What is the Teleological Stance?

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The notion of a Teleological Stance (Csibra and Gergely 1998) has proved fruitful for explaining cognition of action in infancy. But what is this teleological stance? The teleological stance is involves some notion of a goal, and a principle of rationality or efficiency. Which notion of goal is needed to characterise the teleological stance and what is the principle of rationality or efficiency? How, furthermore, does the teleological stance relate to philosophers' accounts of teleological explanation?

As Gergely and Csibra conceive it, the teleological stance is a prototype of commonsense psychological explanation which differs just in that mental states are not involved, contra Csibra et al. I suggest that understanding the role of the teleological stance in both development and adult cognition of action may depend on conceiving of the teleological stance differently, as a mode of perception comparable to causal or phoneme perception. Just as phoneme perception provides us with the units of speech, so the teleological "stance" provides us with the object-directed behaviours that are the units of purposive action.

The Principle of Rationality or Efficiency

György Gergely, Gergely Csibra and colleagues describe a form of 'teleological explanation': an action is treated as being the most efficient or most rational way to realise a goal given the situation. By taking the action, goal and situation to be related in this way it is possible to make three kinds of prediction:

(1) given the goal and situation, one can infer the action (what is the most rational or efficient way to realise the goal in that situation?)

(2) given the situation and action, one can infer the goal (what would that action most efficiently achieve?)

(3) given the action and goal, one can infer the situation (in what situation would *that* be the most efficient or rational way to achieve the goal?)

What exactly is the principle linking actions, goals and situations in teleological explanation? Csibra and Gergely formulate this principle of "rationality" or "efficiency" in different ways. Here are two. In the first formulation, the key concept is justification:

> "the principle of rational action ... states that an action can be explained by a goal state if, and only if, it is seen as the most justifiable action towards that goal state that is available within the constraints of reality" (Csibra and Gergely 1998: 255; cf. Csibra, Bíró, *et al.* 2003)

In the second formulation, the they concept is energy:

> "The efficiency principle of goal attribution requires that agents expend the least possible amount of energy within their motor constraints to achieve a certain end." (Southgate, Johnson and Csibra 2008)

To take the teleological stance towards an action is to suppose that some such principle applies. The principle constrains which combinations of actions, situations and goals are possible. This is why taking the teleological stance licenses the above three kinds of prediction.

However formulated, the principle of rationality or efficiency has two notable features. First, it is non-causal: it does not require that the action happens *because* it brings the goal about. Second, it requires not just that the action be a way of bringing about the goal, but that it be a *most* rational or efficient way. These features distinguish Csibra and Gergely's notion of teleological explanation from philosophers' (as explained below).

This principle of rationality or efficiency is claimed to be the very principle that is involved in adult commonsense psychological explanation:

> "when taking the teleological stance one-year-olds apply the same inferential principle of rational action that drives everyday mentalistic reasoning about intentional actions in adults" (György Gergely and Csibra 2003; cf. Csibra, Bíró, *et al.* 2003; Csibra and Gergely 1998: 259)

Accordingly, the reasoning involved in taking the teleological stance is just like the reasoning involved in taking the intentional stance. The only difference is that when taking the intentional stance, one reasons in terms of situations or facts rather than beliefs and in terms of desires rather than goals (Csibra and Gergely 1998: 258). The teleological stance is a non-mentalistic counterpart of commonsense psychological reasoning.

We can distinguish two theses about the relation between infant and adult reasoning about agents and their actions. One thesis is that adults are like children in that their reasoning about agents involves constraints on the relations between situations, goals and actions. This is too weak a thesis to be controversial, for there is little possibility of reasoning

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about agents without any such constraints. A stronger thesis is implied in the claim that adults and infants "apply the same inferential principle of rational action" {Gergely, 2003 #1436}: the particular constraints which infants recognise also guide infants reasoning.

The teleological stance can be (and is) taken to non-agents (for example, boxes whether self-propelled Luo and Baillargeon 2005; or inanimate Csibra 2008).

The principle of rationality or efficiency has been given several applications, which can be classified according to what efficiency or rationality rules out:

* indirect route: it is established that one object's goal is to reach another; it follows that the object will take the shortest route providing there are no barriers (György Gergely, Nadasky, *et al.* 1995) or narrow gaps (Csibra, Bíró, *et al.* 2003).

