The development of conscious control in childhood

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Developmental data suggest that the growth of executive function in childhood can be understood in terms of the development of consciousness. According to the 'levels of consciousness' (LOC) model, there are age-related increases in the highest degree of self-reflection or LOC that children are able to muster in response to situational demands. These increases in LOC with age have consequences for the quality of experience, the potential for recall, the complexity of children's explicit knowledge structures, and the possibility of the conscious control of thought, emotion, and action. The hierarchical LOCs identified by this analysis are also useful for understanding the complex structure of conscious experience in adults, and they provide a metric for measuring the level at which consciousness is operating in specific situations.

Like psychology generally, research on the development of consciousness in childhood has a short history but a long past. For early theorists such as Baldwin [1] and Vygotsky [2], it was the central problem to be addressed by the new science of psychology. But although there has been an explosion of research on consciousness during the past decade, very little of this research has been conducted from a developmental perspective, and there is currently no consensus concerning the characteristics of children's consciousness. Some theorists consider even infant consciousness to be adult-like in most respects [3,4]. These authors attribute to young infants not just sensory consciousness of present sensations, but self consciousness, consciousness of other minds, and the ability to act deliberately in light of conscious representations. At the other extreme are those who characterize infants essentially as unconscious automata – capable of cognitive function but lacking even sensory awareness [5–7].

Understanding children's consciousness is important in its own right, but developmental data also have implications for consciousness in general. Whereas some models based on adults distinguish between consciousness and a meta-level of consciousness (e.g. consciousness versus meta-consciousness [8], primary consciousness versus higher-order consciousness [9], core consciousness versus extended consciousness [10]), it is often the case, as Schooler [8] notes, that these two levels are conflated. For example, in the influential information-processing models proposed by Schachter [11] and Moscovitch [12], consciousness corresponds to a single system, and information is either available to this system or not. By contrast, developmental data argue for not just two, but *several* dissociable levels of consciousness; information can be available at one level but not at others.

The levels of consciousness (LOC) model [13–15] is a developmental, information-processing model that describes these hierarchically arranged LOCs and provides a metric for measuring the level at which consciousness is operating in specific situations. This metric should be useful in a variety of investigations, not just in research on children's consciousness, because although most adults are *capable* of high LOCs, the reflective processes that bring these LOCs about are effortful and resource-demanding, and adults often operate at relatively low LOCs (e.g. when tired).

Example of a knowledge–action dissociation illustrating the need for different LOCs

Key aspects of this approach can be illustrated using a simple example, which I will subsequently locate in the context of a developmental theory. In the Dimensional Change Card Sort, children are shown two target cards (e.g. a blue rabbit and a red car) and asked to sort a series of bivalent test cards (e.g. red rabbits and blue cars) according to one dimension (e.g. color). Then, after sorting several cards, children are told to stop playing the first game and switch to another (e.g. shape, 'Put the rabbits here; put the boats there.'). Regardless of which dimension is presented first, 3-year-olds typically continue to sort by that dimension despite being told the new rules on every trial (e.g. [16–20]; for review see [21]).

These children also show what Teuber [22] called a 'curious dissociation between knowing and doing.' That is, they respond correctly to questions about the post-switch rules even while perseverating on the pre-switch rules [23]. For example, children who should be sorting by shape (but persist in sorting by color) may be asked, 'Where do the rabbits go in the shape game? And where do the boats go?' Children usually answer these simple questions correctly (but see [24]). Moments later, however, when told to sort a test card ('Okay, good, now play the shape game. Where does this rabbit go?'), they persist in sorting by color.

On our account, 3-year-olds *consciously* represent the post-switch rules at one LOC (which allows them to provide verbal answers to the explicit knowledge questions), and they *consciously* represent the pre-switch rules at that same LOC (which allows them to keep the pre-switch rules in working memory to guide their sorting). However, they

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fail to reflect on their representations of the two rule pairs at a higher LOC, which is why they cannot make a deliberate decision to use the post-switch rules instead of the pre-switch rules (which have now become associated with the act of sorting). As a result, children's knowledge of the two rule pairs remains unintegrated (see Figure 1a), and the particular rule pair that underlies their responses is determined by relatively local considerations, such as the way in which the question is asked. By contrast, 4-year-olds, like adults, seem to recognize immediately that they know two ways of construing the stimuli. These children spontaneously reflect on their multiple perspectives on the situation, consider them at a higher LOC, and, as captured by the Cognitive Complexity and Control (CCC) theory [16,21], integrate them into a relatively complex rule structure (Figure 1b). The close connection between reflection and control is revealed in part by the robust finding that performance on this task is correlated with children's ability to reflect on their own and others' mental states [16,25,26].

