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Developmental aspects of consciousness: How much theory of mind do you need to be consciously aware?

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Abstract

When do children become consciously aware of events in the world? Five possible strategies are considered for their usefulness in determining the age in question. Three of these strategies ask when children show signs of engaging in activities for which conscious awareness seems necessary in adults (verbal communication, executive control, explicit memory), and two of the strategies consider when children have the ability to have the minimal form of higher-order thought necessary for access consciousness and phenomenal consciousness, respectively. The tentative answer to the guiding question is that children become consciously aware between 12 and 15 months (±3 months). © 2002 Elsevier Science (USA). All rights reserved.

Keywords: Theory of mind; Development; Higher-order thoughts; Explicit memory; Executive tasks; Access consciousness; Phenomenal consciousness

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1. Introduction

We organize this paper around a particular question: When do children become consciously aware of events in the world? To answer the question we first specify the meaning of conscious awareness. We outline five strategies for zeroing in on the age in question. Three of these strategies ask when children show signs of engaging in activities for which conscious awareness seems necessary in adults (sufficient conditions for conscious awareness). The other two strategies assume that some minimal form of higher-order thought about one's own mental state is required for conscious awareness and focuses on the question when children acquire the prerequisite understanding of their own mental states (necessary conditions for conscious awareness). Our attempt at obtaining a coherent answer to our question raises interesting issues about each strategy; in particular, the question about what minimal understanding of mind suffices for a higher-order thought. The tentative answer to the leading question is that children become consciously aware between 12 and 15 months (±3 months).

2. Conscious awareness

As we are trying to pin down the meaning of conscious awareness by our experience of it without an initial theoretical position, it is best introduced by example. The paradigm distinction is between the (conscious) awareness that a blindsight patient has about stimuli presented in his healthy, sighted field of vision and the (unconscious) awareness he has about stimuli in his blind field. Although the patient claims that he is blind in this part of his visual field he still processes information about stimuli in it. We know this because the patient unwittingly moves his eyes to the location of the stimuli (Pöppel, Held, & Frost, 1973) and can—what seems to him as a pure guess—point fairly accurately at the stimulus location and describe other features of the stimulus (Weiskrantz, Sanders, & Marshall, 1974; Weiskrantz, 1998). A similar distinction can be observed for people with unimpaired vision under special testing conditions with visual illusions. A dot inside a frame is briefly presented followed by a new brief exposure in which the dot remains stationary but the frame is displaced to the right. People report that the dot has moved to the left (induced Roelof's effect; Bridgeman, Kirch, & Sperling, 1981). However, when asked to point to the spot where the dot was last seen (a declarative action) only some people are subject to the illusion. The other ones point accurately. When asked to touch the spot of the dot (a simple action) all people are accurate (Bridgeman, Gemmer, Forsman, & Huemer, 2000).

The blindsight patient has some awareness about the stimulus in his or her blind field, and the participants in Bridgeman's Roelofs experiment have information of the dot's actual location or else their fingers could not be pointing to/touching the correct spot. This awareness, however, is not conscious because the blindsighted person does not consciously experience any stimulus and the participant in the Roelofs experiment consciously experiences an incompatible event, i.e., a movement of the dot.

The same or similar difference in awareness is perhaps familiar to all of us when we engage in a highly routine activity like driving our car home from work. One can do this quite absentmindedly (no conscious awareness of one's actions) while engaging our full attention (conscious awareness) in a conversation with our passenger. [1] One common denominator of all these cases of nonconscious awareness is that feats (pointing to the stimulus accurately, steering the car through dense traffic) based on nonconscious information come—when they are pointed out to us by others—as a complete *surprise*, in a way that one would not be surprised if the information had been available in fully conscious awareness (Rosenthal, in press).

How do we know that this difference in informational status is a difference between conscious and nonconscious awareness? Well, that is how we experience it, and how we communicate it among ourselves: "I was not (consciously) aware of it, but I must have known (or done) it unconsciously." In other words, without the blindsight patient's adamant denial of seeing anything in his or her blind field and without the clear claim by the participants in Bridgeman's experiment that they saw the dot move (and thereby deny that they had any knowledge of it remaining stationary) we could not ascertain that the observed accurate performance was based on nonconscious information. It could be that it was based on conscious information considered unreliable hence not reported and the behavioral performance was based on it "by mistake." This reliance on adults' verbal communication of conscious awareness raises a problem for investigations with young children or animals, who cannot talk and even if they could would find it difficult to convey their phenomenal experiences. So we need to get an indirect answer to the question as to whether children are consciously aware.

To get indirect access to children's conscious awareness we pursue five strategies. We look for evidence for when children can engage in activities that are thought to require conscious awareness and we look for evidence for abilities that are deemed necessary for conscious awareness by the higher-order thought (HOT) theory of consciousness.

