Working and Reflective Understandings of Sensory Modalities

Do we need to a distinction between working and reflective understanding in order to explain developmental discrepancies in children's understanding of sensory modalities? To demonstrate a need for such a distinction, we have to show that younger children don't understand the relation between sensory modalities and knowledge and also that they have competences which can only be explained by supposing that they do understand this relation.

1. The case for deficient understanding

O'Neill and Chong found that "many 3-year-olds appeared entirely unaware of how their own sensory actions were related to the property knowledge they had gained only seconds earlier … [C]hildren … responded … at times by demonstrating or naming an action that could not possibly have led to the knowledge in question" (O'Neill and Chong 2001: 812). Unlike 4-year-olds, they could not respond to an instruction to "[s]how me how you found out the bubble bath is strawberry bubble bath" (805) which only required them to repeat an action, and they could not respond to "[h]ow did you find out the bubblebath is strawberry bubble bath?" (805) either verbally or by demonstrating an action. Nor could 3-year-olds identify which sensory organ (mouth, eyes or hands) would be required to find out what the bubble bath is.

Is the problem that 3-year-olds do not remember how they experienced an object, whether they felt, saw or smelt it? This might seem plausible as subjects who understood the questions about their sources of knowledge could have answered them simply by recalling that they last smelt or felt an object. However, (Robinson and Whitcombe 2003: Experiment 2) demonstrate that children who fail these tasks can nevertheless remember whether they saw only part of an object or whether they saw a whole object. There is also some evidence that children observing two adults can recall which felt and which saw an object (Robinson and Whitcombe 2003: Experiment 1, video task). Accordingly, children's deficient understanding of sensory modalities cannot be straightforwardly explained by a failure of memory and appears to be a genuine failure to fully understand how sensory modalities lead to knowledge (O'Neill and Chong 2001: 813–4; Robinson and Whitcombe 2003: 58, 60–1). Instead, it is plausible that children's failure to correctly report how they know things arise from difficulties understanding how experience in different sensory modalities leads to knowledge. They do appear not to understand that feeling an object can tell you whether it is hard or soft but not whether it is red or blue.

2. The case for understanding

There are two main sources of evidence that younger children do understand how experience in sensory modalities leads to knowledge. First (Robinson and Whitcombe 2003: Experiment 1) showed that children would accept an adult's testimony only when the adult but not the child had knowledge-yielding sensory access to the object. In their experiment children were allowed to either see or feel an object before being asked what they thought it was. An experimenter then either saw or felt the object and then made a conflicting statement about what the object was. Finally, children were again asked what they thought the object was. Children changed their minds when only the experimenter should have been in a position to

know given their sensory access to the object, but not when the child and the experimenter were both guessing. However, the authors suggest that the same children cannot say whether they know because they experienced the object or because they were told ("How did you know it was a strawberry/tomato—was it because you saw it or I told you?"), at least when this is not conflated with simply being able to recall what happened (Robinson and Whitcombe 2003: 58).

A second source of evidence for understanding comes from an experiment in which children were first given one mode of access to an object (seeing or feeling it) and then asked what it is at the same time as being given the opportunity to see or feel it (Robinson, Haigh and Pendle 2006 submitted). Here, even 3–4 year old children tended to see or feel the object only as necessary, demonstrating that they understood when further information was needed to answer the question and which sensory modality was required to obtain that information. Further support for this interpretation of the findings comes from the fact that children who had seen an object which could only be identified by touch would then choose to feel it rather than see more of it when given the choice (Robinson, Haigh and Pendle 2006 submitted: Experiment 3).

As well as revealing children's understanding of sensory modalities, these findings also indicate that children may have some appreciation that it's possible to have experience of an object without knowing everything about it.

3. Reflective–working contrast experiments

Some pairs of experimental conditions seem to provide a relatively direct contrast between working and reflective understanding.

Contrast using perception–knowledge links in solving a practical task with evaluating knowledge states. Robinson (2000: 67–8) reports a contrast between children's ability to use testimony in deciding what an object is with their ability to evaluate who knows what the object is. In the 'use testimony' condition (my term for it): subjects saw or felt an object then were asked what it is; an experimenter then felt or saw the object and said what the object is, always contradicting the child; children were then asked, "So which one is it?" In this condition, 3–4 year old children tended to say what the experimenter said only when the experimenter's mode of access to the object was informative. This suggests that children do understand that only some modes of access make it possible to identify an object. In the 'evaluate knowledge' condition (my term for it), the same procedure was used except that instead of being asked to identify the object they were asked "Who knows best which one it is, Helen (experimenter) or you?" 3–4 year old children typically failed this task. "Children behaved as if they knew which player was better informed when they decided whether or not to believe what the experimenter said, but they failed to judge correctly who knew best when no utterances were given" (Robinson 2000: 68).

Two further experiments contrast a task where children are involved with a task where children are observers. First, in Robinson and Whitcombe (2003: Experiment 1)'s 'video condition', children observe one experimenter feeling a toy and saying what it is, followed by another experimenter seeing the same toy and contradicting the first experimenter. Children are then asked what the object is really. They also used a

second condition which resembles the video condition except that the child plays the role of the first experimenter. Children found the second condition significantly easier than the first (Robinson and Whitcombe 2003: 55). Second, Robinson et al. (2006 submitted) examine whether children will spontaneously look at or feel an object before answering a question about its identity. In a 'no access' condition (Experiment 2) children has no prior experience of the object, and of interest was whether they would first look or feel the object depending on which form of access was necessary to identify it. They were very poor at this. However, in a 'partial access' condition (Experiment 3) children had already seen the object but were not able to identify it; here the question was whether they would choose to first look at more of it or feel it. Performance on this task was much better, perhaps because the children themselves were already involved with the object.

These contrast experiments may be useful in identifying what a distinction between working and reflective understandings of sensory modalities has to explain. To illustrate, take the idea that children's working understanding of sensory modalities consists in implicit knowledge of rules which associate types of experience with types of knowledge (e.g. seeing is associated with knowledge of colour, feeling with knowledge of hardness). This may be correct but it can't be a fully adequate account because it can't explain the above contrast cases: all things being equal, someone who merely knew the associations ought to be equally good each task in the contrasting pairs of tasks.