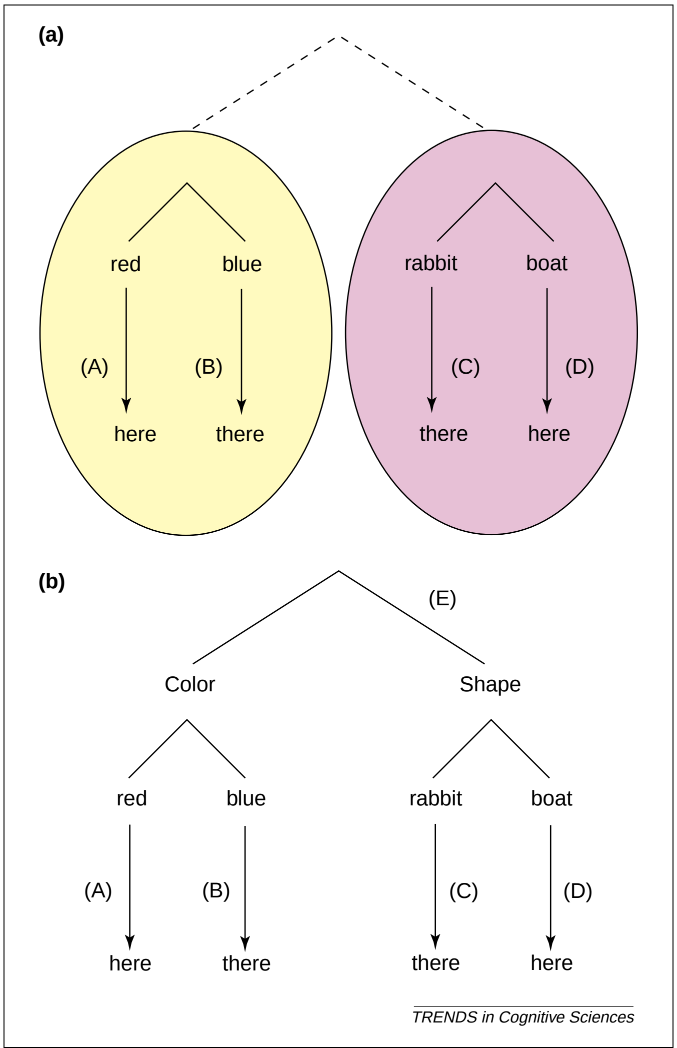

Figure 1. (**a**) Unintegrated rule systems. Two incompatible pairs of rules (A vs. B and C vs. D), corresponding to two different perspectives on the bivalent test cards in the Dimensional Change Card Sort, are each represented at the same LOC. Characteristic failures of executive function, such as perseveration and knowledge–action dissociations, are likely to occur until these rule systems are integrated into a single, more complex rule system. (**b**) An integrated rule system. A degree of reflection is required to consider the two rule pairs in contradistinction at a higher LOC. A higher LOC is required to formulate the higher order rule (E) for deliberately selecting between rule pairs.

The LOC model

As an information-processing model, the LOC model traces the flow of information through a functional system, illustrating the way in which primitive representations (intentional objects) are processed at various LOCs as they contribute to the complex hierarchical structure of consciousness and come to control thought and action (i.e. executive function). A central claim is that higher LOCs are brought about by a type of reflection or re-entrant processing that permits the contents of consciousness at one level to be considered in relation to other contents at that same level, resulting in a more complex conscious experience. As a developmental model, the LOC model shows how this functional system changes in the course of ontogeny. Age-related increases in the highest LOC that children can attain when attempting to solve a problem are invoked to explain systematic age-related changes in executive function [27].

Fundamental assumptions: minimal consciousness as the first LOC

As James [28] noted, 'Consciousness, however small, is an illegitimate birth in any philosophy that starts without it, and yet professes to explain all facts by continuous evolution.' Nonetheless, if one assumes that newborn babies are conscious in *some* sense at birth, then it is possible to account for subsequent changes. According to the LOC model, newborn babies experience **minimal consciousness** (**minC**) (cf. [29]), meant to be the simplest, but still conceptually coherent, kind of consciousness that accounts for the behavioral evidence. As argued elsewhere [30], minC must be characterized by intentionality in Brentano's [31] sense (i.e. if one is conscious in *any* sense then one must be conscious *of* something), and it motivates approach and avoidance behavior based on pleasure and pain. However, minC is unreflective, present-oriented, and makes no reference to a concept of self. So in minC, one is conscious of what one sees (the object of experience), but not seeing what one sees, let alone that one's 'self' is seeing what one sees. Subsequently, one cannot recall seeing what one saw.