3. Five strategies for children

3.1. Strategy 1: Verbal communication

There is the entrenched intuition that verbal communication requires conscious awareness. Dennett (1978) even made verbal reportability the hallmark of consciousness. This intuition is supported by our everyday experience that, e.g., although I can drive a car through dense traffic absentmindedly while talking to my passenger (Armstrong, 1968; Carruthers, 2000, p. 149), why cannot I talk absentmindedly to my passenger while concentrating on the driving? Perhaps sometimes this can happen,

[1] Armstrong (1968) has described a particularly strong version of this phenomenon in the case of long-distance lorry drivers. One objection to it is the possibility of conscious awareness but instant forgetting (Rosenthal, in press).

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but then the conversation tends to consist of rehearsed phrases, like when singing bedtime songs to the children. One keeps singing while thinking about more important matters. When interrupted one has no idea where one was in the song and has to start again from the beginning. This mindless singing is possible only because the song is known by heart and one word follows from the one previously just sung and one need not monitor the meaning of what is being said. In contrast, when trying to communicate about some object in the room and having to choose the right word to refer to it we usually do not do this without conscious awareness. These observations suggest that referential use of language of this kind requires conscious awareness. So, when do children begin to indulge in this kind of referential use?

Most researchers place the emergence of infants' first words at 12–13 months of age (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Carpenter, Nagell, & Tomasello, 1998). Although single word use has been recorded as early as 10 months, real vocabulary growth does not start before 13 months (Fenson et al., 1994, p. 74). Moreover, the first words are part of social routines (e.g., "bye-bye"), whereas referential use of words referring to objects or activities (e.g., "ball" and "up") emerge a month or two later. Since referential use of language appears to require conscious awareness in adults these findings suggest that infants between the ages of 13 to 15 months are consciously aware. We do, however, need to point out the dangers and weaknesses of this kind of conclusion. Although our adult verbal communication typically involves conscious awareness, our communication—unlike children's earliest productions—rarely consists of single word comments. Hence it is less than certain whether our intuitions about adult conversation transfer to children's first utterances. Perhaps they are more like the vervet monkeys' (Cheney & Seyfrath, 1990) or domestic chicken's referentially specific alarm calls (Evans, Evans, & Marler, 1993) that may be automatically elicited by the proprietary stimulus, where our intuition would be less likely to see the necessity for conscious awareness. Perhaps genuinely productive (nonroutinized) combinations of two words are a better indicator of conscious awareness. First signs of such combinations can be seen at 16 months but show in a larger proportion of children not before 19–24 months (Fenson et al., 1994, pp. 50–52).

The case for conscious awareness at the earlier age of 15 months may be better served by the onset of (e.g., protodeclarative pointing; Bates, Camaioni, & Volterra, 1975). Carpenter et al. (1998) report that several different communicative gestures emerge between 9 and 15 months, but a particular convincing kind of gesture is one where the infant directs an adult's attention to a particular (distal) object and checks whether the adult is attending to it. This emerges between 13 and 15 months (Tomasello, 1999, p. 65). It seems particularly convincing that this requires conscious awareness because we never point out a particular object absentmindedly and check whether the other person attends to it.

3.2. Strategy 2: Executive control and focal attention

Another strong intuition is that when we feel to be in charge so that we have full (voluntary) control over what we are doing then we are necessarily consciously aware of what we are doing. This intuition is so strong that Jacoby (1991) used voluntary control over one's memory retrieval as a criterion for deciding which items in our memory are explicitly (consciously) remembered and which items come to mind as part of implicit memory. Since one has the feeling that oneself is fully in charge it has been called "executive control" and the functions that it fulfils, "executive functions" (e.g., Duncan, 1986; Welsh & Pennington, 1988) and the relevant part of our mind/brain the "central executive" in memory research (Baddeley & Hitch, 1974) or the "Supervisory Attentional System" (SAS) in schema theory (Norman & Shallice, 1986) and neuropsychology (Shallice, 1988). The origins of this approach reside in the finding that patients with frontal lobe insult (Luria, 1966; Bianchi, 1922) experience a loss of control over their actions (Milner, 1964) and have difficulty with certain tasks (Norman & Shallice, 1986): (1) planning/decision making, (2) trouble shooting, (3) novel/ill-learned action sequences, (4) dangerous or technically difficult actions, and (5) overcoming strong habitual response tendencies or temptation. Perner (1998) argued that trouble shooting and the overcoming of habitual response tendencies requires an understanding of mind that develops comparatively late. For present purposes it is, therefore, more promising to focus on planning and novel action sequences as early indicators of executive control. What is meant by novel action sequences is not the acquisition of action sequences through gradual feedback learning but instant implementation of a novel action schema. There are two basic ways this can happen, either through verbal instruction by others or through planning in one's own mind. When can children follow verbal instructions and when can they plan a new action sequence?