[Are there any more contrast cases? Are we planning any?]

4. What don't 3–4 year old children understand about how sensory modalities lead to knowledge?

In short, the same children appear to both understand and not understand how sensory modalities lead to knowledge. This suggests that we may need a distinction between working and reflective understanding to explain the discrepancy in the experimental findings.

As a step towards invoking a working–reflective distinction we need some idea of what 3–4 year old children don't understand. One extreme is that children have no understanding that sensory experience is necessary for knowledge. Another extreme view is that 3–4 year olds understand that experience explains knowledge and that different kinds of experience explain different kinds of knowledge, but have yet to learn which sensory modalities give rise to which types of knowledge. On this second extreme view, children have fully adequate concepts of knowledge and of sensory modalities; they simply haven't yet learnt some rules relating these (e.g. the rule that direct knowledge of colour comes only from seeing).

The first extreme view can't be quite right because even 2½ year olds show some understanding of a situation in which visual perception is necessary for knowing (Dunham, Dunham and O'Keefe 2000: Experiment 2). Of course, this may be working understanding since this paradigm involves infants using an adult to obtain stickers: it may be true that 2½ year olds have no *reflective* understanding of how experience leads to knowledge. However, there is also anecdotal evidence that 3–4 year old children genuinely believe that they know things in virtue of their experience

even though they are often wrong about which experiences actually resulted in this knowledge—Robinson (2000: 77) mentions a child who enthusiastically answers "How do you know it's the red one?" with "Cos I feeled it!" This suggests that 3–4 year olds may have some reflective understanding of how experience leads to knowledge.

I suggest that the second extreme view is also not a genuine possibility and that a child who thought that feeling can lead to knowledge of colour cannot have a fully adequate[1] concept of knowledge. Why not? Because part of what it is to be a state of knowledge is to be a state whose existence is (causally) explained by experiences. If we fail to think of knowledge as explained by experiences we fail to understand the connection between knowledge and the world and therefore fail to grasp on what means for knowledge to be knowledge of the world.[2] This is not to say that fully understanding knowledge requires thinking of it as explained by experience in general terms. Rather, the key to understanding knowledge is the ability to explain particular instances of knowledge by appeal to particular sensory experiences. This is relevant to understanding the child who sincerely asserts that she knows it's red "cos I feeled it": while she might have an intuition that experience can somehow explain her knowledge, she has failed to grasp any genuine explanation (feeling doesn't really explain knowledge of colour). Accordingly, her statement suggests an incomplete understanding of knowledge as a state whose existence is explained by experience: it's not that she fails to know some of the facts about knowledge, but that she fails to fully understand what knowledge is.

Fully understanding knowledge and experience involves understanding them as interlocking components of a larger model of the mind. Just as knowledge has to be thought of as explained by experiences, so feelings and seeings are essentially things which explain knowing. So to fully understand what it is to see an object you have to be able to explain particular knowings in terms of particular seeings. The child who explains knowledge of colour by referring to feeling reveals inadequate conceptions of feeling and seeing.[3]

If this is right, there is no straightforward way to characterise what 3–4 year old children don't understand about how sensory modalities lead to knowledge. They neither entirely fail to understand how knowledge depends on experience nor fully understand what knowledge and experience are. Characterising their understanding would be a challenge even if there were no need to appeal to a working–reflective distinction to explain children's understanding of sensory modalities.

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1 'fully adequate' is a fudge. What conception of knowledge should we to contrast the child's with? The adult conception or some philosophical conception which may or may not be fully understood by anyone?

2 The claims in this paragraph need refining to accommodate knowledge by testimony. The view expressed here a relatively controversial claim about knowledge among philosophers (outside Warwick, at least). But for the purposes of our project I think it would be acceptable to cite a couple of philosophers who think of knowledge in this way rather than defending the claim … unless ER or EN disagree about the nature of knowledge.

3 Here Naomi & Johannes have things to say about what sensory modalities are (e.g. that they're distinguished partly by their different enabling conditions) and what it is to understand them. More indirectly, there's also quite a bit of philosophy on individuating sensory modalities.

The following subsections are misc. notes on issues relevant to characterising children's understanding.

4.1 Rules contrasted with explanations

In later attempting to characterise what 3–4 year olds do and don't understand, it may be useful to distinguish between (i) grasping general rules about which senses provide which kind of knowledge and (i) grasping how particular sensory experiences causally explain particular knowings. In principle someone could detect that seeing an object is associated with knowledge of colour without thinking that the seeing causes the knowledge. (I'm not sure if the converse is possible.)

In principle it would be possible to answer "How do you know it's red?" type questions correctly on the basis only of a knowledge of rules, except that only knowing rules would not enable children to sincerely say "*Because* I saw it".

Suppose the rules are understood as associating sensory modalities with types of knowledge typically obtained by their exercise. Then the rules children learn may not exactly correspond to what can be *directly* known from each modality. Although vision cannot directly inform us about properties like texture or hardness, it's often easy to infer these properties from visual experience (e.g. "It looks hard/expensive/tasty" meaning "I can infer that it's hard/expensive/tasty just from the way it looks").

4.2 Partial knowledge

Given that perception and knowledge interlock in ways that preclude fully understanding one without understanding their relation, characterising what children understand about sensory modalities will involve characterising what they understand about knowledge and, in particular, what they understand about the possibility of partial knowledge. And indeed, Robinson et al. (2006 submitted) suggest that children's difficulties understanding sensory modalities as sources of knowledge may be linked to difficulties with understanding partial information.