In adults, minC underlies so-called implicit information processing, as when we drive a car without full awareness [29]. Even in the simplest case, where behavioral routines are elicited directly and automatically, they are elicited as a function of consciousness of *something* – say, immediate environmental stimuli (cf. [32]). Implicit processing does not occur in a zombie-like fashion; it is simply unreflective and unavailable for subsequent recollection.

Consider how minC figures in the production of behavior (see Figure 2). An actual object in the environment (**objA**) triggers a 'description' from semantic long-term memory. This particular description then becomes an intentional object (or **IobjA**) of minC, which triggers an associated action program in procedural long-term memory. A rattle, for example, might be experienced by a minC baby as 'small thing', and this description might trigger the stereotypical motor schema of sucking.

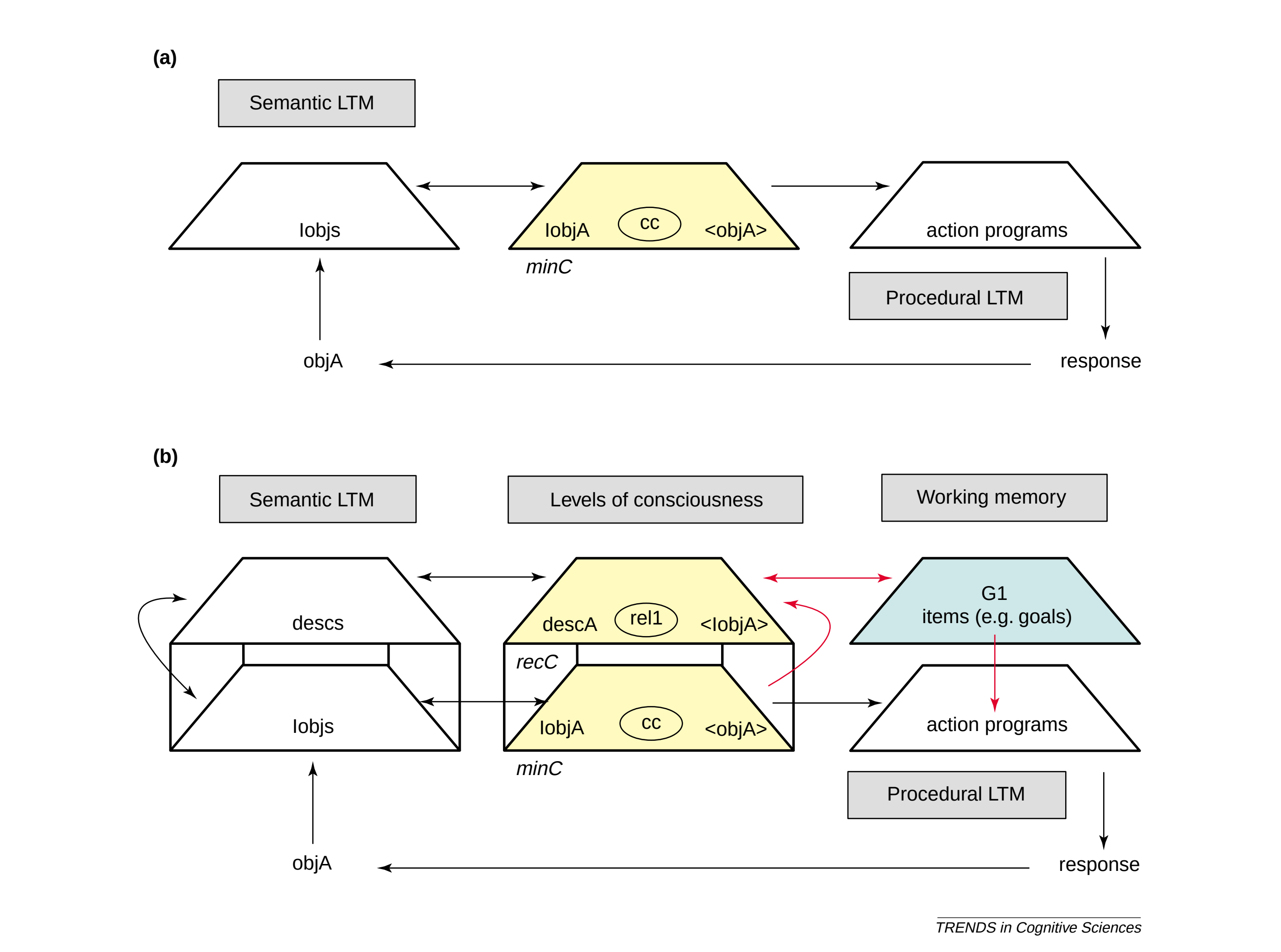

Figure 2. (**a**) A process model of minimal consciousness (minC). An object in the environment (objA) triggers an intentional representation of that object (IobjA) in semantic long term memory (LTM); this IobjA, which is causally connected (cc) to a bracketed objA, becomes the content of minC, by way of which it triggers an associated action program stored in procedural LTM, and a response is generated to objA. (**b**) Recursive consciousness (recC). The contents of minC are fed back into minC via a re-entrant feedback process (curved red arrow), producing recC. The contents of recC can be related (rel1) to a corresponding description (descA) or label, which can then be deposited into working memory (right) where it can serve as a goal (G1) to trigger an action program in a top-down fashion from procedural LTM.

On this account, attribution of minC manages to explain infant behavior until the end of the first year, when numerous new abilities appear within months (i.e. infants speak their first words, use objects in a functional way, point proto-declaratively, and search flexibly for hidden objects, among other milestones [33,34]). According to the model, these changes can all be explained by the emergence of the first new form of consciousness – **recursive consciousness** (**recC**).

Recursive consciousness

The term 'recursive' is used here in the sense of a computer program that refers to itself. In recC (Figure 2), the contents of minC at one moment are combined with the contents of minC at another via an identity relation (**rel1**), allowing the toddler to label the initial object of minC. The 1-year-old toddler who says 'dog', for example, combines a perceptual experience with a label from semantic long-term memory, effectively indicating, 'That [i.e. the object of minC] *is a* dog.' Similarly, on this account, pointing indicates, 'That *is* that.' Notice that there must be two things, the experience and the label, in order for one of them, the experience interpreted in terms of the label, to become an object of recC (see Box 1).

