# Is There a Role for Metacognitive Feelings in Cognitive Development?

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## Contents

# 1. Dual-Process Theory of Cognitive Development

This section introduces two questions and a dual-process theory of cognitive development.

## 1.1. Why Do Different Responses Reveal Different Developmental Patterns?

Physical objects cannot pass through impenetrable barriers. Infants demonstrate sensitivity to this fact from around three months of age (see, for example, Spelke et al. 1992 or Baillargeon 1987 for two classic studies using habituation). There is also evidence for sensitity to this fact in chimpanzees (Cacchione & Krist 2004) and dogs (Kundey et al. 2010).

The infant studies just mentioned use looking-time responses, as in habituation or violation-of-expectation paradigms. But what if we instead measure infants' manual searching to determine when they are first sensitive to the impossibility of physical objects passing through impenetrable barriers? It turns out that 2.5- and 3-**year**-olds struggle on a simple search task (Berthier et al. 2000; Hood et al. 2003). Indeed, using the same stimuli, children can demonstrate competence in tracking causal interactions on violation-of-expectations and anticipatory looking measures while systematically failing to manifest competence in their searching (Mash et al. 2006).

Different responses indicate different developmental patterns. When observing looking times in habituation or violation-of-expectation paradigms, we do not see developmental changes around the third year of life. But when observing searching behaviours we see gradual changes around the third year of life.

This is true not only for sensitivity to physical principles. It also applies to sensitivity to facts about others' minds. Studies of mindreading regularly find that different responses indicate different developmental patterns (see, for example, Low & Watts 2013; the earliest study on this is Clements & Perner 1994).[1]

Why do different responses reveal different developmental patterns? (Or, as I put it in the talk, Why is there an interaction with age?)

[1] There is an issue about replication, on which a variety of views have been offered. Evidence gathering is ongoing (see manybabies2 and their pre-registered publication). My guess, based on currently mixed patterns of success and failure in replication attempts, is that although some individual findings do not reliably replicate, we will see that different responses indicate different developmental patterns (as I explain in Chapter 12.3 of Butterfill 2020).

## 1.2. The Differences Are Not a Quirk

One tempting idea is that measures based on looking times are simply more sensitive. The appearance that other measures (verbal responses or manual search) reveal developmental changes is an illusion. They are merely noisier measures.

This is unlikely because in a range of tasks looking-time measures fail to reveal knowledge that manual search and verbal responses do demonstrate (see Low & Watts 2013 on mindreading or Charles & Rivera 2009 on object tracking, for example).

Researchers have mostly treated evidence that different responses reveal different developmental patterns as a methodological quirk. This has led to explanations that are specific to one domain. Even if one such explanation were convincing, we should wonder why the pattern of differences arises in multiple domains.

Suppose we treat the fact that different responses reveal different developmental patterns as a key bit of data, rather than as a quirk. Then we are led to a dual-process theory of cognitive development.

## 1.3. A Dual-Process Theory of Cognitive Development

Before stating the theory we need the notion of a *fast* process:

> One process is faster than another: it makes fewer demands on scarce cognitive resources such as attention, inhibitory control and working memory.

The theory states:

1. There are two (or more) processes.[2]
2. One process is faster than another.
3. Faster processes are relatively unchanging, slower processes change across development through learning.
4. Faster processes dominate anticipatory looking, slower processes dominate verbal responses.

This theory is in the spirit of views about core knowledge (Carey & Spelke 1996) but without commitments concerning what (if anything) is represented, innateness of phylogeny.

[2] Compare Frankish & Evans (2009, p. 1): 'These theories come in different forms, but all agree in positing two distinct processing mechanisms for a given task, which employ different procedures and may yield different, and sometimes conflicting, results.'

### 1.4. Why Different Responses Reveal Different Developmental Patterns

It is because some responses are mainly reflect the operations of faster processes, which are relatively unchanging and largely immune to learning and culture, whereas other responses are dominated by slower processes, which do change across development through learning.

### 1.5. Predictions of The Dual-Process Theory

The dual-process theory makes a prediction about commonalities between infants and adults:

> Where infants can track objects or beliefs, in adults there will be two distinct processes and one adult process will have features in common with the infant process.

This prediction can be tested in specific domains using the method of signature limits (Carey 2009).

### 1.6. How Could Fast Processes Influence Looking Duration?

Observations that reveal early sensitivity to others' minds, and to causal interactions, typically involve differences in looking times of around 10–20 seconds. It is unclear how fast processes could explain these. Indeed, the suggestion that they do appears to be post-hoc. From the way fast and slow are distinguished, the differences in looking times might equally well be attributed to slow processes.[3]

So it seems that the dual-process theory of cognitive development does not work after all. Apparently, the theory cannot explain why different responses reveal different developmental patterns.