3.2.1. Verbal instruction

Zelazo and Reznick (1991) investigated children's ability to follow simple conditional rules. The earliest evidence points to $2\frac{1}{2}$ years. However, the even simpler ability to follow instructions, like "Give me the doll/keys/etc.!" where the child has to choose the appropriate item from an array of objects and hand it to the experimenter, also requires the implementation of a novel action sequence without feedback. Evidence from psycholinguistic studies points to the age of $1\frac{1}{2}$ years (Shatz, 1978; Babelot & Marcos, 1999) or earlier—but younger infants have not been investigated in these studies.

3.2.2. Planning and reasoning

Invisible displacement is a good indicator of logical/spatial reasoning ability. A bead is placed inside a box and the box goes underneath a cover. The box is taken from underneath the cover and opened. The bead is still inside. Then the box goes under another cover and taken from under it. Now it is empty. Where could the bead be? Children can reason correctly that it must be under the second cover by the age of about 15–18 months (Haake & Somerville, 1985; Piaget, 1937). Another indicator is the ability to spontaneously combine two familiar actions into a novel sequence (recombination of secondary circular reactions: Piaget, 1936/1953). The age estimates at which this can be achieved are still under dispute; somewhere around 12 months (Willatts, 1989) but perhaps as early as 8 months (Willatts, 1999).

One problem with relying on reasoning and planning is that it is not certain that the critical processes that lead to novel combinations are indeed based on conscious, volitional processes. The incubation phase in Poincaré's description of creative problem solving takes place subconsciously. Ach (1905, p. 187) pointed out that many elements in the determining tendency leading to a wilfull determination consist of associative (unconscious) elements. [2] Hence we cannot be sure that novel combinations must be based on conscious processes. The ability to implement novel actions on the basis of verbal instructions is probably a more reliable indicator. Unfortunately it is somewhat redundant because it necessarily involves referential use of language.

3.2.3. Focal attention

To keep attention on a stimulus in view of some distractor requires executive control. Gardner, Feldman, Karmel, and Freedland (2000) let infants play with interesting toys and assessed whether infants paid focal attention to the toy (looking at the toy with serious facial expression, slowed body movement, and shoulders turned in toward the object). At 10 months infants were almost as likely to turn their attention to a distractor when paying focal attention to the toy as when they were not. In contrast, at 16 months they were much less likely to do so when paying focal attention than when not paying focal attention. This finding suggests that within that age bracket children develop stronger executive control over their attention processes.

3.2.4. Summary

Although the ability to follow conditional instructions comes somewhat later, the ability to execute a novel action in response to simple instructions can be demonstrated at 18 months and probably earlier. Also demonstrations of logical/spatial reasoning and planning of novel action sequences are in place by 12 or 15 months. Finally, distractibility from focal attention seems to decrease in this age bracket.

3.3. Strategy 3: Explicit memory

In a classical definition of implicit and explicit memory conscious awareness of the remembered past event is a defining characteristic of explicit memory: "Implicit memory is revealed when previous experiences facilitate performance on a task that does not require conscious or intentional recollection of those experiences; explicit memory is revealed when performance on a task requires conscious recollection of previous experience" (Schacter, 1987). Since the time that this definition was given many experimental variables have been identified that affect explicit memory in a different way than implicit memory that lacks conscious awareness. There is now also increasing evidence reviewed by Wheeler (2000) that some early memories respond to the different manipulations in a similar way to explicit memory. Consequently the onset of these memorial abilities gives us another clue as to when infants become consciously aware.

[2] Compliments to Tony Marcel for pointing this out.

Of particular relevance are studies of delayed imitation that is commonly found around 14 months (Meltzoff, 1985) with one study showing some evidence of it as early as 9 months (Meltzoff, 1988). Infants imitate a sequence of actions performed by a model. For instance, the experimenter bends forward to touch a box with his forehead upon which the orange top of the box lights up. A day later the infant is given the box to play with and the experimenter observes whether his action sequence of the previous day is carried out by the infant.

It is not immediately apparent why the infants' carrying out the action sequence reflects explicit memory of the experimenter's performing the sequence the day before. The experience of the experimenter's action may simply have given the infant the idea of what one can do with this box, which the infant would not have got without the experimenter's demonstration. However, there is evidence from amnesic patients that suggests involvement of explicit memory in delayed imitation task (McDonough, Mandler, McKee, & Squire, 1995). Patients with amnesia (moderate to severe long-term memory impairment without short-term impairment and intact implicit memory), did not engage in target action sequences demonstrated a day ago more frequently than inexperienced controls (who hadn't seen the actions performed), whereas experienced controls and patients with frontal lobe injury did so two or three times as frequently. The interpretation is that without explicit long-term memory of the demonstrated acts people will not perform the demonstrated action sequences more often than with some baseline frequency.