In the absence of a label, the contents of minC are fleeting and unrecoverable; they are immediately replaced by new intero- and exteroceptor stimulation. However, because a label can be decoupled from the experience labelled, the label provides an enduring trace of that experience that can be deposited into both long-term memory and working memory. The contents of working memory (e.g. representations of hidden objects) can then serve as goals to trigger action programs indirectly so the toddler is not restricted to responses triggered directly by minC of an immediately present stimulus. Now when objA triggers IobjA and becomes the content of minC, instead of triggering an associated action program directly, IobjA is fed back into minC (called recC after one degree of reflection) where it can be related to a label (**descA**) from semantic long-term memory. This descA can then be decoupled and deposited in working memory where it can serve as a goal (G1) that triggers an action program even in the absence of objA, and even if IobjA would otherwise trigger a different action program (Figure 2). For example,

Box 1. Language and LOCs

Language has long been held to play an important role in consciousness (e.g. [2,9,43,44]), and the LOC model follows in this tradition. Language is required for recC and it plays a similar role at higher LOCs, promoting increases in LOC (within age-related constraints on the highest LOC). In particular, labeling one's subjective experiences helps make those experiences an object of consideration at a higher LOC. Increases in LOC, in turn, allow for the flexible selection of perspectives from which to reason. Therefore, for people who are capable (in principle) of adopting a particular higher LOC, labeling perspectives at the next level down will increase the likelihood that they will adopt this higher LOC.

The effect of labeling on LOCs and flexibility can be illustrated by work by Jacques, who developed the Flexible Item Selection Task [45]. On each trial of the task, children are shown sets of three items designed so that one pair matches on a certain dimension (e.g. category of object), and a different pair matches on a different dimension (e.g. size). A set of three items might therefore be a small yellow teapot, a large yellow teapot, and a large yellow shoe). Children are first told to select one pair (i.e. Selection 1), and then asked to select a different pair (i.e. Selection 2). To respond correctly, children must represent the pivot item (i.e. the large yellow teapot) according to both dimensions. Four-year-olds generally perform well on Selection 1 but poorly on Selection 2, indicating inflexibility [45]. According to the LOC model, although 4-year-olds might not do so spontaneously, they should be *capable* in principle of comprehending two perspectives on a single item (as indicated, for example, by successful performance on the Dimensional Change Card Sort and a variety of measures of perspective-taking [27]). Therefore, the model predicts that asking children to label their perspective on Selection 1 (e.g. 'Why do those two pictures go together?') should increase their tendency to adopt a different perspective on Selection 2, which is exactly what Jacques found [46]. This was true whether children provided the label themselves or whether the experimenter generated it for them.

when presented with a telephone or an object hidden at a new location, the recC toddler might put the telephone to her ear (functional play) or search for a hidden object without perseverating (as in Piaget's famous A-not-B task). The toddler responds mediately to the label in working memory rather than immediately to an initial, minC gloss of the situation.