In what follows we will see that by adding metacognitive feelings we can make the dual-process theory succeed.

## 2. Metacognitive Feelings

What are metacognitive feelings and what is their role in explaining the developmental emergence of knowledge?

[3] The objection can be made stronger by considering details of how the faster processes are supposed to work in object cognition (Butterfill 2020, §7.1)

## 2.1. Metacognitive feelings connect fast and slow processes

According to Koriat,

> 'metacognitive feelings … allow a transition from the implicit-automatic mode to the explicit-controlled mode of operation' (Koriat 2000, p. 150).

Koriat's focus is not dual-process theories, but his claim hints that metacognitive feelings might be relevant to understanding how fast processes could influence slow processes.

## 2.2. What Are Metacognitive Feelings?

Metacognitive feelings include:

- familiarity (Whittlesea & Williams 1998; Scott & Dienes 2008)
- the feeling of knowing (Koriat 2000)
- feeling that a name is on the tip of your tongue (Brown 1991)[4]
- the feeling you have when someone's eyes are boring into your back
- Déjà vu (Brown & Marsh 2010)
- ? surprise (Reisenzein 2000)
- the feeling of being the agent of an event ('sense of agency') (Haggard & Chambon 2012)

This is not supposed to be an exhaustive list. Dokic (2012) lists several more, and others have postulated novel metacognitive feelings (for example, Velasco & Casati (2020) argue that there is a metacognitive feeling of disorientation). It is also possible that some items on the list do not qualify as metacognitive feelings.

What makes something a metacognitive feeling? I adapt an idea from Dokic (which is not actually about metacognitive feelings):

> 'the causal antecedents of [certain] feelings can be said to be metacognitive insofar as they involve implicit monitoring mechanisms that are sensitive to non-intentional properties of first-order cognitive processes' (Dokic 2012, p. 310).

I propose that a metacognitive feeling is a feeling which is caused by a metacognitive process, that is, a process which monitors another cognitive

[4] Widner et al. (2005) provides evidence that the feeling of knowing is distinct from the feeling that something is on the tip of your tongue.

process. For example, a process which monitors the fluency of recall, or of action selection, is a metacognitive process.

## 2.3. The Feeling of Familiarity

What causes feelings of familiarity? Not familiarity as such, it turns out. Instead they are caused by the ease with which you can process the features of a face relative to difficulty of identifying the person. Roughly, the greater the discrepancy between fluency of processing and difficulty of identification, the stronger the feeling of familiarity (Whittlesea & Williams 1998).

So what is this feeling of familiarity?

First, it is phenomenal. It is an aspect of the phenomenal character of some experience associated with acting. So we can call it a feeling.

Second, it is metacognitive in the sense that it's normal causes include processes which monitor fluency of processing. This is why the feeling of familiarity counts as a metacognitive feeling.

Third, it does not necessarily give rise to beliefs. The feeling does not lessen even if you believe (or know) that the thing which causes your feeling of familiarity is not one you have ever encountered before.

Fourth, you are not forced to treat feelings of familiarity as being about actual familiarity: instead you can use feeling of familiarity in deciding whether a stimulus is from that grammar (Wan et al. 2008). In this respect, metacognitive feelings are unlike perceptual experiences and unlike emotions. As Dokic observes:

> 'It is difficult to imagine fear that does not have the function of detecting danger. In contrast, many [metacognitive] feelings seem to be recruited by the organism through some form of learning' (Dokic 2012, p. 308).

## 2.4. The Sense of Agency

Feelings of agency, seem to arise from a number of cues including comparison between outcomes represented motorically and outcomes detected sensorily and the fluency of an action selection process (that is, the ease or difficulty involved in selecting one among several possible actions to perform motorically; this can be manipulated by, for example, providing helpful or misleading cues to action (Wenke et al. 2010; Sidarus et al. 2013, 2017)).

The sense of agency is relevant to us because it serves to link two largely independent processes concerned with evaluating whether you are the agent of an event. One involves detecting the cues just mentioned; the other involves

thinking about how likely it is that you are the agent of an event, perhaps in the light of your background knowledge.

## 2.5. Metacognitive Feelings as Sensations

Metacognitive feelings are aspects of the overall phenomenal character of experiences which their subjects take to be informative about things that are only distantly related (if at all) to the things that those experiences intentionally relate the subject to.[5]

To illustrate, having a feeling of familiarity is not a matter of standing in any intentional relation to the property of familiarity, but it is something that we can interpret as informative about familiarity.[6]

We might think of metacognitive feelings as lacking intentional objects altogether; this would make them like sensations in Reid (1785)'s sense. Not everyone accepts that such things could exist, of course (because they aim to explicate phenomenology in terms of intentional content or whatever). We can be agnostic by noting that nothing is lost by treating metacognitive feelings as if they were sensations.