With support from this finding the infant data on delayed imitation are suggestive. Around 12–15 months (with first signs as early as 9 months) children have explicit memory, that is, they are consciously aware of past events. One should, though, point out the following—not implausible—possibility that infants have no explicit memory. In this respect they do not differ from the amnesic patients. The difference is that infants freely play with an object and do with it whatever comes to their mind, unencumbered by any social embarrassment. Adults are reluctant to engage in playful actions with toys. They need the social facilitation of the experimenter's model. Adults with unimpaired memory have the required facilitation in their memory of the experimenter's modeling act; the amnesic patients lack this memory and, therefore, are reluctant to execute the modeled activity.

Rovee-Collier (1997) boldly argued that infants as young as 2 to 3 months have explicit memory. She investigated this in her so-called foot kicking studies. Infants learn to kick with their feet to make an interesting mobile move. They spontaneously kick again after a week or more when seeing the mobile again because—so the claim—they have *explicit recognition* of the mobile. In contrast after too long a delay, infants need a brief reexposure to the mobile for *reactivation* of their memory before they start kicking. The reactivated memory is supposed to reflect implicit memory. Rovee-Collier backed this claim by investigating the effects of 13 experimental manipulations that are known to affect explicit memory more strongly than implicit memory in adults. She reports that spontaneous foot kicking (allegedly based on recognition) was indeed influenced by most of these 13 factors more than foot kicking after reactivation (due to implicit memory). Unfortunately, all 13 factors were ones that affect spontaneous kicking more strongly than reactivated kicking. This leaves the much simpler explanation that reactivated memory is more

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robust than memory underlying spontaneous kicking. If another set of factors could be found that is known to affect implicit memory more strongly than explicit memory and that would affect reactivated kicking more strongly than spontaneous kicking, then we would have much more convincing demonstrations of very early explicit memory (and conscious awareness). As it stands we reserve judgement about the possibility of such early onset.

In sum, on the strength of the inability (rather than unwillingness) of patients with amnesia to engage in delayed imitation infants' ability to do so suggests that explicit memory develops between the ages of 12 to 15 months (perhaps 9 months). And under the assumption that explicit memory requires conscious awareness in infants as it does in adults then the data suggest that infants at this age are capable of conscious awareness.

3.4. Strategy 4: Access consciousness and theory of mind

3.4.1. A guarded commitment to higher-order thought theories

HOT theories (Rosenthal, 1986) developed from a Lockean (Locke, 1959, p. 138) suggestion, more recently expanded by Armstrong (1968) that conscious awareness consists of awareness of inner states. This original suggestion proposed this awareness as a type of inner perception; HOT theories deny the perceptual analogy (see Carruthers, 1998, for genealogy). Our initial considerations of how conscious awareness registers in our phenomenal awareness (e.g., the contrast between normal seeing and the visual information uptake by a blindsight patient or by our action system when absentminded or under illusion) suggests that HOT theories of consciousness capture something essential about conscious awareness. Here is an attempt to argue that some sort of higher-order thought is necessary to capture this distinction.

From our own experience, the following strong link seems to hold empirically: If we are *consciously aware* of *this pencil lying on the table*, then we are also *consciously aware* that we are *seeing the pencil lying there*. It never happens that we can genuinely claim being consciously aware of it and at the same time deny being consciously aware of whether we *see* it, just *dream* of it, *know* by touch, *want* the pencil to be there, and so on. This means that whenever we consciously *see* (the pencil lying there), then we *are consciously aware* [that we *see* (the pencil lying there)]. Or, at least on demand, we need to be *able to form* such higher-order awareness about our seeing the pencil (see Carruthers, 1996 for a "potentialist version" of the theory). When we close our eyes we are still consciously aware of the pencil lying on the table, but we are also aware that we do not see it in that moment. It is difficult (nay, impossible) to think of an incident of being consciously aware of some event or state of affairs without awareness of the first order mental state by which we behold that event or state of affairs.

From these considerations we might try to track the onset of conscious awareness by looking at the age when children develop the prerequisite concepts for representing first order mental states. This strategy, however, leads to quite different answers due to a difference in views about when children possess a particular concept. We now illustrate this issue with the concept of knowledge.

3.4.2. Children's concept of knowledge

The answer to the question about when children acquire a concept of knowledge (required for attributing to them conscious awareness) depends on one's theoretical approach. One very influential approach is the so called "theory theory" (Sellars, 1956; Premack & Woodruff, 1978; Churchland, 1984; Gopnik, 1993) according to which mental concepts are constituted as the theoretical terms in a theory of behavior. In the case of knowledge this means that the child has to understand the causal role that knowledge serves in connecting access to information with the ability to act as intended. There is very consistent evidence that the connection with informational access is not understood until the age of about 3–4 years or even later.