* unnecessary steps: it is established that a hand's goal is to grasp an object in a box; it follows that the hand will not contact the lid of another box that does not contain this object (Woodward and Sommerville 2000)

* inconvenient movements: a head-press is used to turn on a light; if the hands were free, it follows that the goal must have involved using the head (Gyorgy Gergely, Bekkering and Kiraly 2002)

Empirical Applications
Commonsense-psychological explanation is claimed to be "computationally more costly" than teleological explanations because the former involve mental states such as beliefs (Csibra and Gergely 1998: 258; Csibra

2003: 452). This claim does not appear to have been tested.

Csibra and colleagues also argue that infants construct teleological explanations of behaviour from 9-months or earlier using habituation and violation-of-expectation paradigms. They show that infants engage in all three kinds of prediction mentioned above (Csibra, Bíró, *et al.* 2003; Csibra 2003). To illustrate (3), infants where habituated to a small ball approaching a large ball by arcing up; the area below its path was occluded as in (A) below. After habituation the screen was removed and infants then saw either no-obstacle or an obstacle. Those in the no-obstacle condition looked significantly longer than those in the obstacle condition, suggesting that they expected to find a barrier to explain the small ball's arcing path (Csibra 2003: Experiment 2, the illustration is p. 125 fig. 6).
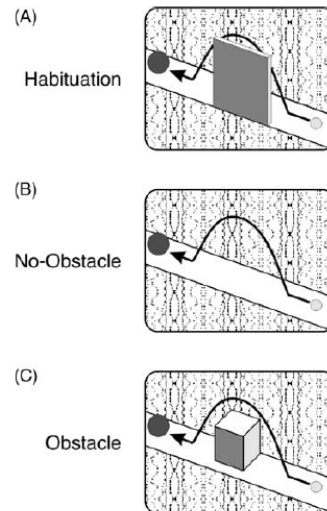
The teleological stance is further taken to precede and to ground the ability to explain actions by appeal to

mental states such as beliefs and desires (Csibra and Gergely 1998: 258).

There debate concerning what cues trigger infants to adopt the teleological stance. Some authors argue that the teleological stance is applied when objects are classified as self-propelled or "psychological" (e.g. Premack and Premack 1997a). Opposing this view, Gergely, Csibra and colleagues argue that no single cue is necessary and almost anything that could be a cue serves as a cue (Csibra and Gergely 2007; Southgate, Johnson and Csibra 2008; Csibra 2008). This leads them to the view that the teleological stance is taken whenever it is possible to take it:

"an action may be interpreted as goal-directed whenever it is judged to be an efficient means to achieve its end" (Southgate, Johnson and Csibra 2008).

This claim and the grounds for it resembles Liberman and Mattingly's view that stimuli are interpreted as speech whenever such an interpretation is possible—no more basic cues exist (Liberman and Mattingly 1985: 11).

What is efficiency?
The principle constitutive of teleological explanation hinges on the notion of efficiency (or rationality). But what constitutes efficiency? Some formulations suggest energy is key, but we might wonder whether minimising the time to goal or the use of limited cognitive resources (say by reliance on habitual routes rather than calculating an optimal route) could also count as efficient. In fact these authors seem to regard exactly what is meant by efficiency or rationality as an open question ("A number of different factors may

influence judgements of efficiency" (Southgate, Johnson and Csibra 2008)). Until we specifying what efficiency amounts to we have not specified the relation between goal, action and situation that is characteristic of teleological explanation.

This has important empirical consequences. Take this movement from the first study (György Gergely, Nadasky, *et al.* 1995: 175 fig. 2b):
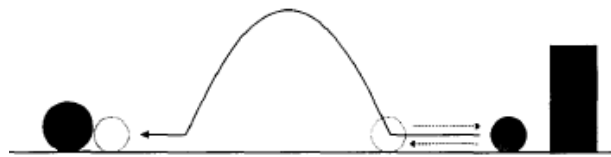

Is this an efficient or rational movement? Clearly the small ball is not taking the *shortest* route, but hopping rather than rolling may require *less energy* or *mental effort* from the ball. What is more efficient or more rational? Answering this question post hoc runs the risk of making it difficult to falsify the thesis that subjects reason teleologically.