Sensations are:

- monadic properties of events, specifically perceptual experiences,
- individuated by their normal causes—in the case of feelings of familiarity, its normal cause is ease of processing
- which alter the overall phenomenal character of those experiences
- in ways not determined by the experiences' contents (so two experiences can have the same content while one has a sensational property which the other lacks).

If this is right, why do metacognitive feelings invite judgements? Why does the feeling of familiarity (say) even so much as nudge you to judge that the

[5] This is consistent with, but weaker than, Koriat's theory: 'metacognitive feelings are mediated by the implicit application of nonanalytic heuristics … [which] operate below full consciousness, relying on a variety of cues … [and] affect metacognitive judgments by influencing subjective experience itself' (Koriat 2000, p. 158; see also Koriat 2007, pp. 313–5).

[6] Why accept this? You cannot perceive familiarity or agency any more than you can perceive electricity. Perceptual processes do not reach far back into your past, nor are they concerned with questions about whether you are the agent of an action. So to think that metacognitive feelings intentionally relate you to facts about familiarity or agency requires postulating a novel kind of sensory process, some kind of inner or bodily sense.

face photographed here is familiar to you? (This is roughly Dokic (2012)'s question.)

### 2.6. Metacognitive Feelings Are Intentional Isolators

Metacognitive feelings have no intentional objects, or none that are related to any beliefs that you might ordinarily acquire on the basis of them. They therefore serve as intentional isolators. That is, they provide a nonintentional link between two intentional states. The processes involved in action selection (or face processing) involve representations of an action (or face), and the beliefs you acquire also intentionally specify an action (or face). But the metacognitive feeling of agency (or of familiarity) that connects these two has no such intentional object. In acquiring the belief, you have to form a view about what caused the feeling.

### 2.7. How Metacognitive Feelings Link Fast to Slow Processes

The feeling of familiarity is reliably caused by things which are familiar. This is because in a limited, but useful, range of cases, things which you can process fluently are things which are familiar to you. After all, familiarity is one (of several) causes of ease of processing.

Over time you learn, perhaps implicitly, to associate the feeling of familiarity with things being familiar. (Although you can unlearn this association in a carefully controlled experimental setting; Wan et al. 2008.)

So a fast processes causes a feeling, which triggers a learned association, which in turn biases a slow process to determine that the likely cause of the feeling is familiar.

This is one model for how fast processes can influence slow processes.

## 3. A Conjecture about Metacognitive Feelings

In earlier sections we saw that:

- different responses reveal different developmental patterns;
- a dual-process theory aims to explain why this is so; but
- that theory, by itself, cannot explain looking times.

In this final section I suggest that adding metacognitive feelings to the dual-process theory will solve the problem.

## 3.1. Surprise

There appears to be a metacognitive feelings of surprise:

> 'the intensity of felt surprise is not only influenced by the unexpectedness of the surprising event, but also by the degree of the event's interference with ongoing mental activity, [...] the effect of unexpectedness on surprise is [...] partly mediated by mental interference' (Reisenzein 2000, p. 271).

That is, there is a feeling of surprise which is a sensational consequence of mental interference. (This can be tested by increasing cognitive load: this intensifies feelings of surprise without, of course, making the events themselves more surprising. But see Reisenzein et al. (2017) for an alternative interpretation of such findings.)

So whereas the feelings of agency and familiarity are both consequences of unexpected fluency of processing, the feeling of surprise is supposed to be the opposite: it is a consequence of unexpected disfluency.[7]

## 3.2. Surprise Explains Looking Times

Why will an infant observing an occluded object appear to pass through an impenetrable barrier look at the scence much longer than an infant who sees a physically possible event (Spelke et al. 1992)? Perhaps because: > * the impossible event causes a problem for the faster process, which fails to identify a possible trajectory for the object; > > * this interference in the faster process generates a metacognitive feeling of surprise; and > > * that feeling causes the infant to look longer at the impossible event.

And why will such an infant (or even a much older child) fail to manually search in the correct place for the object (Mash et al. 2006)? Because: > * the faster process cannot initiate actions; and > > * the metacognitive feeling reveals nothing about the object's location (it is an intentional isolator).

[7] An alternative is proposed by Foster & Keane (2015, p. 79): 'the MEB theory of surprise posits that: Experienced surprise is a metacognitive assessment of the cognitive work carried out to explain an outcome. Very surprising events are those that are difficult to explain, while less surprising events are those which are easier to explain.' Foster & Keane (2015, p. 79) is about reactions to reading about something unexpected, whereas Reisenzein (2000) measures how people experience unexpected events (changes to stimuli while solving a problem). The latter is much closer to our concerns. But the truth of either account of surprise, or of an account combining the two insights, would indicate that there is a metacognitive feeling of surprise.