Wimmer, Hogrefe, and Perner (1988) either showed or told children what they put inside a box. Three-year-olds had no problem answering the question about the contents of the box. They did, however, fail to answer questions about the origin of their knowledge ("How do you know that there is X in the box?"). Only children of about 4 years understood the question and answered with "because you showed me" or "because you told me." The younger children simply seemed to have no conception of how knowledge depended on access to relevant information. Young children's difficulty in this respect is confirmed in their inability to distinguish between whether they had learned some word (e.g., "mauve") just a few minutes ago and whether they had known it before (e.g., "red"; Taylor, Esbensen, & Bennett, 1994). Even those up to 6 years of age have difficulties with understanding that particular sense organs give information about certain properties and not others, e.g., looking with the eyes about color but not weight and lifting by hand about weight but not color (O'Neill, Astington, & Flavell, 1992). A younger child may suggest that the color of an object can be determined without looking by just lifting the object. The child is then totally perplexed when this method does not yield a satisfactory answer. The theoretical consequence of this finding is that children before that age cannot be consciously aware because they do not have a concept of knowledge to form a second order thought that they know something.

It is, of course, possible to weaken the theoretical requirements for the possession of a concept of knowledge that just suffices for forming the content of higher-order thoughts. Perhaps, an understanding of the informational origins of knowledge is not necessary and an understanding of the ability to provide relevant answers is sufficient. Gordon (1995) pointed out that within one's own perspective there is a one-to-one correspondence between what is a fact and what one knows. Hence one can ascend within one's perspective from "X is a fact" to "I know that X" (ascent routine). Separating knowledge from fact only pays when concerned about other people as others may, e.g., not know about things that are facts for oneself. Since higher-order thought theory of consciousness is not concerned about thoughts about others but only about one's own thoughts, this aspect of knowledge seems essential. Gordon's proposal also seems intuitively correct when one considers being asked whether one knows something. To answer one usually does not need to treat oneself (as theory theory would have it) like another person and check whether one had appropriate informational access. One can simply judge by whether one has factual information on the matter.

We can now ask when children acquire this minimal understanding about their own knowledge, i.e., when they can attribute knowledge and ignorance to them-

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selves. The experimental evidence for this is sparse. It is clear from the investigations by Wimmer et al. (1988) on children's understanding of the sources of knowledge from the age of 3 years and onward, that even the youngest children in their study had no problem answering whether they knew (because they had seen something put inside or were told what it was) or did not know what was inside a box (because they had not been given any information).

From recordings of children's spontaneous language use the earliest mention was reported by Bretherton, McNew, and Beeghley-Smith (1981, p. 369) for a 15-month-old infant who said "I don't know" while gesturing with hands turned up when asked about the location of an object. Other reports point to a somewhat later age. First uses were observed at 24 months (Furrow, Moore, Davidge, & Chiasson, 1992) or 28 months (Bartsch & Wellman, 1995, Table 3.10). Fabricius, Bailey, and Prost (2001) engaged children with their mothers in a 10- to 25-min-long game in the laboratory and counted the children's use of mental terminology. In these short sessions none of the 50 children referred to own knowledge at 14 months. Only three did at 20 months and 59% did at 32 months. Analyzing the 90-s samples three times an hour during one day of the Wells (1981) corpus of the CHILDES database (MacWhinney, 2000), Fabricius et al. (2001) found no mention to own belief at 18 and 21 months but from 13% of the 32 children at 24 months.

3.4.3. Other mental concepts

If we look at children's verbal self-attributions of other mental states the picture does not change much. Fabricius et al. (2001, Study 2) provide a nice comparison in line with other data. Attribution of perceptual states (seeing, hearing,...) follows closely the attribution of knowledge and belief to themselves. Only attribution of desire ("I wanna...") occurs noticeably earlier. A quarter of the children as young as 18 months referred at least once to their own desire.

At this point we can conclude that from around 18 months onward children refer to their own mental states, a sign that they have concepts for first order mental states. Their ability to talk about these states also shows that they are able to form a second order state about the first order state and, thus, have mastered a prerequisite for conscious awareness according to the HOT theory of consciousness—provided we admit the ability to verbally refer to a mental state as sufficient for possessing the concept. This approach depends essentially on children's verbal ability and raises the question if we can find nonverbal signs of higher-order mental states at an earlier age.

3.4.4. A nonverbal indicator of surprise?

In search of an earlier, nonverbal indicator one might think of infants' looking time in the habituation–dishabituation paradigm, which has brought so many insights into infants' early perceptual (e.g., Eimas, Siqueland, Jusczyk, & Vigorito, 1971) and cognitive abilities (e.g., Spelke, 1988; Baillargeon, Spelke, & Wasserman, 1985). This technique is based on the finding that infants look longer at novel stimuli than to familiar stimuli to which they have been repeatedly exposed. This difference occurs because—it is often loosely claimed—infants are more "surprised" by the new stimuli. It is tempting to take surprise as an indicator of conscious awareness because a blindsight patient would be equally surprised by a stimulus whose presence he or she discovers for the first time in his or her sighted field as by a stimulus appearing in his sighted field about which he or she has already had information from his or her blind field. Unfortunately, we do not know whether infants' looking time is governed by surprise in that sense or whether it is a function of ease of processing. That is, stimuli that have been (unconsciously) processed before take less time for renewed processing without any conscious awareness being involved. In fact, faster reaction to unconsciously primed stimuli (e.g., a subliminal prime indicates where a target will occur and speeds up the reaction to the target; Neumann & Klotz, 1994) is one of the main means for investigating unconsciously perceived stimuli. In sum, from the habituation–dishabituation paradigm that has been used so productively with young infants it is difficult to draw strong conclusions about consciousness of processing.

