that: “In this game if Sue finds the sticker, then she wins, but if Sue looks under the wrong cup then you win”. After Sue was brought back and said “hello” to Mark, children were asked the target question by Sue: “where should I look for the sticker”.

Children received a score of 1 for the target question if they indicated a false location or if they claimed not to know. Whether their score increased depended on what they did when given a chance to cover up Mark’s footprints. Specifically, children received a score of 2 if they erased the footprints that they had originally made when hiding the sticker. They received a score of 3 if they made multiple sets of footprints. Finally, they received a maximum score of 4 if they erased the original set of footprints and made a false set to one of the empty cups.

4.3. Results

4.3.1. Coding: leaning blocks

The two versions of LB were equally weighted and combined to form a total LB score from 0 to 2. In total, 11 children incorrectly answered one or more control questions (7 answered one incorrectly and 4 answered more than one incorrectly). Three children did not complete any of the LB tasks because they decided not to play the games and provided no data for the analyses. In addition, one child was excluded from the analyses related to the LB-perceptual score because he did not stop grabbing the blocks. Six additional children were excluded from analysis related to the LB-structural score because they were missing one or more of the tasks (1 didn’t stay seated, 1 continued to only build the castle, 2 continued grabbing/knocking-over the blocks, 2 didn’t maintain interest). Finally, for an overall pass/fail score on LB-perceptual, children who received a score of 2 or 3 were coded as passing and scores of 0 or 1 were coded as failing. For an overall pass/fail score on LB-structural, children who received a score of 2 were coded as passing and scores of 0 or 1 were coded as failing.

4.3.2. Coding: ToM

Three tasks were used to assess children’s false-belief understanding: Unexpected Contents (UC), Change of Location (CL), and Active Deception (AD). For both of the first two tasks, children were scored as passing or failing the test question (1 or 0). The active deception task was scored out of 4 and weighted to be out of a total of 1. Finally, a composite Theory of Mind (ToM) score was created for a maximum total score of 3 (1 for each of the FB tasks). For an overall pass/fail score, children who received a score of 2 or 3 were coded as passing and scores of 0 or 1 were coded as failing.

4.3.3. Age analyses

Table 1 provides children’s pattern of performance for each of the three sets of tasks according to age. Consistent with typical FB performance, 3-year-olds mostly failed, 5-year-olds mostly passed and 4-year-olds were at an intermediate level. Statistical analyses indicated that FB performance differed by age ($\chi^2(n = 68) = 39.8; p < .001$) such that all three age groups were significantly different from each other ($p < .001$ for each follow-up comparison). For the LB tasks, children’s performance on both LB-perceptual and LB-Structural showed an age-4 transition. Specifically, performance on LB-structural was similar to performance on the FB tasks in terms of the age effect ($\chi^2(n = 64) = 24.5; p < .001$) such that 3-year-olds differed from 4-year-olds ($p < .05$) and 4-year-olds differed from 5-year-olds ($p < .01$). Although performance on LB-perceptual also differed by age ($\chi^2(n = 70) = 14.0; p < .01$), the effect was more of a threshold from 3 to 4. That is, 3-year-olds differed from 4-year-olds ($\chi^2(n = 47) = 8.9; p < .01$) but 4- and 5-

Table 1
Classification of Age by Number Correct on the Leaning Blocks and False-Belief tasks.

Age	Number Correct			
	0	1	2	3
LB Perceptual				
3-year-olds	10 (37%)	5 (19%)	7 (26%)	5 (19%)
4-year-olds	2 (10%)	1 (5%)	6 (30%)	11 (55%)
5-year-olds	1 (4%)	2 (9%)	8 (35%)	12 (52%)
LB Structural				
3-year-olds	10 (46%)	11 (50%)	1 (5%)	–
4-year-olds	4 (21%)	9 (47%)	6 (32%)	–
5-year-olds	0	7 (30%)	16 (70%)	–
False-Belief				
3-year-olds	18 (75%)	4 (17%)	2 (8%)	0
4-year-olds	4 (19%)	8 (38%)	6 (29%)	3 (14%)
5-year-olds	0	3 (13%)	5 (22%)	15 (65%)

year-olds did not differ from each other ($\chi^2(n = 43) = 0.00$).