Premack and Premack hint that we should recast the principle of rationality in terms of motor competence:

> "Taking the shortest path in the pursuit of a target, like not turning left when a target turns right, is evidence, not for rationality, but for motor competence" (Premack and Premack 1997b)

One finding appears to count against this proposal. This concerned two ways of reaching an object (Southgate, Johnson and Csibra 2008: 1062 fig1c-d):
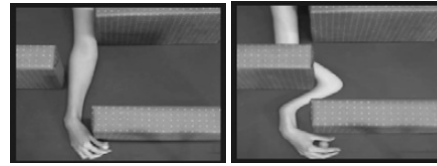
The left reach involves first moving a barrier and then reaching to the object; the right reach involves a biomechanically impossible snaking movement to get around the barrier. Southgate and colleagues argue that the right reach is more efficient. Indeed, they show that infants discriminate between the reaches illustrated in the left and right pictures much as they discriminate between an object's taking circuitous and direct routes to its target. They take this to show that infants' principle of efficiency does not take into account even the most basic biomechanical constraints. If this is correct, it would be surprising if they were thinking of efficiency of action in terms of motor competence. The problem with this interpretation is that, by their own admission (Southgate, Johnson and Csibra 2008), Csibra and colleagues did not specify a principle efficiency or rationality that would predict this effect. In the absence of independent grounds for thinking infants' looking times in this experiment are a function just of their expectations about how arms will reach objects, it is not obvious that the authors' interpretation is correct.

Contrast with Philosophers
How does Csibra and Gergely's notion of teleological explanation compare to philosophers' notions? Philosophers define teleological behaviour in terms of aetiology:

> "Teleological behavior is not *simply* appropriate behavior: it is appropriate behavior *with a certain etiology*. Establishing the etiology is what is central to the teleological characterization" (Wright 1976: 52)

Aetiology are missing entirely from Csibra and Gergely's notion of teleological explanation. This is probably because they take for granted the existence of the goal; it is no part of their project to say what it is for the agent's action to have a goal. By contrast, philosophers *are* concerned with this. Consider:

> Atta ants cut leaves in order to fertilize their fungus crops (not to thatch the entrances to their homes) (Schultz 1999)

What does it mean to say that the ants' grass cutting has this goal rather than some other? According to Wright:

> "S does B for the sake of G iff: (i) B tends to bring about G; (ii) B occurs because (i.e. is brought about by the fact that) it tends to bring about G." (Wright 1976: 39)

For instance:

> The Atta ant cuts leaves in order to fertilize iff: (i) cutting leaves tends to bring about fertilizing; (ii) cutting leaves occurs because it tends to bring about fertilizing.

This has counterfactual consequences:

> If S's situation had differed such that B did not tend to bring about G, then B would not have occurred.

In the simplest cases, (ii) is made true by history. In the past, behaviour like B occurred and brought about G. This B-like behaviour was then reproduced because it brought about G on that past occasion.

This historical circumstance is one way of fulfilling (ii). Alternatively, (ii) can be fulfilled by an agent's recognition that B would bring G about.

In sum, the philosophers' notion of teleological explanation differs from Csibra and Gergely's in two respects: (a) it does not require that S perform a most rational or most efficient action that could result in G; (b) it does require that B occurs because it tends to bring about G.

The first difference, (a), means that the philosophers' notion does not presuppose an account of rationality or efficiency. This difference, (a), will also give the philosopher's notion greater generality, if things don't invariably happen in a most rational or efficient way. The second difference, (b), renders the philosophers' notion more demanding: it makes teleological explanation a form of causal explanation. By contrast, Csibra and Gergely's notion is non-causal, requiring only that action, situation and goal fit together. If our aim is to understand infant cognition, these differences may be advantageous: it is more plausible to explain infants' abilities in terms of a less general, non-causal form of explanation. (These differences do however undermine the claim that the principle of rationality involved in infant "teleological reasoning" is the same principle involved in adult commonsense psychological explanation.)

That the difference exists is no criticism of either party; the point of considering these differences and their consequences is only that it may bear on some of the claims made about the teleological stance and its relation to adult reasoning about agents and their actions.

What has the goal?