3.5. Strategy 5: Phenomenal consciousness and theory of mind

3.5.1. From access to phenomenal consciousness

Block (e.g., 1995) distinguished several concepts of consciousness of which the distinction between access and phenomenal consciousness has become widely accepted (e.g., Carruthers, 1998). *Access consciousness* captures the intuition that the contents of which we are consciously aware are accessible to us, i.e., to our other mental processes. Access to higher-order thoughts (reflective access) is a kind of access consciousness. In contrast, the notion of *phenomenal consciousness* is to capture the subjective feel of our experiences as highlighted in the provocative question of Nagel's (1974) paper, "What is it like to be a bat?" Or one could ask in our case, "What is it like to taste a Chateau so-and-so?" or more mundanely, "What is it like to perceive a certain hue of red?" This aspect of consciousness has been dubbed the "hard problem" (Chalmers, 1996) because this subjective aspect is difficult or even impossible (McGinn, 1991) to integrate within our scientific world view.

Some claim that (reflective) access consciousness and phenomenal consciousness are independent (Block, 1995; Tye, 1995). This is counterintuitive. Carruthers, 2000 and Rosenthal (2000) provide sustained arguments that higher-order thoughts are both necessary and sufficient for phenomenal consciousness. Carruthers also addresses the consequences for child development. His argument is based on the assumption that the "subjectivity" of consciousness can in principle be explained by the fact that mental representations inevitably present the world under a certain *mode of presentation* (perspective, Frege's sense). However, this only explains what the *world is like* for the organism (*worldly subjectivity* due to the fact that the world takes on a subjective aspect by being presented). It does not account for—what we really need—*experiential subjectivity* (mental state subjectivity), what the organism's *experience of the world is like* for the organism (that the organism's experience takes on a subjective aspect). This would follow from a higher-order representation of the experience of the world because the higher-order representation presents the experience under a certain mode of presentation and thereby conferring a subjective aspect to the experience.

The important developmental implication of this analysis is that one needs the ability to form a higher-order representation of a first-order mental state. Before we can ask when children can do this we need to know what feature of being a first-order mental state needs representing so that the higher-order representation yields the experiential subjectivity. Carruthers (2000, p. 196) gives a clear answer to this question: it needs a notion of "seeming" (or appearance or perspective), and Carruthers makes clear that he means a fairly explicit understanding as it develops around the age of 4 years (p. 202, footnote 11). There is converging evidence from different studies that this development takes place at this age. Most directly relevant are the appearance–reality studies by Flavell, Flavell, and Green (1983). For instance, when shown a piece of sponge that looks deceptively like a rock children say that it is a rock. As soon as they take that "rock" in their hands they realize that it is just sponge. When now asked what this *really is* most children correctly answer with, "piece of sponge," but when asked what it *looks like*, when one is just looking at it, the children younger than 4 years answer again with, "piece of sponge," whereas the older children answer correctly with, "rock." It seems that the younger children cannot understand that visual appearance can specify something as being a rock when they know that it is a piece of sponge. [3]

Earlier work by Flavell, Everett, Croft, and Flavell (1981) on Level 2 visual perspective taking also showed that young children cannot understand that someone else can interpret a drawing differently than the way they see it themselves. For instance, the child sits facing the experimenter over a small table with a piece of paper depicting a turtle from its side. When the picture is oriented so that the turtle's feet are pointing toward the child, the 3-year-old interprets it as "the turtle is standing on its feet." When the picture is rotated by 180° the child interprets it as "it is lying on its back." However, only at around 4 years can children understand that another person sitting opposite would interpret the drawing differently (e.g., "it's standing on its feet") from the child herself (e.g., "it's lying on its back").

Also understanding of false belief demonstrates an understanding of perspective which is not acquired before the age of 4 years (Wimmer & Perner, 1983; Perner, Leekam, & Wimmer, 1987; Wellman, Cross, & Watson, 2001). Children have to understand that a story character Maxi, who did not witness an unexpected transfer of his chocolate bar to a new location, will look mistakenly for his chocolate in its original location. This requires an understanding that Maxi has a different perspective on the chocolate's location than the children themselves. The younger children incorrectly claim that he will look in the location where the chocolate actually is. Moreover, since many children with autism, despite a mental age (verbal and nonverbal intelligence) well above 4 years, have difficulty with such false belief

[3] A problem with the appearance–reality task is that the question, "what does it look like," can be interpreted nondeceptively to simply mean, "what kind of features does it have?" For instance, when one says that a child *looks like* her father, one means that she has the same or similar facial features. One does not mean that she *appears to be her father*. Under this interpretation of "looks like" the task does not pose a perspective problem because a single perspective can be construed that states that *the object is a sponge that has features of a rock*. For this reason children's mastery of this task does not establish (as unambiguously as the false belief and ignorance tasks) that they are able to understand perspective (see Perner, in press).

tasks, Frith and Happé (1999) suggested that they have a different kind of consciousness than normally developing children after the age of 4 years.