4.3.4. Task performance asymmetries

Given the minimal task demands of the LB-perceptual tasks, we hypothesized that it would be an earlier manifestation of the age-4 transition as compared to the FB-tasks. The same criteria were used to categorize LB-perceptual and FB performance into pass/fail scores. Children with 0–1 correct responses (see Table 1) were categorized as failing while children with 2–3 correct responses were categorized as passing. Table 2 provides the pattern of pass/fail performance on the resulting 2 × 2 tables. While children who passed LB-perceptual may or may not pass FB, children who fail LB-perceptual almost all fail FB (McNemar test with Yates correction; $n = 67$; $p < .001$). To explore the simple effect for those who failed LB, a follow up binomial test with Bonferroni correction indicated a significant difference between those who passed versus failed FB ($p < .05$). Finally, the odds ratio indicated that children were 6.14 times more likely to fail FB if they failed LB-perceptual compared to if they passed. Although we did not have an a priori hypothesis for the relationship between LB-perceptual and LB-structural, the resulting 2 × 2 table indicates a similar pattern of results as what was found between LB-perceptual and FB (McNemar test with Yates correction; $n = 66$; $p < .001$). The same follow up analysis was conducted for LB structural and indicated a significant difference between those who passed versus failed the task ($p < .01$). The odds ratio indicated that children were 6.22 times more likely to fail LB-structural if they failed LB-perceptual compared to if they passed.

4.3.5. Simple and age-partialled correlations

Table 3 provides the correlations between age and the outcome variables using both separate and composite scores. Age is correlated with all of the measures and all of the measures are correlated with each other. Of note are the smaller correlations between LB-perceptual and each of the FB tasks as compared to LB-structural and those tasks. Table 3 also provides the age-partialled correlations between the outcome measures. After controlling for age, LB-perceptual is not correlated with any of the other measures including LB-structural. LB-structural was correlated with ToM total and UC after controlling for age. If the data points are restricted to only 3- and 4-year olds, there is no change in the pattern of relations among the LB tasks and FB tasks (see Table 4). After controlling for age, the Change of Location (CoL) task was correlated with the other two FB tasks but those two tasks (UC and AD) were not themselves correlated.

4.4. Discussion

There are a number of domains in which a significant developmental shift seems to take place between 3- and 4-years of age (Bickhard, 1992). One such transition concerns the ability to reason explicitly about the false-belief states of other agents in novel situations (i.e., ToM research). While there is much debate concerning the exact nature of the transition between 3- and 4-years of age, few psychology researchers claim that children younger than three cannot reason about any of the mental states of another person (intentions and goals as well as beliefs and desires). Those researchers who do reject mental-state attribution as foundational

Table 2
Classification of Performances on LB-Perceptual by FB and LB-Structural tasks.

LB Perceptual	False-Belief		LB Structural	
	Fail	Pass	Fail	Pass
Fail	15 (83%)	3 (17%)	16 (89%)	2 (11%)
Pass	22 (45%)	27 (55%)	27 (56%)	21 (44%)

Table 3
Simple and Age-Partialled Correlations Among the Tasks.

Variable	LB Total	LB Perceptual	LB Structural	ToM Total	Unexpected Contents	Change of Location	Active Deception
Age	0.65 ^{***}	0.42 ^{**}	0.62 ^{***}	0.75 ^{***}	0.61 ^{***}	0.63 ^{***}	0.64 ^{***}
LB Total		0.81 ^{***}	0.83 ^{***}	0.64 ^{***}	0.54 ^{***}	0.53 ^{***}	0.45 ^{***}
-LB Perceptual			0.37 ^{**}	0.41 ^{**}	0.28 [*]	0.41 ^{**}	0.32 ^{**}
-LB Structural				0.64 ^{***}	0.61 ^{***}	0.51 ^{***}	0.40 ^{**}
ToM Total					0.77 ^{***}	0.87 ^{***}	0.79 ^{***}
-UC						0.58 ^{***}	0.49 ^{***}
-CoL							0.59 ^{***}
Age-partialled correlations							
LB Total		0.77 ^{***}	0.72 ^{***}	0.29 [*]	0.23 [†]	0.21	0.07
-LB Perceptual			0.15	0.16	0.04	0.21	0.08
-LB Structural				0.33 ^{**}	0.37 ^{**}	0.20	0.01
ToM Total					.60 ^{***}	0.77 ^{***}	0.62 ^{***}
-UC						0.32 [*]	0.17
-CoL							0.32 [†]

^{*}p < .05, ^{**}p < .01, ^{***}p < .001, [†]p < .10

Table 4
Age-Partialled Correlations Among the Tasks for 3- & 4-year-olds.