A goal can considered to be had by either *the action* or *the actor*. It seems consistent with the evidence surveyed so far to suppose the goal is taken to be feature of the action: it is analogous to the notion of a function (Wright 1976; Millikan 1984). Indeed, we need not suppose that there is an actor at all. The results show that infants' parse a range of actions not in terms only of superficial motion properties but also in terms of their objects.

Supposing that the actor has the goal would introduce additional elements: the actor itself, its relation to the action (it *performs* the action), and the possibility that this actor would have acted differently in another situation. Unless there is sensitivity to properties of the actor as influencing the action performed, introducing an actor would appear unwarranted. [GYORGY'S TALK & DISCUSSION AFTER GIVES SOME EVIDENCE NOT SURVEYED THAT ALTERS THE PICTURE]

Whether the teleological stance involves a notion of goal which is a property of actions or of agents has consequences for how the principle of rationality or efficiency could be formulated and for the relation of this teleological reasoning to later commonsense psychology.

What is a goal?
Adult commonsense psychology regards agents as having intentions with propositional content, so that (for example) one can act on the intention to smile at every unarmed person one meets today. Arguably the capacities of infants to apply the teleological stance does not enable them to think of agents as acting on intentions, or at least not intentions of this complexity. But how are infants' capacities simpler—

what determines the range of recognizable goals? Little evidence so far collected bears on this question. One possibility is that the activities infants recognize involve a single object (or location?), and that they are basic activities such as approaching, pushing and reaching—these activities are basic in the sense that they are not naturally thought of as having parts which are means to ends. Following Phillips and Wellman we could label them object-directed behaviors (Phillips and Wellman 2005). This raises two questions: what kind of thing can the behaviors infants track be directed to? And what kinds of behaviors can they distinguish?

Cognitive Efficiency
Is reasoning not involving mental states computationally less demanding than reasoning which does? Not obviously. It is difficult to measure how computationally demanding a form of reasoning is likely to be. Certainly it is possible in principle for conceptual sophistication to reduce rather than increase computational demands. For example, using causal features to classify stimuli may reduce the number of different categories and conditions that need to be tracked compared to using superficial features only. And several efficient cognitive processes operative in infancy involve computations over unobservables; these unobservables include intended phonic gestures in speech perception (Liberman and Mattingly 1985; Liberman and Whalen 2000; Jusczyk 1995) and causal relations (Oakes and Cohen 1990; Saxe and Carey 2006). This indicates that conceptual complexity does not straightforwardly result in unmanageable computational demands.

There is an alternative possible source of cognitive efficiency that Csibra and colleagues do not mention.

The principle of rationality involved in adult commonsense psychological explanation is as complex as the concept of good evidence: whether a set of beliefs and desires justify an action is a question comparable in difficult to whether a body of evidence supports a theory. This sort of question arguably requires general reasoning and scarce cognitive resources such as inhibition, working memory and attention. Accordingly, cognitive efficiency relative to adults' commonsense ways of thinking about agents and their actions could be achieved if, contrary to the view of Csibra and colleagues, the "principle of rationality" required for infants' teleological stance were radically simpler than the principle of rationality involved in adult commonsense psychological explanation. For example, that principle might be framed in terms of factors such as the routes to a goal, the number of steps required and the awkwardness of the movements required to reach it.

Relation to commonsense psychological explanation

Is infants' rationality or efficiency principle the same as that involved in adult commonsense psychology? Csibra and colleagues suggest the difference between the teleological and intentional stances is just that facts become beliefs and goals become desires (Csibra and Gergely 1998; György Gergely and Csibra 2003):