Together, these developmental findings strongly suggest that children before the age of about 4 years do not understand perspective (or appearance and seeming) and therefore, according to Carruthers' analysis, do not have phenomenal consciousness in the sense of experiential subjectivity. Linking this developmental conclusion to the earlier discussion of access consciousness leaves us with the somewhat counterintuitive result that from the age of about 15 months to about 4 years children have access consciousness without phenomenal consciousness. In order to get these two diverging developments back into line we have two options. We can adhere to Carruthers' analysis but check whether its developmental consequences do indeed require an explicit conceptual understanding of appearance. Alternatively we can adopt Rosenthal's (2000) application of higher-order thought theory to phenomenal consciousness: "HOTs do not require the elaborate conceptual apparatus characteristic of humans; they are simply thoughts that one is in states of particular types, states which we humans classify as mental."

Both positions require representation of experience independently of what is experienced. Hence, an organism that can only represent the world as it is would not meet this requirement. Such an organism can have different experiences (we would need to say *unconscious* experiences) but as they are inextricably tied to differences in what is experienced, there is no independent notion of experience. Hence such an organism cannot have phenomenal consciousness in terms of experiential subjectivity. One indicator that children do have a separate notion of mental state or experience and the target of the experience is their verbal references to their own states. From the earlier discussion on children's reference of their own mental states we find this ability appearing between 15 and 24 months.

This indicator relies, of course, exclusively on infants' ability to verbally refer to their mental states. It remains, therefore, possible that infants are able to entertain a notion of experience distinct from the target of their experience well before they can express this verbally. Consequently, it remains a possibility within Rosenthal's theory that with a nonverbal indicator at hand we might be able to demonstrate phenomenal consciousness in much younger infants—perhaps neonates (or even prenatally).

In contrast to Rosenthal, Carruthers (2000) explicitly states that phenomenal consciousness requires understanding of experiences as providing a perspective (appearance) of their target (what they are about). The developmental consequences that he draws are based on evidence from children explicitly representing the difference between what something is and how it appears to us in verbal discourse (Flavell et al., 1983). This evidence points to the late development of about 4 years. He does not consider the possibility that an implicit, procedural grasp of different experiences of the same thing might suffice. Consider an organism that can *pretend* that the world is different than experienced. For such an organism the world does not just present itself in the subjective way in which it is represented by the organism. Rather, the pretending organism has some voluntary control over changing its subjective representation and at the same time realizing that the world has not changed. Consequently, it has the ability to savour (subjectively experience) differences in subjective experience of one and the same state of the world. Naturally, this ability to experience experiential differences about the same state of the world falls short of having a conceptual understanding of how precisely one's changing experiences relate to the experienced state of the world. Nevertheless, it provides some *procedural grasp* of experiential subjectivity, hence a form of phenomenal consciousness in line with Carruthers' analysis.

The only difference to Carruthers' position is that he does not consider the possibility of such a procedural grasp but requires (conceptual) representation of the different experiences *as subjective perspectives* of the world. The developmental implications are large. The understanding of experience as subjective perspective (appearance–reality distinction, false belief understanding)—as we have seen—develops late around 4 years, whereas the ability to pretend develops in the second year of life. Take Piaget's famous example of his daughter Jacqueline, who at 15 months treated a blanket as her pillow and her laughing testified to her awareness that this was not her pillow. Pretence involving an object at this early age is rare but children commonly start pretending to, e.g., act like mother (Fenson et al., 1994, using the CDI communicative development inventory). However by 18 months pretend play with objects can be elicited (Harris & Kavanaugh, 1993).

In sum, following Carruthers' analysis of phenomenal consciousness as experiential subjectivity we get two different answers as to when children acquire the necessary cognitive sophistication. If we follow Carruthers' suggestion that a conceptual understanding is required to represent experiences as subjective perspectives on reality then children cannot have phenomenal consciousness before the age of about 4 years. If, however, we admit a procedural grasp of the subjectivity of experience as sufficient for phenomenal consciousness then children as young as 15 to 18 months display that ability in their pretend play. Moreover, if we follow Rosenthal's suggestion that representation of the first-order state as state one suffices because the representation of that experiential state gives a subjective perspective on that state, then children's verbal reference to their own mental states also points to the similar age range of 15 to 24 months of onset. However, the plausible suspicion that infants might have an earlier emerging preverbal ability to think of being in a mental state suggests that the onset of phenomenal consciousness might be much earlier. Our problem is, that we do not even know which kind of preverbal measure to collect to find out.