The ascent of consciousness through subsequent levels

With each increase in LOC, the same basic processes are recapitulated, but with different consequences at each level. In general, however, as one ascends LOCs, which correspond to minC with additional degrees of reflection, one moves away from what Dewey [35] called the 'exigencies of a situation'. Reflective processing is interposed between a stimulus and a response, and this permits the increasingly sophisticated selection and amplification of certain determinants of behavior when multiple determinants are present. It permits flexibility, as opposed to perseveration; conscious control, as opposed to stimulus control.

Self-consciousness

The next major developmental transition occurs at the end of the second year – a transition so dramatic that Piaget [36] called it the emergence of symbolic thought. More recent accounts have tended to focus on implications for children's awareness of Self, emphasizing children's first use of personal pronouns, their self-recognition in mirrors, and their display of self-conscious emotions such as shame [37–39]. Consistent with these accounts, according to the LOC model, this transition is brought about by another LOC, referred to as **self consciousness** (**selfC**).

This LOC allows children to consider their own capabilities vis-à-vis a situation (i.e. to consider available *means* as well as desired ends). Consideration of a means relative to the goal that occasions it is a major advance that allows children consciously to follow rules linking means to ends [40]. As shown in Figure 3, children with selfC can take as an object of consciousness a conditionally specified self-description (**SdescA**) of their behavioral potential. This SdescA can then be maintained in working memory as a single rule (R1, including a condition, C, and an action, A), considered against the background of a goal (G1). Keeping a rule in working memory allows it to constrain responses, regardless of fluctuating environmental stimulation, which might pull for inappropriate responses.

Reflective consciousness

In contrast to 2-year-olds, 3-year-olds exhibit behavior that suggests an even higher LOC, **reflective consciousness 1** (**refC1**). For example, they can systematically employ a pair of arbitrary rules (e.g. things that make noise versus are quiet) to sort pictures. According to the model, 3-year-olds can reflect on a SdescA of a rule (R1) and consider it in relation to another Sdesc (SdescB) of another rule (R2). This relation (rel2) is a second-order *contrastive* relation (as opposed to an identity relation). Both of these rules can then be deposited into working memory where they can be used contrastively to control the elicitation of action programs. As a result, unlike 2-year-olds, 3-year-olds do not perseverate on a single rule when provided with a pair of rules to use [40].

Of course, there are still limitations on 3-year-olds' executive function, as seen in their perseveration in the Dimensional Change Card Sort. This task requires the integration of two incompatible pairs of rules into a single structure, and this in turn requires children to adopt an even higher LOC, **reflective consciousness 2** (**refC2**), at which the entire contents of refC1 can be considered in relation to a Sdesc of comparable complexity. Evidence indicates that this LOC first emerges by around 4 years of age, together with a range of metacognitive skills studied under the rubric of 'theory of mind' [16,25,26] (Box 2).

Notice that these LOCs are proportional to the degrees of embedding illustrated in the tree structure in Figure 1 and captured by CCC theory. CCC theory shows how changes in executive function can be explained by changes in the maximum complexity of the rules children can formulate and use when solving problems. The LOC model shows how these changes in rule complexity are, in turn, explained by increases in LOC. Together, CCC theory and the LOC model provide a framework for understanding executive function in terms of underlying processes, and they illustrate why both executive function and reflective processing might depend on the same neural systems involving prefrontal cortex [41].

