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Action monitoring: lower, higher and intermediate levels

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James Russell offers an insightful analysis of the role of agency and executive functioning in cognitive development. In particular, I am quite sympathetic to his view concerning the nature of R-negation and its crucial role in the development of a first-person experience of agency. I also agree with him that, although this experience of agency is necessary for normal mental development, certain types of representational abilities, including symbolic capacities, are also needed.

Russell devotes part of his paper to characterizing the kinds of action monitoring mechanisms that might underpin R-negation and showing how disruptions of these mechanisms could explain certain aspects of schizophrenia and certain core features of autism. I have some reservations about certain aspects of his analysis. In particular, Russell argues that executive difficulties in both autism and schizophrenia are likely to be due to impairments of action monitoring at 'a fairly high level'. I think there is room for some 'intermediate' level of action monitoring in between the higher and lower levels he distinguishes and that impairments at this intermediate level may play an important role in explaining some of the difficulties encountered by both schizophrenic patients and subjects with autism.

At the lower level of action monitoring Russell stresses the role played by efference copying mechanisms and by forward models. They make it possible for creatures to distinguish perceptual changes brought about by their own movements from those caused by environmental changes and they allow predictions to be made about the results of certain actions in advance of making them. The latter feature is necessary for actions to be minimally intentional. Yet, both those mechanisms operate at subpersonal levels and the representations they operate on (motor commands, predictions) are normally non-conscious. Thus, they are not enough to ensure that its actions be intentional *for the creature* itself. For this to be achieved, a higher level of action monitoring is needed. Here, Russell follows Frith's suggestion that higher-level intentions and thoughts expressed in inner speech are themselves efference-

copied and that the copies made are matched against results. Russell also accepts Frith's hypothesis that perturbations of these higher-level mechanisms of intention-monitoring may account for the fact that schizophrenics confuse their own and others' actions and he further suggests that the action monitoring difficulties in autism are also likely to involve the monitoring of high-level intentions.

Although I do not deny that both schizophrenic patients and subjects with autism may have difficulties keeping track of their intentions, I do not think this should be blamed primarily on a defective intention-monitoring system as characterized by Frith. So what alternative do I suggest? Let me briefly return to forward models and introduce the notion of intermediate action monitoring. Forward models, as described by Jeannerod (1997), are hierarchically organized sets of motor representations, with representations at the higher level encoding relatively global specifications concerning the action, and representations at lower levels encoding subactions in more detailed ways. Forward models also involve comparison mechanisms testing the degree of match between the desired and the current state of the system and operating in parallel at all levels of processing. Jeannerod also contends that, although the process of motor representation is largely non-conscious, the content of at least the higher levels of motor representations can be accessed consciously in certain conditions. These conditions include execution being accidentally blocked or delayed, as well as attention being voluntarily directed to those representations. My suggestion is that, by thus accessing certain aspects of their motor representations, agents are capable of some intermediate form of action monitoring. At this level, the comparison operates not between the high-level intention and the resulting action, but between certain aspects of a motor representation and the resulting action.

In the Daprati *et al.* (1997) study, where subjects were asked to judge whether what they saw on a TV screen while performing a simple hand movement was their

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own hand or an alien hand, schizophrenic patients were only specifically impaired in the condition where what they saw was an alien hand performing the same movement. If, as Russell contends, their problem was with higher-level intention monitoring, they should also have been impaired in discriminating their own hand from the alien hand performing a different action. In order to make the correct judgement in the difficult 'experiment-same' condition, the subjects had to pay attention to slight differences in timing and kinematic patterns between their internal motor representations and that perceived by perceptual channels. Since these fine-grained temporal and kinematic aspects of the actions are presumably not encoded in the content of high-level intentions, what is needed to succeed at the task and is, I suggest, impaired in schizophrenic patients is intermediate action monitoring, i.e. a capacity to appropriately shift the cognitive focus to internal motor representations.

Similarly, an appeal to intermediate action monitoring may help fill what otherwise appears to be a gap in Russell's account of the impairments of children with autism. Russell claims that, if children are to develop a theory of mind, it is necessary that they enjoy the right kind of pre-theoretical experience of their own mentality, where this involves being capable of intention monitoring. Intention monitoring is in turn said to depend on the development of symbolic functioning that enables the child to regulate his or her behaviour in terms of symbolically encoded goals. The latter ability is what, according to Russell, fails to develop in autism.

Now, even if we agree that the development of symbolic function cannot be the result of mere bootstrapping and thus posit an innate symbolic capacity that makes language-learning possible, we still need to solve the symbol-grounding problem. In order for representational contents to be attached to sounds, the representational contents have to be independently available. What is needed for the semantic anchoring of words having to do with actions and goals is the availability of motor representations (Pacherie, 1998). Lower-level action monitoring operates at subpersonal levels and will not provide the necessary anchors, whereas appealing to intention monitoring would make the account circular. So, what remains to do the trick is intermediate action monitoring that makes available at least part of the content of motor representations.

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