It seems to me that understanding that knowledge can be partial might go with grasping explanations for why knowledge is partial. What is known and what is not known both need explaining, and these explanations typically rely on facts about perception or testimony. For example, how could Heinz know that an object is a Lego block but not that it is red? Because he saw it wrapped in aluminium foil in such a way as to obscure its colour but not its shape. Partial knowledge can be explained in various ways including:

> Access to an object is from a particular perspective (e.g. can't see the back of a tomato)
>
> Access to the object is restricted to certain sensory modalities (e.g. feel but not see)
>
> Access to a partially occluded object (e.g. seeing just part of a picture that might be a picture of a tomato strawberry)

Non-specific testimony (e.g. “It’s under one of the bowls”)

Before around 3 years, children think of knowledge of an object as an all-or-nothing state—either you know an object, in which case you know everything about it, or else you don’t know the object at all—and that any kind of experiential contact with an object is sufficient for knowing it.[4] Since these children cannot imagine that someone could know what colour an object is but not whether it is hard or soft, it would also be impossible for them to understand the significance of accessing an object by particular sensory modalities. Older (3–4 year old) children do understand some forms of partial knowledge. For example, they know that someone who has seen some partially occluded sticks will not know that one of them is long, or that a Lego block wrapped in aluminium foil is red (Sprung, Perner and Mitchell 2004 draft). On the other hand, these children struggle to understand non-specific testimony. For example, in one paradigm children are told by an experimenter where a mouse is; in one condition, the utterance provides sufficient information to locate the mouse, in another it does not (for example, “the mouse is under one of the bowls”). Even 5-year-old children rarely ask questions about the location of the mouse when given insufficient information about its location, although 4- and 5- but not 3-year-olds do hesitate significantly longer before beginning to search for the mouse when given insufficient information (Plumert 1996). Similarly, 4- and 5-year-old children who are given a message consistent with two possibilities (for example, “I think it’s the red one” when there are two red items) will rarely say that the message is defective (Robinson and Apperly 2001).[5]

Questions about partial knowledge. First, are children’s problems understanding sensory modalities related to other problems involving partial knowledge (for example, Robinson et al. (1997) describes a possibly related problem)? Second, can children’s difficulties with non-specific testimony be entirely explained by an inadequate understanding of verbal utterances, or are these difficulties related to an inadequate understanding of partial knowledge and the relation between testimony and knowledge? Third, is there any empirical evidence relating children’s understanding of partial knowledge to their understanding of sensory modalities? For example, take children who don’t know how they know something is red: if they’re told that Jack knows an animal is red and Jack doesn’t know whether its hard or soft, can they infer that Jack doesn’t know which animal it is?

5. Working vs. reflective understanding

The idea that a working–reflective distinction may explain apparent discrepancies in children’s performance on tests for understanding sensory modalities has already been endorsed, but it is an open question how the distinction should be made:

> “At this stage we leave it vague as to what the labels *automatic*, *implicit*, *abstract*, and *reflective* might mean in terms of what knowledge is represented” (Robinson and Whitcombe 2003: 59).
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> “Children’s well-documented over-estimation of the knowledge to be gained from ambiguous or limited information was not in evidence. Our preferred

[4] *Any canonical refs on this?

[5] [More references on this in (Robinson, Haigh and Pendle 2006 submitted: 3).]

explanation is that children's task of finding out which toy was in the tunnel tapped working understanding, rather than more reflective understanding demanded for success in typical tasks on children's handling of ambiguity" (Robinson, Haigh and Pendle 2006 submitted: 24).

"their deficit is perhaps … an inability to become explicitly or declaratively aware of the source of perceptual experiences, perhaps as a result of an inability to process the source at the time of leaning the perceptual information" (O'Neill and Chong 2001: 814).

Intuitively a working–reflective distinction seems appropriate because the tasks children fail seem to involve some sort of reflection on how they know detached from any practical activity, whereas the tasks which they can pass seem to involve using information about sensory modalities in the course of doing something else (generally identifying an object). Accordingly, the discrepancy between success on intuitively practical tasks and failure on intuitively reflective tasks has suggested a comparison with children's discrepant performance on false belief tasks: information about false beliefs appears to be effective in controlling their eye movements, word learning and some deception-related behaviours (e.g. false denials) (Robinson, Haigh and Pendle 2006 submitted: 6; Robinson and Whitcombe 2003: 59).

Of course, applying a working–reflective distinction is not straightforward. If the distinction is to explain discrepant performance, we need answers to an array of questions including the following. The earlier questions are ones that should emerge from an adequate account of the working–reflective distinction; the later questions are ones we attempt to answer in giving the account.

Why (if at all) is it a good thing to have reflective understanding?

What makes certain tasks tests of working understanding and what makes others tests of reflective understanding (Robinson, Haigh and Pendle 2006 submitted: 28)? In other words, we need to know what working understanding enables children to do and what reflective understanding enables them to do. One fixed point is that asking a question about an object or seeking help with identifying it are always tests of reflective understanding.

What can there be working understanding of? For example, given our conception of working understanding, would it make sense to suppose that children might have a working understanding of testimony as a source of knowledge? (If we thought of working understanding as implicit knowledge of rules associating sensory modalities with types of knowledge, the answer would depend on whether any types of knowledge are usefully associated with testimony.)

Does reflective understanding supplant or supplement working understanding? ~~For example, 'supplant' seems to be the correct answer for Goldin-Meadow's gesture speech discrepancies in children's grasp of strategies for solving mathematical problems (Goldin-Meadow 1999); the answer is also 'supplant' on Dienes and Perner (1999) and 'representational redescription' models.~~ [I got this wrong. Maybe 'supplement' is the mark of a genuine working–reflective distinction, whereas 'supplant' suggests a transition from partial to full understanding (e.g. Wellman and Lagattuta 2000), from lower to higher confidence, or in 'graded representations' (Munakata 2001).]

How are working and reflective understanding each acquired?

How if at all does having working understanding facilitate the acquisition of reflective understanding?

How are working and reflective understanding coordinated in solving particular problems?

How do working and reflective understanding each contribute to purposive action? Working understanding must somehow inform decision making because we know that children use their working understanding of sensory modalities in deciding which adults to believe and how to interact with an object (Robinson, Haigh and Pendle 2006 submitted: 28). Presumably younger children they can't form intentions whose contents directly involve sensory modalities but can only use information about sensory modalities indirectly. It would be useful to know what range of activities working understanding of sensory modalities is manifested in—whether there's an open-ended range of tasks, or whether it might be confined to using testimony and word learning (say).

What are the contents of children's working and reflective understandings of sensory modalities?