(Csibra 2003: 452 fig 7)
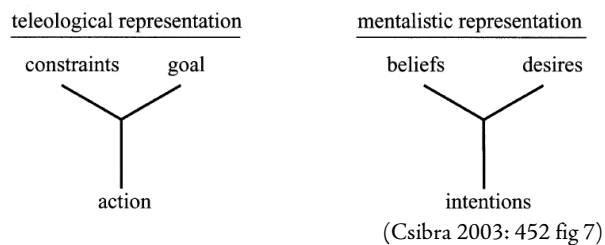
I reject this proposal for three reasons. First, as suggested above, the teleological stance does not require actors whereas desires and beliefs do (they are properties of actors, whereas one kind of goal can be understood as a property of an action); the rationality principle of adult commonsense psychology concerns actors so cannot be the same as that required for the teleological stance. Second, adult commonsense psychology does not appear to require that people act in most efficient ways. Third, adult commonsense psychology involves justificatory relations among propositions: the principle is that the action must be rational in light of the beliefs and desires that cause it, whatever they are. For example, the belief that it is better to remain quiet and be thought a fool than open one's mouth and remove all doubt together with the desire not to be known as a fool would justify one in keeping quiet. Whichever principle of rationality or efficiency constitutes infant teleological reasoning, it seems unlikely that it needs to be a principle about justificatory relations among propositions. Given the current evidence, a principle concerning the possible ways of performing a simple reach, push or grasp would be sufficient: and such a principle could be formulated in terms of mechanical rather than propositional relations.

Revisionary Proposal

Dare Baldwin conjectures that one part of our ability to reason about intentional action may involve sensitivity to "sequencing and temporal dynamics of bodily motion that are probably unique to intentional action, and that correlate with the initiation and completion of intentional acts" (D. A. Baldwin and Baird 2001). She proposes that just as language learning and production is facilitated by statistical learning of phonotactic and other structural features of speech, so also reasoning about action may be facilitated by statistical learning of structural features of movements which are intentional. In developing these conjectures she has demonstrated statistical learning of sequences of action components comparable to simple phonotactic rules in adults (D. Baldwin, Andersson, et al. 2008) and 9-month-old infants (Saylor, Baldwin, et al. 2007).

It is possible to interpret the present research on the teleological stance in this light, as providing the basic units of action perception—the analogues of phonemes in linguistic activity. Just as the units of speech perception are not acoustic chunks but intended phonic gestures (Liberman and Mattingly 1985), so the units of action perception are not mere sequences of movement (Zacks 2004) but behaviors with functions.

Understood in this way, the teleological stance is not continuous with later-developing false-belief reasoning (at around 13-16 months), which requires actors as bearers of desires and beliefs (or desire- and belief-like states) as well as actions. However, it does provide a developmental ground for that later development. And, more importantly, it provides the perceptual basis for adults' as well as infants' understanding of intentional action.

The present proposal is related to David Premack's hypothesis that infants' understanding of intention is comparable to the understanding of causal interactions as shown by Michotte's launching stimuli (Premack 1990; see also Premack and Premack 1997a). Since I argued elsewhere that causal perception is best understood on the model of phoneme perception (Butterfill 2008 forthcoming), I would claim, further, that Baldwin and Premack offer

two perspectives on the same proposal. However, the present proposal differs from Premack's on some points of detail.

Premack claims perceiving action involves representing intention: "in perceiving one object as having the intention of affecting another, the infant attributes to the object a representation of its intentions" (Premack 1990: 14). I reject this interpretation: first because there is no actor so no potential subject of representations; and second, because the action is partly constituted by its goal in roughly the way that natural processes can have functions, so that it is no more necessary to invoke representations of goals here than in the case of the ants cutting leaves in order to fertilize fungus.

Premack also suggests that patterns of movement trigger perceptions of intention: "What counts for the infant … is not the identity of the object but the kind of motion in which the object engages" (Premack 1990: 12). Here Premack intends to follow Michotte. The claim may be true if "motion" is understood in very broad terms. In the case of speech, there is no straightforward mapping from acoustic properties to phonemes. Similarly, in the causal case, there is no straightforward mapping from motion properties to causal perception because whether an interaction is perceived depends on many interacting factors which include contextual factors. And although this area has been little studied so far, the same may be true of the perception of goal-directed action: what is perceived depends on a complex set of cues involving significant context (e.g. Zacks 2004).

Conclusion

Our understanding of intentional action and its development is grounded in the perception of goal-directed action. This involves a weak notion of 'goal' which is a property of the action itself, not the actor (who need not be perceived at all): the action is seen as having an end or function. We perceive such goal-directed action in roughly the sense that we perceive phonemes and causal interactions. Such perception is not a cut-down form of adult commonsense psychological reasoning; it is the perceptual identification of the basic units in terms of which such explanations can be constructed. Just as phoneme and causal perception provide the building blocks for cognition of speech and objects, so too might the perception of goal-directed action provide building blocks for theory of mind reasoning.

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