Variable	LB Total	LB Perceptual	LB Structural	ToM Total	Unexpected Contents	Change of Location	Active Deception
LB Total		0.77 ^{***}	0.75 ^{***}	0.35 [*]	0.25	0.23	-0.03
-LB Perceptual			0.19	0.25	0.08	0.23	0.10
-LB Structural				0.34 [†]	0.35 [*]	0.24	-0.10
ToM Total					0.58 ^{***}	0.78 ^{***}	0.62 ^{***}
-UC						0.23	0.19
-CoL							0.35 [†]

^{*}p < .05, ^{**}p < .01, ^{***}p < .001, [†]p < .10

for young children’s social capabilities tend to argue that social-pragmatic participation is the foundation for social understanding (Allen, 2015; Carpendale & Lewis, 2015; Fenici, 2015). The necessity of social interaction as the foundation for social understanding follows from the broader theoretical implication of an action-based framework for knowing and cognition – the “thought-only-in-(inter)action” constraint. Although interactive knowing can become quite complex, and with such complexity there may come emergent properties (e.g., object permanence), interactive knowing will not involve explicit representations of perceptually unavailable contents, which include mental states as well as relations among objects. Instead, perceptually unavailable contents will be implicit in the organization of interactive knowing and epistemic reflection will be required to develop explicit representations of those implicit contents.

The LB tasks were based on an empirical implication of the knowing levels model within the interactivist framework. The power of the LB tasks comes from the idiosyncrasy. Contrary to our intuitions and contrary to existing research in the domain of physical object knowledge (Hespos & Baillargeon, 2008; Needham & Baillargeon, 1993), results from the LB tasks indicated a clear age-4 transition in preschooler’s object reasoning capabilities. This transition in performance is explained by the interactivist perspective as a consequence of a domain-general development that enables epistemic reflection. In turn, reflection enables children the potential to explicitly represent and reason about the relations between the blocks.

For both variants of the LB tasks, the 4-year-olds’ performance was better than the 3-year-olds’ but they were significantly different from the 5-year-olds’ performance only on the LB-structural version of the task. The ceiling effect for performance on LB-perceptual after 4-years of age is consistent with our a priori assumption that the perceptual version is a relatively pure measure of reflection in that it involves few extraneous performance factors in order to succeed. The major task difference for LB-structural comes from the second part of the task. The first part of the LB-structural task mirrors that of the perceptual tasks in that children are being asked about what will happen to a block that is leaning on a third block (or not) when released. The difference is that there are three blocks present rather than two and one is leaning on the third block while the other is not. In contrast, for the second part of LB-structural, children must adjust their predictions in accordance with the newly learned fact that the two blocks are now stuck together (i.e., block 2 is not leaning on block 3 but is stuck to block 1, therefore block 2 will not fall when released). This additional reasoning seems to increase the difficulty of the task such that 5-year-olds performed significantly better than 4-year-olds.

The increased difficulty of LB-structural resulted in performance differences across the age groups that parallels what was found for the FB tasks. This makes sense given the fact that FB tasks also involve additional abilities (Stone, Carpendale, Sugarman, & Martin, 2012). Further, the correlation between LB-structural and FB was stronger than for LB-perceptual and remained after controlling for age. Frye et al. (1995) have argued that “age-partialled correlations reveal the individual differences that are present when the basic effect of development has been removed”. If the basic effect of development is the reflective ability to explicitly reason, then, collectively, these results suggest that the two LB tasks capture both the basic effects of development that underlie FB

performance as well as some of the additional task demands that are involved. Overall, these results show a strong unity between task performances across very different domains (physical and social-cognitive).

4.4.1. Alternative proposals for the age-4 transition

In the introduction, we discussed two groups of researchers who have argued for a domain-general development that explains the age-4 transition (Perner, 1991; Zelazo 2004). In addition, there are other models within the general construct of working memory³ (e.g., Case, 1991; Halford, Wilson, & Phillips, 2010) as well as research focused on comparative studies (Penn, Holyoak, & Povinelli, 2008) that could be interesting to discuss as part of the broader issues concerning “reflection” or “higher-order” cognitive processes. However, we will restrict our discussion to the two groups from which we drew our modus operandi for the current study.

For Perner and colleagues, metarepresentational abilities are what develop around age 4. Based on the sorts of tasks that Perner and his colleagues designed, metarepresentations of objects would seem to concern their potential for dual-representation (e.g., the same person is both Clark Kent and Super Man; a robin is both a bird and an animal). In the case of objects, this would suggest a situation where the object is being used as a symbol (e.g., the object is both a toy block and a rocket ship). However, our task does not involve the sort of dual-representational nature that seems to be captured by the sorts of tasks that Perner and his colleagues have used to demonstrate the non-specificity of the transition at age 4.