How (if at all) do the cognitive processes in which working and reflective understanding feature differ? For example, is working understanding automatic? Does it rely on working memory, and does it require attention? Reflective understanding directly informs theoretical and practical reasoning—does working understanding also? If not, how is working understanding influential in shaping a subject's knowledge? If we take the view that working and reflective understandings differ from each other in something like the way that associations and thoughts differ from each other, then we would expect to find that working and reflective understandings feature in two different kinds of process, just as associations are acquired and modified by associative learning whereas thoughts are acquired and modified by reasoning which is a different kind of process. Modular cognition (e.g. phoneme perception) appears similarly different from reasoning.

If we accept that these questions need answers, we cannot be entirely satisfied with current attempts to characterise working–reflective distinctions. The most widely discussed in developmental contexts is Dienes and Perner (1999). Roughly speaking, they analyse working understanding as representation and reflective understanding as representation of representations. Whereas this approach assumes that the concept of representation is well understood and can be taken as basic, we take the experimental discrepancies that motivate invoking a practical–reflective distinction to suggest that we as theorists inadequately understand what it is to represent (i.e. understand) relations between sensory modalities and knowledge. It is also possible that in our case, the working–reflective distinction will involve a distinction between kinds of representation rather than between representations and metarepresentations. Most importantly, applied to the case of understanding sensory modalities, Dienes and Perner's (1999) scheme does not fully answer the question, What makes certain tasks tests of working understanding and what makes others tests of reflective understanding?

We do not think there are currently any correct off-the-shelf answers to these questions.[6] Although working–reflective distinctions appear to be needed in a variety of developmental cases (for example, false belief and object permanence), it is possible that different cases may require different working–reflective distinctions. This seems plausible partly because the behaviours to be explained vary from case to case. For example, in the Object Permanence case the behaviours to be explained by working understanding are eye movements, and the behaviours to be explained by reflective understanding are searching. By contrast, in the case of false belief the behaviours to be explained include word learning and deception-relation behaviours which include verbal behaviour (e.g. false denials, see Polak and Harris 1999). Similarly, in the case of understanding of sensory modalities we know that children use their working understanding in deciding which adults to believe and how to interact with an object (Robinson, Haigh and Pendle 2006 submitted: 28). Arguably no one distinction can be applied in every case.

That said, comparing and contrasting understanding sensory modalities with other cases may be useful for characterising the working–reflective distinction for understanding sensory modalities.

The following sub-sections contain notes on some of the above questions. I think the questions about content and processes are especially important.

5.1 What do you gain from reflective understanding?

Dienes and Perner suggest that reflective understanding (which they call 'explicit representation') of beliefs, desires and intentions is necessary for voluntary control of knowledge and action.[7] Could this explain why reflective understanding is

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6 The working–reflective distinction and related distinctions have widely discussed in philosophy. For example, (Sperber 1997) on intuitive and reflective beliefs, (Baier 1979) on change of mind, (Ryle 1949) on knowing how and knowing that, (O'Shaughnessy 1980: vol. II ch. 10) on sub-intentional acts and sub-propositional knowledge, (Bennett 1976) on registration and belief, (Stich 1978) on subdoxastic states, (Evans 1985), (Davies 1989) and (Wright 1986) on tacit knowledge, (Dennett 1998) on belief and opinion, (Cohen 1992) on belief and acceptance, (de Sousa 1971) on belief and assent, (Campbell 1992) on practical and reflective levels of thought, and (Velleman 2000) on full-blooded action and (mere) behaviour. As far as I know, none of these philosophers have considered developmental cases where a working–reflective distinction is needed; although (Dienes and Perner 1999) and (Perner 2003) have discussed how some of these ideas might be applied to developmental cases. Philosophers tend to focus on explaining how animal and human thinking differ (e.g. Bennett 1976), or on the notion of knowledge of syntax as invoked by Chomsky (e.g. Davies 1986). With a few exceptions (e.g. Stich 1978; Campbell 1993), philosophers have attempted to provide practical–reflective distinctions with very general application and have not considered particular applications in detail.

7 On action, cf. (Dienes and Perner 1999: 741): "the ability to exert voluntary control in contrast to automatic action has been associated with explicit, conscious knowledge. This link is justified because voluntary control requires explicit representation of one's attitude." On knowledge, cf. (Dienes and Perner 2002): "Voluntary or intentional control of knowledge means that one can use it intentionally. That is, one needs to represent that one wants to use that knowledge. One needs to reference the content as *something to be desired* and not, for example, as an existing fact. Thus, the factuality (or otherwise) of the content of the knowledge must be made explicit. This analysis shows why the common notion that voluntary control is associated with explicitness is justified."

beneficial—reflective understanding is valuable because it enables us to exercise voluntary control over our thoughts and actions? In the case of understanding sensory modalities, the idea would be that reflectively understanding how experience leads to belief enables us to voluntarily control whether particular experiences lead to particular beliefs. [Dienes and Perner express a similar idea using the notions of vehicle and content control: explicit representations are necessary for content control.]

To elucidate this idea we might follow Perner (1998) in drawing on David Velleman. (As we'll see, Velleman's view is not directly related to our question about the value of reflective understanding because he focuses on self-awareness rather than reflective understanding.) David Velleman claims that action involves "two, hierarchically related activities". At the lower level, there is activity caused by beliefs and desires. At the higher level, awareness of our beliefs and desires 'controls' and 'guides' the lower level activities.[8] He explains the idea with a useful analogy:

> "Action is like the corporate enterprise of work performed under management: it's behavior executed under conscious control. And just as the corporate enterprise includes both a basic work activity and the higher-order activity of managing that work […], so full-blooded action comprises both a basic activity and the higher-order activity of controlling it" (Velleman 2000: 192).