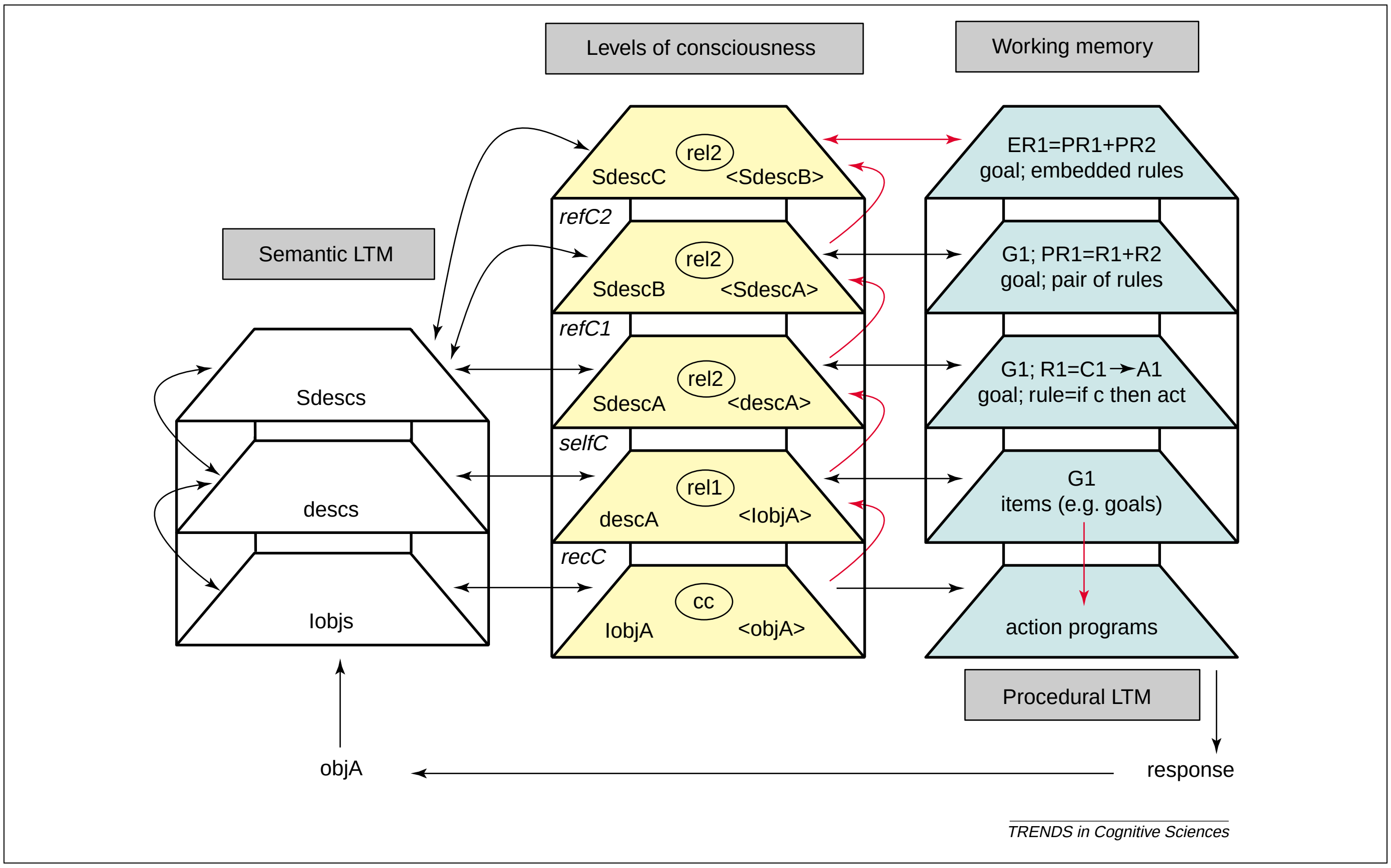

Figure 3. Subsequent (higher) LOCs, including self consciousness (selfC), reflective consciousness 1 (refC1), and reflective consciousness 2 (refC2). The contents of each LOC feed into the next level up, allowing increasingly elaborate representations and rules to be held in working memory.

Conclusion

According to the LOC model, there are four age-related increases in the highest LOC that children can muster. With each increase, reflection has important consequences for the quality of subjective experience, the potential for recall, the complexity of knowledge structures, and the possibility of executive function. First, reflection adds depth to subjective experience because more details can be integrated into the experience before the contents of consciousness are replaced by new environmental stimulation. Second, each added degree of reflection (higher LOC) causes information to be processed at a deeper, less superficial level, which increases the likelihood of retrieval [42]. Third, higher LOCs allow for the formulation and use of more complex knowledge structures. Characteristic errors of executive function, such as perseveration and knowledge–action dissociations, are likely to occur until incompatible pieces of knowledge are integrated into a single, more complex structure via their subordination to a higher-order rule, which is only possible at a higher LOC.

Although formulated to explain developmental data, this model suggests a framework for understanding the vagaries of human consciousness across the life span, and it makes predictions for future research. For example, for each LOC in the model, it should be possible to demonstrate conscious processing at that level but not higher levels. These dissociations should be age-related in childhood (and senescence) but should also occur in adults in circumstances that demand effortful processing (e.g. dual-task conditions, damage to prefrontal cortex). In all cases, however, these dissociations should have characteristic consequences for the control of thought and action.