4. Conclusion

We have tried to find an answer to the question about when children have conscious awareness. Since this is not possible by simply asking children in that many words, we pursued five indirect strategies by asking when children display abilities that are deemed to be impossible without conscious awareness (sufficient conditions: language use, explicit memory, and executive control) or deemed to be necessary for conscious awareness (theory of mind for access and phenomenal consciousness). Answers within each strategy often differ depending on theoretical options. If particular options are taken a fairly consistent answer is possible: 12–15 (± 3) months. It shows how the drive for a consistent empirical answer can help make theoretical decisions. Table 1 gives an overview of the different strategies, theoretical options within strategies, and their developmental implications.

Dienes and Perner (1999) provided a conceptual framework for seeing how these strategies fit together. They described a hierarchy of ways in which knowledge can be explicit, the most explicit way corresponding to a higher-order thought, i.e., the putatively necessary and sufficient condition for conscious awareness. To be consciously aware of a fact like, "the object in front of me is a circle," one must form a higher-order thought like, "I *see* that the object in front of me is a circle." If one saw the object as a circle, but only unconsciously, one might minimally represent explicitly only a feature, e.g., "circle." A minimal representation, "circle" would not provide conscious awareness or conscious seeing since it does not qualify as a full constituent of a higher-order thought. The representation could make more aspects of the situation explicit than just the feature, e.g., that this feature is predicated of the object in front of me: "the object in front of me is a circle." This explicitly represents the whole proposition, but it is still not sufficient for conscious awareness. Next, one could explicitly represent the factuality (or otherwise) of the object in front of you being a circle: "It is a fact that the object in front of me is a circle." The ability to form representations of this degree of explicitness can be compared by analyzing the

Table 1
Age of onset of conscious awareness according to different assessment strategies

Strategy: Theoretical option	Age brackets			
	0–9 months	9–18 months	$1\frac{1}{2}$–3 years	3–5 years
Strategy 1: Verbal communication				
Single words—referential use	●	☺	☺	☺
Productive two-word combinations	●	☺	☺	☺
Strategy 2: Executive control				
Conditional rules (if-then)	●	●	☺	☺
Simple verbal instructions	●	☺	☺	☺
Focal attention	●	☺	☺	☺
Strategy 3: Explicit memory				
Delayed imitation	●	☺	☺	☺
Footkicking studies (Rovee-Collier, 1997)	☺	☺	☺	☺
Strategy 4: Access consciousness and theory of mind				
Causal role (*theory theory*): *information access*	●	●	●	☺
Ascent routines (*simulation theory*, Gordon, 1995)				
Pretend play	●	☺	☺	☺
Reference to own knowledge	●	☺	☺	☺
Strategy 5: Phenomenal consciousness and theory of mind				
Concept of appearance (*Carruthers*)	●	●	●	☺
Procedural grasp of subjectivity	●	☺	☺	☺
Representation of experiential state (Rosenthal)	?	☺	☺	☺

stage of development in multiple models (Perner, 1991; Suddendorf & Whiten, 2001): One can consider the same individual in different models, e.g., one model being true and the other false. In the final level of explicitness, one could represent one's attitude toward the fact, e.g., seeing "I see that [it's a fact that (the object in front of me is a circle)]." It is this final level of explicitness that provides conscious awareness by the higher-order thought theory. Note that the final higher-order thought occurs later in the hierarchy than the representation of factuality and hence depends on factuality explicitness.

Now consider our five strategies for determining the age at which children become phenomenally aware. Perner (in press) argued that all the executive function tasks listed by Norman and Shallice (1986) required the use of factuality-explicit representations. Hence, the demonstration that children can perform executive function tasks indicates they have achieved a prerequisite degree of explicitness for forming higher-order thoughts. The use of language in novel ways, or as part of planning, makes the same point, in that in these cases language is being used as a tool for performing executive function tasks. Similarly, to have an explicit memory is to appreciate the remembered information as an event in the past; this minimally requires multiple models and appreciation that what is true at time *t* is not a fact now (i.e. explicit memory requires factuality explicitness).

Finally the considerations about access and phenomenal consciousness relied mostly on children's ability to verbally refer to their mental states and to engage in pretend play as key evidence for children having the right sort of abilities. As argued by Perner (1991), the ability to understand and use verbal description and to pretend play requires minimally the multiple models stage of development. One model has to represent the way the world is (labeled as "true" or "fact") and another model is needed to show the verbally described world or pretend scenario (labeled as "false" or "nonfactual"). In other words: verbal description and pretence also require minimally factuality explicitness.

All five strategies were ways of determining whether children had acquired a minimal degree of representational explicitness required for forming higher-order thoughts, namely factuality explicitness. These strategies do not require the use of language to claim one is having phenomenal experience, although many of them are based on linguistic evidence. Nevertheless, some of them do not require language at all and hence may be of use in determining which other animals also have conscious awareness (cf. Suddendorf & Whiten, 2001).

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