Although Velleman is taking about action in this quote, the same analogy can be applied to the acquisition of knowledge or belief. Someone who lacks awareness of her own beliefs acquires beliefs automatically as a consequence of experience and testimony. However, someone who has awareness of her own experience, testimony and belief can intervene in the processes by which she acquires beliefs. She can attempt to make sure that she acquires beliefs only when the automatic causes of them provide her with sufficient evidence of their truth. In this way, self-awareness enables a subject to exercise some measure of voluntary control in how she acquires beliefs. In short, just as Velleman suggests that an agent's role is to "intervene between reasons and intention, and between intention and bodily movements" (Velleman 2000: 125), we could similarly claim that a thinker's role is to intervene between experiences or testimony and the belief states which result from these. This is the *monitoring and control* view of self-awareness—on this view, self-awareness enables us to monitor our experiences, beliefs and actions and to control otherwise automatic relations among them.[9]

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[8] Cf. Velleman (2000, 197-8): "In my view, extending your hand out of a desire and belief is the underlying behavior over which you may or may not exercise conscious control – the //p. 198// underlying work that may or may not come under your executive management. And practical reasoning is the process by which you exercise conscious control over this activity in some cases but not others. If you extend your hand without any guiding knowledge of what you're doing, then even though your behavior is motivated by a desire and belief, it isn't under your conscious control, and so it isn't a full-blooded action." See also Perner (1998: 272): "Of fully controlled action we can only speak if the organism represents the determinants of its actions (i.e., its desires and knowledge of contingencies) and can thus have the potential for deliberating changes in its desires and knowledge."

[9] Versions of the monitoring and control view are endorsed by (Fodor 1991) and (Shoemaker 1996). Paul Grice also suggests that the rationale for being able to think about our own states is "to control or regulate [our] own judgings or willings" (1974-5: 48).

Against the monitoring and control view, Richard Moran objects that "there is no more reason to think that the rational regulation of belief requires awareness of the beliefs in question than there is to think that the regulation of heartbeat, respiration, or metabolism requires conscious monitoring, or even a creature with the capacity for consciousness at all. … //p. 111// my beliefs, like the flow of perceptions, interact and undergo revisions all the time without any intervention on my part. Their general rationality does not need my constant supervision" (2001: 110–111). Accordingly, we would expect Moran to deny that reflective understanding of experience–knowledge relations is required for the rational regulation of belief.

I think Moran's objection to the monitoring and control view may be too strong. We should make two distinctions. One is between the claims that (i) awareness of our own beliefs is *somehow* necessary for the rational regulation of belief, and (ii) awareness of our own beliefs is necessary for the rational regulation of belief because it enables us to intervene in the processes by which beliefs are acquired and acted on. The monitoring and control view accepts (i) and (ii), Moran rejects them both; it's also possible that (i) is true but (ii) is false. The second distinction is between the claims that (i) awareness of our own beliefs is *generally* necessary for the rational regulation of belief, and (ii) awareness of our own beliefs is only necessary for the rational regulation of belief in particular cases. Moran appears to reject both (i) and (ii), but we might accept (ii).

Some current empirical work seems relevant to evaluating these claims about the value of awareness of our own beliefs. For example, Koenig et. al. (2004: 694) show that "when young [3 year old] children have well-established knowledge of a given fact—for example, they know what an object is called, they know what color it is, or they know the properties of the class to which it belongs—they do not accept statements that contradict those known facts. They correct speakers who make false statements and refuse these statements as bases for subsequent reasoning." That is, 3-year-olds can use testimony intelligently in forming beliefs despite lacking both awareness of their own beliefs and reflective understanding of testimony as a source of belief. Apparently, then, using testimony to acquire knowledge does not depend in any very general way on being aware of your own beliefs or on reflective understanding of testimony.

Is this debate about the value of self-awareness relevant to our question about the value of reflective understanding of sensory modalities? It is directly relevant if the kind of self-awareness necessary for monitoring and controlling your own beliefs involves reflective understanding, or if monitoring and control requires not just self-awareness but also reflective understanding. It's hard to tell whether either of these possibilities are true. Philosophers who advocate versions of the monitoring and control view generally haven't distinguished between practical and reflective (or implicit and explicit) understanding. Late in the development of his own view, Velleman claimed that voluntary control of belief and action primarily involves "implicit" or "subdoxastic" (i.e. unreflective) awareness of belief and that the regulation of belief, desire and intention is performed by non-conscious mechanisms (Velleman 2000: 19–20, footnote 3 to page 245, 253). He didn't develop this claim in any detail.

If the monitoring and control view doesn't explain the value of reflective understanding, what does? Existing experiments suggest that reflective understanding may be necessary for certain kinds of planning and certain uses of testimony:

> *Planning:* in the 'no access' condition of (Robinson, Haigh and Pendle 2006 submitted: Experiment 2), children have to decide whether to feel or look at an object. Younger children's failure on this task (but not on a similar task in which they were first given uninformative access to an object) suggests that planning how to explore an object prior to having any experience of it might require reflective understanding.
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> *Evaluating testimony from multiple sources*: in the 'video' condition of (Robinson and Whitcombe 2003: Experiment 1), children see two adults, one who feels and one who sees the object; each adult says what they believe and the child is then asked what the object is. Younger children's failure on this task (but not on a similar task where children took on the role of one of the adults) suggests that although working understanding may be sufficient for them to use testimony about something they themselves have had perceptual experience of, it does not allow them to use testimony intelligently on the basis of knowledge about others' modes perceptual access when they haven't experience the object themselves. [Are some of Paul Harris' paradigms relevant?]

If reflective understanding is necessary for certain types of planning and using testimony, why? What is it about the working understanding that prevents it from being used in planning or evaluating testimony about things one has no direct experience of?

> *On planning*, (i) process explanation: planning which sense to use requires reasoning and working knowledge can't directly feature in practical reasoning, whereas practical reasoning is not required for switching from exploring with one sense to exploring with another (although planning it would be necessary if subjects had to decide which of two senses to switch to); (ii) content explanation: planning requires anticipating how things are independently of any immediate experience of them, which is impossible with working knowledge if we think of the content of working knowledge as 'causally indexical' (whatever exactly that means, see §5.5).

5.2 How are working and reflective understandings each acquired?

Is working understanding innate? Is it acquired gradually or does it emerge all at once? Sometimes working understanding is supposed to be acquired by "abstraction of situational regularities" (Robinson and Whitcombe 2003: 59 discussing Dienes and Perner 1999). This is perhaps conceivable if working understanding involves associating types of experience with types of knowledge (for example, knowledge of hardness with feeling, knowledge of where something is made with testimony).

Is reflective understanding acquired in something like the way scientific discoveries are made? Can its acquisition be facilitated by providing instruction or relevant experiences?