Box 2. HOTs and LOCs

Insofar as the LOC model emphasizes the importance of a second-order process for the experience of awareness at level recC, it resembles a higher-order thought (HOT) theory of consciousness [29,47]. However, it differs from these theories in crucial ways. HOT theories claim that consciousness consists in a belief about one's psychological states (i.e. a psychological state is conscious when one believes that one is *in* that state). By contrast, reflection is simply a functional process that permits the contents of consciousness to become an *object* of consciousness at a higher level, and it entails no belief regarding psychological states. Indeed, according to the model, a relatively high LOC (refC2, effected by several degrees of reflection) is required for the formulation of beliefs about mental states – often referred to as meta-representation or theory of mind [48]. This suggestion is supported by the finding that children who switch flexibly on the Dimensional Change Card Sort also tend to pass tests indicating that they can reflect on their own (and others') mental states as such [16,25,26]. From our perspective, the suggestion that meta-representation is required for conscious experience [5] would seem to be a case of the psychologist's fallacy – the confusion of the psychologist's own standpoint with that of the psychological state in question. One need not have a concept of pain, for example, to feel it [49]. A developmental perspective is instructive in helping us to appreciate this point, which is supported empirically by the presence of age-related dissociations between different LOCs.

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References

1 Baldwin, J.M. (1892) Origin of volition in childhood. *Science* 20, 286–288
2 Vygotsky, L.S. (1986) In *Thought and Language* (Kozulin, A., ed.), MIT Press
3 Meltzoff, A. (2002) Imitation as a mechanism of social cognition: origins of empathy, theory of mind, and the representation of action. In *Handbook of Childhood Cognitive Development* (Goswami, U., ed.), pp. 6–25, Blackwell
4 Trevarthen, C. and Aitken, K.J. (2001) Infant intersubjectivity: research, theory, and clinical applications. *J. Child Psychol. Psychiatry* 42, 3–48
5 Carruthers, P.K. (1996) *Language, Thought, and Consciousness: An Essay in Philosophical Psychology*, Cambridge University Press
6 Kagan, J. (1998) *Three Seductive Ideas*, Harvard
7 Perner, J. and Dienes, Z. (2003) Developmental aspects of consciousness: how much theory of mind do you need to be consciously aware? *Conscious. Cogn.* 12, 63–82
8 Schooler, J.W. (2002) Re-presenting consciousness: dissociations between experience and meta-consciousness. *Trends Cogn. Sci.* 6, 339–344
9 Edelman, G.M. and Tononi, G. (2000) *A Universe of Consciousness*, Basic Books
10 Damasio, A.R. (1999) *The Feeling of What Happens*, Harcourt Press
11 Schacter, D.L. (1989) On the relation between memory and consciousness: dissociable interactions and conscious experience. In *Varieties of Memory and Consciousness: Essays in Honour of Endel Tulving* (Roediger, H.L. and Craik, F.I.M., eds), pp. 355–389, Erlbaum
12 Moscovitch, M.M. (1989) Confabulation and the frontal systems: strategic versus associative retrieval in neuropsychological theories of memory. In *Varieties of Memory and Consciousness: Essays in Honour of Endel Tulving* (Roediger, H.L. and Craik, F.I.M., eds), pp. 133–160, Erlbaum
13 Zelazo, P.D. (1999) Language, levels of consciousness, and the development of intentional action. In *Developing Theories of Intention: Social Understanding and Self-control* (Zelazo, P.D. *et al.*, eds), pp. 95–117, Erlbaum
14 Zelazo, P.D. and Sommerville, J. (2001) Levels of consciousness of the self in time. In *Self in Time: Developmental Issues* (Moore, C. and Lemmon, K., eds), pp. 229–252, Erlbaum
15 Frye, D. and Zelazo, P.D. (2003) The development of young children's action control and awareness. In *Agency and Self-awareness* (Roessler, J. and Eilan, N., eds), pp. 244–262, Oxford
16 Frye, D. *et al.* (1995) Theory of mind and rule-based reasoning. *Cogn. Dev.* 10, 483–527