For Zelazo and colleagues, it is the embedded rule abilities related to EF that develop around age 4. These abilities enable the creation of “meta”-rules that allow for the integration of lower-level rules such that children can *flexibly switch* between conflicting representations. The conflict is in terms of which feature/dimension of the representation has been highlighted with respect to the purpose of the activity (e.g., another’s activity based on my perspective versus your perspective, my activity based on the color of the card or the shape of the card, the ball’s activity based on the light being on or being off). Accordingly, explanations in terms of embedded rules involve tasks that can be characterized as “...reasoning tasks with two conditions that share a conflicting judgment” (Frye et al., 1995, p. 487).

However, the LB task does not create a conflicting characterization of the representation of the blocks (i.e., two conditions) that can then involve conflicting judgments. Instead, all three questions in the LB tasks are the same in that children are asked if the blocks will fall or stay up. No manipulation takes place such that children are induced to represent the block by one feature/dimension (e.g., by height) and then required for it to be represented in another conflicting way (e.g., by width). Instead, children make a judgment about what they see and we argue that those children who have developed the ability to “see” relations, answer correctly. The reason that reflection is necessary to perceive the relation between the blocks is because it is not perceptually present in the same way as other features and properties of the block (shape, color, etc.). A first level knowing system is restricted to anticipations about potential further interaction (e.g., the anticipation that an unsupported block will fall) and cannot anticipate about a novel situation that requires them to go beyond the thought-in-action constraint.

Presumably there is overlap in the sorts of performances that the metarepresentational and EF perspectives are intended to explain. Similarly, several of the functions that are attributed to metarepresentational and/or EF abilities are going to converge with the knowing-levels model. However, the knowing-levels model has additional theoretical considerations that contribute to its support. First, knowing levels are a direct consequence of the underlying model of representation. While the specific age for the development of reflection is not predicted a priori by the model, that such a development take place is a direct prediction of the interactionist model of representation and knowing. Second, interactionism avoids many of the problems that affect other approaches to representation – key among these is the problem of new representations (Allen & Bickhard, 2013; Bickhard & Terveen, 1995). Action-based approaches argue that representation is emergent from action and in so doing provide a framework for the naturalization of representation in particular and mental phenomena in general (Bickhard, in-preparation). Third, interactionism started as a model of representation but has derived subsequent models of other mental phenomena such as: perception, motivation, emotion, language, sociality, persons, and others. This means that interactionism has a degree of internal coherence between areas that offers a unified framework for a broad range of psychological phenomena. This does not mean that interactionism is correct, but such coherence is itself a benefit in the context of a science with ever increasing fragmentation of theories and phenomena.

4.4.2. Implications for social-cognition

One consequence of the current perspective is that the wealth of experimental research interpreted as demonstrating infant and toddler mindreading abilities (e.g., goal or intention attribution) is diagnostically insufficient to draw those conclusions (Heyes, 2014). The possibility that young children do not engage in any mental state reasoning despite their ability to navigate their social environment is less contentious if we consider comparative researchers who argue against mindreading abilities for animals (Povinelli & Vonk, 2003). Many animal species are socially competent in ways that allow for sophisticated social coordination and cooperation. To the extent that it is thought that there is a qualitative difference between our species and our more proximate relatives, it cannot depend on such basic competencies for social interaction. Further, if these sophisticated social competencies can be understood without the need to posit a “theory of mind”, then they demonstrate the types of social complexity that can be accounted for by non-mental state attribution frameworks.

From the current action-based perspective, attributing internal states to other people in order to understand their behavior becomes as unnecessary for social situations as it is for knowing about objects. That is, just as there is no need for people to attribute

³ Models of working memory from within an information-processing framework are going to involve assumptions that are incompatible with an action-based framework. See Bickhard (1993) for a specific response to Case’s (1991) model.

internal states to objects in an effort to know them (i.e., understand their interactive potentialities), there is no need for people to attribute internal mental states to each other in order for them to engage in successful social interactions. Although the interactive potentialities of objects are largely knowable from perceptually available contact and people are not, interactive potentiality is at the core of both domains. From this perspective, the relevant difference between objects and people is a matter of shared knowledge in the sense of *mutually* held interactive potentialities among people. What is necessary then for knowing other people is a history of shared practices that are learned and developed within the social-emotional cradle constitutive of human caregiving (Carpendale & Lewis, 2015; Gallagher & Hutto, 2008). Infants come to learn the meaning that their actions have for those around them through the anticipation of what is possible given the situation. Further, just as the interactive potentialities afforded by balls will come to be differentiated from those that are afforded by blocks, so too must the interactive social potentialities of an imitation game come to be differentiated from those of an eating activity. Accordingly, from the interactivist perspective, *development* of the social-cognitive domain is a matter of learning about the differentiations and subsequent interactive potentialities for different types of social situations.