On how reflective understanding is acquired, we should ask about children's state prior to having reflective understanding. When asked how they know something is red or hard, do they entirely fail to understand the question or do they have an incorrect understanding of sensory modalities? (For example, in principle they might incorrectly suppose that seeing is the source of all knowledge.) Where children entirely fail to understand we might expect them to fail tasks which demand reflective knowledge by not answering or guessing rather than by systematically giving wrong answers. Since children appear reluctant to answer open-ended 'How do you know?' questions [*can't find refs], it seems plausible that in this case they do not have an initially incorrect view about the sources of knowledge. (By comparison, in the false belief case, children may progress from (i) giving systematically false answers to (ii) answering randomly to (iii) reliably answering correctly.[10])

5.3 How if at all does having working understanding facilitate the acquisition of reflective understanding?

How working and reflective understanding interact in development may well vary significantly from case to case (and there may well be no interaction in some cases).

Elizabeth Spelke offers one account of how core knowledge facilitates the development of adult cognitive capacities: we acquire new abilities 'by *assembling* in new ways the representations delivered by core systems' (Spelke 2000: 1233 my italics). For instance, Spelke argues that children have distinct two sets of core knowledge, one for small numbers of representing objects and another for representing approximate numerosity. She suggests that we acquire adult concepts of cardinal numbers by *assembling* representations from our core knowledge of approximate numerosity module with representations from a core system for representing concrete objects (Spelke 2000). Her general claim, based on these and other case studies, is that:

> 'The building blocks of all our complex representations are the representations that are constructed from individual core knowledge systems' (Spelke 2003: 307).

Of course, Spelke's position is schematic until we understand what assembling representations from different core systems involves. Spelke offers at least two explications. One is to understand assembling representations on the model of bringing together items of specialist knowledge from different domains, as happens for example when scientists discover ways of applying mathematics to describe physical phenomena. On this view, "conceptual change in childhood is the same sort

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[10] The mean performance of groups of children on standard false belief tasks goes from 80% incorrect at 30 months to 50% correct at 44 months (Wellman, Cross and Watson 2001: 662). On the face of it, this 50% mean performance could be due either to individual children performing at chance or to half the children giving consistently correct answers and half giving consistently incorrect answers. However, Wellman et al found a correlation between (a) individual children's consistency across tasks and (b) the absolute difference between a group's mean performance and chance. That is, groups whose mean performance is close to chance are more likely to contain individuals who perform inconsistently than groups whose mean performance is above or below chance (ibid.: 678). This indicates that individual children go from consistently failing Standard Tasks (at 30 months) to performing closer to chance at around 44 months.

of process as is conceptual change in the history of science" (Carey and Spelke 1994: 193; cf. Spelke 1999). A second way to explicate the notion of assembling representations from different systems of core knowledge involves language. Here the idea is that language serves as a general-purpose mechanism for combining representations, and assembling ideas means something like forming a phrase out of several words. Spelke illustrates this idea for the case of children discovering how to use both geometric and non-geometric cues in navigation: "Once they have learnt these terms ["left" and "blue"], the combinatorial machinery of natural language allows children to formulate and understand expressions such as *left of the blue wall* with no further learning" (Spelke 2003: 296).

I think this approach is intriguing but difficult to fully explicate because Spelke's notions of assembling both depend on the assumption that representations which constitute core knowledge (working understanding) can feature in reasoning and talking in just the same ways that ordinary knowledge (reflective understanding) does. To me it seems likely that working and reflective understanding are best thought of as involving distinct systems of representation which cannot directly interact.

There are various ideas about how there could be indirect interaction between distinct systems of representation. For example, Goldin-Meadow (2001) suggests the following interaction: working understanding of a strategy for solving a mathematical problem causes children to gesture; their gestures are then read by adults as a signal that they are ready to learn a particular strategy; the adults then teach children the strategy, which provides them with reflective knowledge of it. Here working understanding facilitates the acquisition of reflective understanding via input from other people.

Working understanding might also facilitate the acquisition of reflective understanding indirectly without involving other people: working understanding may influence what is experienced, what is attended to or what is salient and thereby contribute to the acquisition on reflective understanding. We can get a glimmer of how the details might go by looking at other cases. Mark Johnson and colleagues (1991; see Johnson 2005a: §5.2 for a summary) postulate two distinct but interacting mechanisms for face recognition. One of them, called CONSPEC, is a relatively simple mechanism that distinguishes faces from non-faces in an infants' normal environment, and particularly faces making direct eye contact with the infants. It uses crude heuristics which may involve, for example, discerning regions of high-contrast; accordingly, it is easily fooled by artificial stimuli with face-like configurations of elements.[11] CONSPEC's effects on behaviour are reflexes; it does not facilitate the smooth tracking of stimuli but rather results in the repeated orienting to a stimulus in the periphery of the infants' field of view that is characteristic of infants under two months (Morton and Johnson 1991: 169). CONLERN uses much more sophisticated techniques to identify faces; and it modulates instrumental behaviour and the smooth tracking of stimuli rather than reflexive orienting. Although CONSPEC is essential for the development of CONLERN, there is no direct representational link between them Rather, CONSPEC facilitates the development of CONLERN by ensuring that infants get lots of experience of faces; this experience is necessary for the

[11] See (de Haan, Humphreys and Johnson 2002: 203–4) for discussion of what CONSPEC discerns.

development of CONLERN which gradually becomes finely tuned to the particular characteristics of conspecifics over many months (for an example, see de Haan, Humphreys and Johnson 2002: 205). CONSPEC trains CONLERN by moving the eyes and head, not by providing it with information or filtering the inputs CONLEARN receives.

Of course, CONSPEC's capacities are more basic than those involving in working understanding of sensory modalities, but there might be something to the core idea that working understanding can facilitate the development of reflective understanding by influencing what is experienced. Gelman and Leslie (2001: 61) endorse (but do not develop) a related idea involving attention: "Specialized cognitive mechanisms can allow attention to go to specific properties or sets of properties. … For example, the 'Michotte module' allows young infants to attend to causes and effects, grounding the concept 'cause' without infants knowing anything about what causes really are … But once the child can selectively attend to the property in question, the child can have thoughts about that property, make observations about that property and, most importantly, can begin to learn things about that property." Again, this idea doesn't seem straightforwardly applicable to the case of understanding sensory modalities because it isn't easy to understand what working understanding could direct the attention to.