17 Jacques, S. *et al.* (1999) Rule selection and rule execution in preschoolers: an error-detection approach. *Dev. Psychol.* 35, 770–780
18 Perner, J. and Lang, B. (2002) What causes 3-year-olds' difficulty on the dimensional change card sorting task? *Infant and Child Development* 11, 93–105
19 Brooks, P.J. *et al.* (2003) The role of selective attention in preschoolers' rule use in a novel dimensional card sort. *Cogn. Dev.* 18, 195–215
20 Kirkham, N. Z *et al*. Helping children apply their knowledge to their behavior on a dimensional-switching task. *Dev. Sci.* (in press)
21 Zelazo, P.D. (2003) The development of executive function in early childhood. *Monogr. Soc. Res. Child Dev.* 68 Serial No. 274
22 Teuber, H.L. (1964) The riddle of frontal lobe function in man. In *The Frontal Granular Cortex and Behaviour* (Warren, J.M. and Akert, K., eds), pp. 410–440, McGraw-Hill
23 Zelazo, P.D. *et al.* (1996) An age-related dissociation between knowing rules and using them. *Cogn. Dev.* 11, 37–63
24 Munakata, Y. and Yerys, B.E. (2001) All together now: when dissociations between knowledge and action disappear. *Psychol. Sci.* 12, 335–337
25 Perner, J. and Lang, B. (1999) Development of theory of mind and cognitive control. *Trends Cogn. Sci.* 3, 337–344
26 Carlson, S.M. and Moses, L.J. (2001) Individual differences in inhibitory control and theory of mind. *Child Dev.* 72, 1032–1053
27 Zelazo, P.D. and Müller, U. (2002) Executive function in typical and atypical development. In *Handbook of Childhood Cognitive Development* (Goswami, U., ed.), pp. 445–469, Blackwell
28 James, W. (1950) *The Principles of Psychology* (Vol. 1), Dover
29 Armstrong, D.M. (1980) *The Nature of Mind and Other Essays*, Cornell University Press
30 Zelazo, P.D. (1996) Towards a characterization of minimal consciousness. *N. Ideas Psychol.* 14, 63–80
31 Brentano, F. (1973) *Psychology from an Empirical Standpoint*, Routledge & Kegan Paul
32 Perruchet, P. and Vinter, A. (2002) The self-organizing consciousness. *Behav. Brain Sci.* 25, 297–388
33 Zelazo, P.R. and Zelazo, P.D. (1998) The emergence of consciousness. *Adv. Neurol.* 77, 149–165
34 Tomasello, M. (2000) *The Cultural Origins of Human Cognition*, Harvard University Press
35 Dewey, J. (1960) *On Experience, Nature, and Freedom*, Liberal Arts Press
36 Piaget, J. (1967) In *Six Psychological Studies* (Elkind, D., ed.), Vintage
37 Howe, M. and Courage, M. (1997) The emergence and early development of autobiographical memory. *Psychol. Rev.* 104, 499–523
38 Lewis, M. (2003) The development of self-consciousness. In *Agency and Self-awareness* (Roessler, J. and Eilan, N., eds), pp. 275–295, Oxford University Press
39 Wheeler, M. (2000) Varieties of consciousness and memory in the developing child. In *Memory, Consciousness, and the Brain: The Tallinn Conference* (Tulving, E., ed.), pp. 188–199, Psychology Press
40 Zelazo, P.D. and Jacques, S. (1996) Children's rule use: representation, reflection and cognitive control. *Annals of Child Development* 12, 119–176
41 Stuss, D.T. and Alexander, M.P. (2000) Executive functions and the frontal lobes: a conceptual view. *Psychol. Res.* 63, 289–298
42 Craik, F.I.M. (2002) Levels of processing: past, present and future? *Memory* 10, 305–318
43 Dennett, D.C. (1991) *Consciousness Explained*, Little Brown & Co
44 Rolls, E.T. (1998) *The Brain and Emotion*, Oxford
45 Jacques, S. and Zelazo, P.D. (2001) The flexible item selection task (FIST): a measure of executive function in preschoolers. *Dev. Neuropsychol.* 20, 573–591
46 Jacques, S., Zelazo, P.D. Language and the development of cognitive flexibility: implications for theory of mind. In *Why Language Matters for Theory of Mind* (Astington, J.W. and Baird, J.A. eds), Oxford University Press (in press)
47 Rosenthal, D. (2000) Consciousness, content, and metacognitive judgements. *Conscious. Cogn.* 9, 203–214
48 Wellman, H.M. *et al.* (2001) Meta-analysis of theory-of-mind development: the truth about false belief. *Child Dev.* 72, 655–684
49 Anand, K.J. and Hickey, P.R. (1987) Pain and its effects in the human neonate and fetus. *N. Engl. J. Med.* 317, 1321–1329