5. Summary

Piaget's genetic epistemology was concerned with the emergent origins of new forms of knowing and his stage model was intended to capture the qualitatively different forms of knowing that could be constructed throughout development. While there are several differences between Piaget's stage model and interactivism's knowing levels model (Campbell & Bickhard, 1986; Bickhard & Campbell, 1989), both share in their attempt to explain the emergent origins of knowledge from within an action-based framework. Action-based approaches provide a naturalistic explanation for cognition and mind that rejects the foundationalism present for any of the varieties of nativism or empiricism (Allen & Bickhard, 2013). An important challenge for action-based approaches concerns more abstract forms of knowing for which there would seem to be nothing in the world to interact with. That is, if knowing is fundamentally a matter of interactive competence, then certain forms of human knowledge are going to require additional theoretical explanation. We argue for an architectural development that enables a second level knowing system to interact with the first level system in a fashion similar to how the first level system interacts directly with the world. Such a development was originally predicted in the early 70s (Bickhard, 1973, 1978, 1980) and is consistent with the wealth of research since then that has demonstrated important transitions across different domains at around 4-years of age. Age 4 was originally identified as the probable age of the beginnings of reflection based on the advent of Piaget's 'anticipatory imagery' (Bickhard, 1973, 1978). As mentioned above, there are many other transitions that occur at about this age (Bickhard, 1992). Children's performance on the LB tasks extend this consistently found transition between 3- and 4-year-olds but in a domain and with a task that would be predicted by extant theories to have developed much earlier. Most broadly, these results demonstrate the potential value in reconsidering what can be accomplished by young children without the need to attribute to them the cognitively sophisticated abilities.

6. Limitations and future directions

In order to clarify what role inhibitory and working memory demands exist for preschooler performance on the two versions of LB, future work should include appropriate measures. Based on our discussion about the differences between LB-perceptual and LB-structural, we would predict that inhibitory and working memory demands may be related to the latter but not the former. Future research could also attempt to devise additional object reasoning tasks that also tease apart reflective from non-reflective abilities. Alternatively, future research could be extended to other cultures to see if children's performance on LB shows both an age 4 transition and/or the asymmetry relationship to FB tasks. To further explore what it means for reflection to enable explicit thought, future research could consider how children's object reasoning might be related to their understanding of other tasks that are thought to involve qualitatively new representational abilities (e.g., appearance-reality, seriation, alternative labels, etc.). Finally, future work could compare and contrast different theoretical models of reflection.

7. Conclusion

The primary purpose of the current study was to provide evidence for the claim that the development of epistemic reflection at around age 4 is a domain-general enabling constraint on the emergence of explicit thought. As theoretically derived from the interactivist model, reflection explains the relatively synchronous transitions within and across domains that have been demonstrated in the literature. The theoretical basis for the claim about reflection was explicated early in the development of the interactivist framework as a necessary consequence of an action-based model of knowing (Bickhard, 1973; Campbell & Bickhard, 1986). The LB tasks provide strong empirical support for this claim because the predictions are both novel and difficult to explain from other perspectives. Although there have been other proposals that argue for a domain-general development at around age 4 (e.g., Perner, 1991; Zelazo, 2004), these do not offer a model of this development as a direct consequence of the underlying model of representation, knowing, and cognition. Further, the interactivist framework is broader than extant perspectives in terms of its integrated models of normative phenomena that span from neurons to neighborhoods (Bickhard, in-preparation). Lastly, the interactivist framework resolves or avoids a multitude of other theoretical problems that affect non-action-based frameworks with corresponding problems for methodology (Allen & Bickhard, 2013).

In sum, the interactivist model of cognition and representation predicts a development of the ability to engage in reflective thought. This shift occurs at about age 4, and has multiple manifestations across numerous developmental domains—the general

prediction is that there is such a shift across all domains. The discussion has focused primarily on two of these developmental shifts: the false-belief tasks, and a novel prediction in the domain of object (and object relation) representation—far removed from the social-cognition domain involving false beliefs. If the interactivist model is correct, these tasks (and others) should be related via the underlying age-4 emergent ability to engage in reflective thought, and we discuss experimental evidence that that is the case. The theoretical prediction of an underlying domain general age 4 shift is, thus, supported.

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