At a stretch, we might think that working understanding of sensory modalities somehow enables children to realise that different sensory modalities are associated with different types of knowledge (e.g. seeing with knowledge of colour). How might this be helpful if reflective understanding consists in being able to explain particular instances of knowledge as caused by particular types of experience or testimony, as in "I know it's red because I saw it"? First, knowing associations between sense and types of knowledge might help children to discover the correct explanations here. Second, knowledge of associations may be useful in getting children to realise that there is something to explain: someone who knew generalisations would be in a position to wonder why they obtain—why knowledge of colour is associated with seeing whereas feeling is associated with knowledge of hardness.

5.4 How are working and reflective understanding coordinated in solving particular problems?

Where two mechanisms can each influence behaviour, we might expect them to occasionally exert conflicting influences. For example, subjects reveal susceptibility to some visual illusions involving size, depth, motion and location in their explicit judgements but not in their undelayed jabbing or grasping actions (e.g. Bridgeman, Lewis, *et al.* 1979 demonstrate conditions under which subject's pointing behaviour is independent of whether they consciously detect the movement of stimuli; Haffenden and Goodale 1998 show that while subjects report seeing that the circles in the Titchner illusion are of different sizes, they adjust their grasp to their actual sizes when asked to grasp them). This discrepancy between judgement and jabbing or grasping is regarded as important evidence for a distinction between two independent representational systems in vision, the perceptual or cognitive and sensorimotor

systems.[12] Similarly, Tony Dickinson and Bernard Balleine argue that aversion and desire are distinct states which feature in independently operating process on the grounds that we can desire things we are averse to—in his paradigm case, a rat pushes a lever and approaches a bowl in order to obtain sugar solution only to experience an averse reaction on nearing the sugar solution which causes the rat to avoid it and never to pressing the lever again (Dickinson and Balleine 1993). This involves conflicting influences on behaviour in the sense that desire leads the rat to something the aversion repels it from.

Can we find any cases where working and reflective understanding exert conflicting influences? For example, if working understanding of sensory modalities involved rules associating modalities with types of knowledge, some of these rules might be incorrect from the point of view of the subject's reflective understanding—perhaps knowledge of textures is associated with vision in working understanding but is reflectively understood to be directly explained only by touch.

If it is possible for working and reflective understanding to exert conflicting influences on behaviour, how are they co-ordinated? What ensures that they will not constantly pull a subject in different directions?

One type of solution to the coordination problem is illustrated by Tony Dickinson (2000), who suggests that associative learning systems and reasoning sometimes work independently on the same problem. In his view, convergence is generated not by any direct interaction between the two systems, but rather thus: the associative learning system has effects on the body which are consciously experienced as positive or negative (aversion), and these experiences inform what we desire. In other words, it's experiencing the effects of our aversions as undesirable that keeps the associative and belief–desire systems coordinated by preventing us from desiring things we're averse to. (Of course, this does not explain how associative learning results in judgements about causation, nor how top-down effects on associative learning are possible. As far as I know, Dickinson has no explanation of these, which shows that explaining interactions is a hard problem.)

In the case of vision, Bridgeman (2002) suggests a somewhat similar solution to the coordination problem. Here the problem is particularly pressing because it must be possible for a subject to decide to act on a target identified by the cognitive system ("a sensorimotor system that could not receive specific instructions on which of many alternatives is relevant would be of little value"). Accordingly, it must be possible for the sensorimotor system to operate on a target identified by the cognitive system. Since the sensorimotor and cognitive mechanisms are thought to involve distinct representations (the former being egocentric, the latter not), there is no possibility of direct representational links between the two systems. Instead, Bridgeman suggests that "[a]ttention serves as a pathway for the cognitive system to motivate actions,

[12] Whether these apparent dissociations between behaviour and judgement really warrant postulating two distinct visual systems has recently been questioned and alternative explanations not involving two systems have been proposed for certain cases; see (Dassonville, Bridgeman, *et al.* 2004; Dassonville and Bala 2004) on the Roelofs effect. These findings do not undermine the point here, which is that if there is working and reflective understanding of sensory modalities then we might expect to find dissociations between behaviour and judgement.

which are then carried out under the guidance of sensorimotor information." This idea is not worked out in detail, but a gist of the idea can be obtained from the following presumably implausible version: the cognitive system represents several targets; the subject uses this system to decide to act on one of them and attends to its location; the sensorimotor system then somehow identifies the location attended to acts on whatever is at that location.

Finally, in the case of the face recognition mechanisms CONSPEC and CONLEARN mentioned above, Johnson and colleagues claim that both mechanisms are operative in adults and that normally developing infants become able to prevent CONSPEC from controlling their behaviour as they acquire greater executive control over their reflexes. The continuing presence of CONSPEC in adults is thought to explain residual face recognition skills in adults with blindsight and prosopagnosia (Johnson 2005b: 766–7, 771). Similarly, perhaps coordination of working and reflective understanding requires children to inhibit the effects of working understanding.

5.5 What are the contents of children's working and reflective understandings of sensory modalities?

Some theorists have elaborated distinctions according to which exactly the same understanding may be implicit (i.e. working) or explicit understanding (e.g. Dienes and Perner 1999). Others have supposed that the concepts involved in working understanding are more basic than those involved in reflective understanding, and that this difference in content contributes to explaining discrepant performance (e.g. Campbell 1992). To illustrate with a possibly implausible suggestion: younger children have a notion of experiential contact between a person and an object which is not differentiated by modality; they slowly learn that experiential contact does not always yield knowledge of an object, and observe that different types of action or body part are associated with success and failure without realising that these associations have any causal significance. Accordingly they don't understand the question "how do you know?" but they can predict in a limited range of cases when someone's experience provides knowledge of an object.