### 3.3. Predictions

What predictions follow from the conjecture that metacognitive feelings connect developmentally unchanging, fast processes for tracking objects and minds to slow processes?

One basic prediction is that manipulations which affect metacognitive feelings of surprise in adults will also have task-irrelevant effects on infants' performance in violation-of-expectation tasks.

In particular, given that cogntive load can enhance the metacognitive feeling of surprise in adults, we might predict—counterintuitively—that infants' sensitivity will be better demonstrated by showing them slightly more complex scences.

## 4. Conclusion

My aim was to identify a reason for thinking that metacognitive feelings are be important in the development of abilities to track objects and their causal interactions, and minds.

My conjecture is that metacognitive feelings link early-developing, faster processes to the less automatic processes whose development involves a series of significant conceptual changes.

Why does this matter?

If you are building a survival system you want quick and dirty heuristics that are good enough to keep it alive: you don't necessarily care about the truth. If, by contrast, you are building a thinker, you want her to be able to think things that are true irrespective of their survival value. This cuts two ways. On the one hand, you want the thinker's thoughts not to be constrained by heuristics that ensure her survival. On the other hand, in allowing the thinker freedom to pursue the truth there is an excellent chance she will end up profoundly mistaken or deeply confused about the nature of objects or minds. So you don't want thought contaminated by survival heuristics and you don't want survival heuristics contaminated by thought. Or, even if some contamination is inevitable, you want to limit it.

This combination is beautifully achieved by giving your thinker relatively automatic processes for tracking objects and minds which appear fully-formed early in development, and also a mind which allows her to acquire knowledge of minds gradually over years, taking advantage of social interactions.

As intentional isolators, metacognitive feelings enable distinct kinds of process to operate with fundamentally different ways of modelling a domain

throughout life.

So the intentional isolation provided by metacognitive feelings is critical: it allows development to be a process of rediscovery, and so extracts maximum benefit from the operations of distinct processes for tracking objects and minds.

# Glossary

**automatic** As we use the term, a process is *automatic* just if whether or not it occurs is to a significant extent independent of your current task, motivations and intentions. To say that *mindreading is automatic* is to say that it involves only automatic processes. The term 'automatic' has been used in a variety of ways by other authors: see Moors (2014, p. 22) for a one-page overview, Moors & De Houwer (2006) for a detailed theoretical review, or Bargh (1992) for a classic and very readable introduction 11

**cognitively efficient** A process is *cognitively efficient* to the degree that it does not consume working memory, attention, inhibitory control or other scarce cognitive resources. 11

**fast** A *fast* process is one that is to to some interesting degree cognitively efficient (and therefore likely also some interesting degree automatic). These processes are also sometimes characterised as able to yield rapid responses.

Since automaticity and cognitive efficiency are matters of degree, it is only strictly correct to identify some processes as faster than others.

The fast–slow distinction has been variously characterised in ways that do not entirely overlap (even individual author have offered differing characterisations at different times; e.g. Kahneman 2013; Morewedge & Kahneman 2010; Kahneman & Klein 2009; Kahneman 2002): as its advocates stress, it is a rough-and-ready tool rather than an element in a rigorous theory. 3–5, 8–10, 12

**intentional isolator** An event or state which links representations but either lacks intentional features entirely or else has intentional features that are only very distantly related to those of the two representations it links. Metacognitive feelings and behaviours are paradigm intentional isolators. 8–10

**metacognitive feeling** A metacognitive feeling is a feeling which is caused by a metacognitive process. Paradigm examples of metacognitive feelings include the feeling of familiarity, the feeling that something is on the tip of your tongue, the feeling of confidence and the feeling that someone's eyes are boring into your back. On this course, we assume that one characteristic of metacogntive feelings is that either they lack intentional objects altogether, or else what their subjects take them to be about is typically only very distantly related to their intentional objects. (This is controversial—see Dokic 2012 for a variety of conflicting theories.) 5, 6, 9–11

**metacognitive process** A process which monitors another cognitive process. For instance, a process which monitors the fluency of recall, or of action selection, is a metacognitive process. 5, 12

**signature limit** A *signature limit* of a system is a pattern of behaviour the system exhibits which is both defective given what the system is for and peculiar to that system. A *signature limit* of a model is a set of predictions derivable from the model which are incorrect, and which are not predictions of other models under consideration. 4

**slow** converse of fast. 4, 5, 8

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