I think 'content' is a good question to start with. This is complicated because we may not fully understand the content of adults' conception of sensory modalities and their relation to other psychological states. It's also complicated because there's a fine line between postulating a working–reflective distinction part of which is a distinction between two types of content, and simply attempting to explain discrepant performance by postulating partial understanding (as e.g. Wellman and Lagattuta 2000 does in the case of false belief). Ideally it would be possible to start with some quite general respect in which younger children's thinking might be limited and deduce from this some respects in which their concepts of sensory modalities and knowledge are limited. John Campbell attempted to do this for space and time by characterising working concepts as 'causally indexical':

> "Often, one's grasp of the significance of … a judgement will be, in the first instance, a matter of how one reflectively expects the world to behave, and what counterfactuals one explicitly takes to be true In such cases, one's grasp of the judgement has to do with the detached picture one builds up of how things stand around one But there are cases in which one's grasp of the causal significance of a notion has to do not with any detached picture, but rather consists, in part, in

> one's practical grasp of its implications for one's own actions These are the causally indexical terms" (Campbell 1993: 82).

Campbell illustrates this distinction with 'heavy'. We could imagine an animal who could think of things as heavy or not only relative to its own capacity to lift them, so that it would be baffled if someone struggled to pick up something it didn't find heavy. This would be a causally indexical concept; the animal has no notion that things have masses independently of anyone's capacity to life them. Campbell also applies the distinction to thinking about space and time. [*Hemdat: have I got this right? Are there better ways to illustrate it?]

Can we use the notion of causally indexical concepts to characterise children's working understanding of sensory modalities? *ER: Contrasting the 'partial access' condition with the 'no access' condition, the only different is that subjects have uninformative access in one case. Why should this be helpful? Perhaps the notion that children lack a detached conception of sensory modalities will be helpful here: they have a problem thinking of perceptual access "not involving me". [*Can anyone elaborate on this?]

A complementary or alternative idea might be to characterise the content of working understanding as implicit knowledge of rules associating sensory modalities with types of knowledge (for example, seeing is associated with knowledge of colour). This would be one way of capturing the (possibly false?) idea that younger children do not think of the senses as causally explaining knowledge. By itself, this idea can't explain the contrast cases mentioned in §3, but then again explaining the contrast cases doesn't have to be done solely by appeal to differences in the contents of working and reflective understanding (e.g. differences in processes might also be relevant).

If working knowledge does involve rules associating types of experience with types of knowledge, then we might expect children to make systematic mistakes in determining how people know things by virtue of having slightly incorrect rules ('incorrect' in the sense that they do not always associate types of knowledge with the sensory modalities that provide direct knowledge of them; for example because they are insensitive to the distinction between inferring texture from the characteristic look of things and directly experiencing texture by feeling). Children may also have difficulty understanding that two people can find out about the same property in two different ways—for example, if all the hard ones are red, one person could see its redness while another could infer that it's red from feeling its hardness.

6. Compare & contrast with other working–reflective distinctions

Although elucidating working–reflective distinctions probably has to be done case by case, it might be useful to compare and contrast the case of understanding sensory modalities with other developmental cases. We might consider false belief, object permanence, and understanding gaze. [Any others?]

On understanding gaze, Martin Doherty (2005: 4) suggests there are three stages:

> Pre-18-months: "gaze following may be a conditioned response (Moore, 1999)"

18-months to 3–4 years: “infants represent a spatial relationship between object and viewer. The relationship is between the viewer and the first object in their line of sight, and can extend through apertures. … shortly before 18 months … children start to track gaze to the space behind them … (Butterworth and Jarrett, 1991).” They will also look around a barrier to see what an adult is looking at.

3–4 years plus: children can make explicit judgements about gaze, eye direction and whether someone is looking at them.

Doherty claims “The functional distinction between gaze following and gaze judgement suggests that two systems may be in operation. … [the] two systems might … involve one that is innate, fast and approximate, and another learned, more computationally difficult but more accurate. The learned system is probably the basis of gaze judgments, and begins to operate at 3 years” (Doherty 2005: 5–6).

Where theorists refer to implicit representations or core knowledge, we take these to be similar to our notion of working understanding at least much they are supposed to be what enables younger children to succeed on some tasks despite lacking adult understanding of the concepts involved.

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		3 or 3–4 years	4 or 4–5 years	5 years	source
1	[source] "How did you find out the bubblebath is strawberry bubble bathy" (805)	no	yes on lenient score		
2	[source] "Show me how you found out the bubble bath is strawberry bubble bath" (805)	no	yes		(O'Neill and Chong 2001)
3	"You show me what Mr Potato Head needs to use to find out what the toys are"	no	yes		
x cf. #4 ct. #y	children revise their judgements after testimony from a better-informed experimenter only when they are guessing (=the experimenter knows)	yes			(Robinson 2000)
y	Children see [or feel] and an experimenter feels [or sees], then children are asked "Who really knows?"	no	yes		(Robinson 2000)
4 ct #y	children revise their judgements after testimony from a better-informed experimenter, but not when both the child and experimenter are guessing	yes			(Robinson and Whitcombe 2003)
5 (ct #4)	Children correctly choose which of two adults' testimonies to believe on the basis of their information access (seeing vs. feeling)? [video task]	no	yes		(Robinson and Whitcombe 2003: Experiment 1)
6	"How do you know it's the red bug, because you saw/felt it or because I said so?" (conflates recall with source monitoring)	no	yes		(Robinson and Whitcombe 2003: Experiment 1)
7	[recall] "Did you see all of the strawberry/tomato or a bit of the strawberry/tomato?	yes	yes		(Robinson and Whitcombe 2003: Experiment 2)
8	[source] "How did you know it was a strawberry/tomato—was it because you saw it or I told you?"	no	no		(Robinson and Whitcombe 2003: Experiment 1)
9	Feel/see an object already seen/felt only when necessary to identify it? [partial access]	yes			(Robinson, Haigh and Pendle 2006 submitted: Experiment 1)
10 ct #9	Decide whether to it's necessary to see or feel an object before having any experience of it? [no access]	no	yes (harder than partial access)		(Robinson, Haigh and Pendle 2006 submitted: Experiment 2)
11 cf #8	"Did you know it was the hard one because you saw it or because you felt it?" [source]	no	yes		(Robinson, Haigh and Pendle 2006 submitted: Experiment 1)
12	Decide whether it's necessary to feel an object rather than to see more of it?	yes			(Robinson, Haigh and Pendle 2006 submitted: Experiment 3)