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ARTICLE COMMENTARY

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Varieties of instrumental theories of emotional action: commentary on "a perceptual control theory of emotional action"

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ABSTRACT

Eder proposes a theory of action causation based on Powers' control theory and Hommel's theory of event coding in which emotional feelings play a crucial role. After presenting a rough description of Eder's theory in which I try to spell out the various steps in the control cycle, I compare his theory to my own goal-directed theory. The two theories converge in that they (a) rely on a control cycle in which different states are compared and (b) emphasise the instrumental or goal-directed nature of emotional actions. Points of divergence include the content of the representations involved in the control cycle and the meaning and role of feelings.

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Eder (this issue) addresses the question of what the evolutionary function might be of "emotional feelings", largely understood as positive or negative affect. His answer is that emotional feelings play a role in action causation. He introduces a theory of action causation that combines Powers' (1973) perceptual control theory (PCT) of action with elements of Hommel et al.'s (2001) theory of event coding (TEC) and a revised version of the ideomotor hypothesis (Kunde et al., 2017), incorporating affect. For ease of communication, I will call Eder's (this issue) theory the affective PCT (aPCT).

In this commentary, I will take the opportunity to compare the aPCT with my own goal-directed theory (GDT) of action causation – emotional or otherwise (Moors, 2017a, 2017b, 2022; Moors et al., 2017; Moors & Boddez, 2017). By undertaking this comparative analysis, I hope to contribute to a better understanding of the evolving landscape of emotion theory. Such an endeavour holds the potential to generate future targets for empirical research.

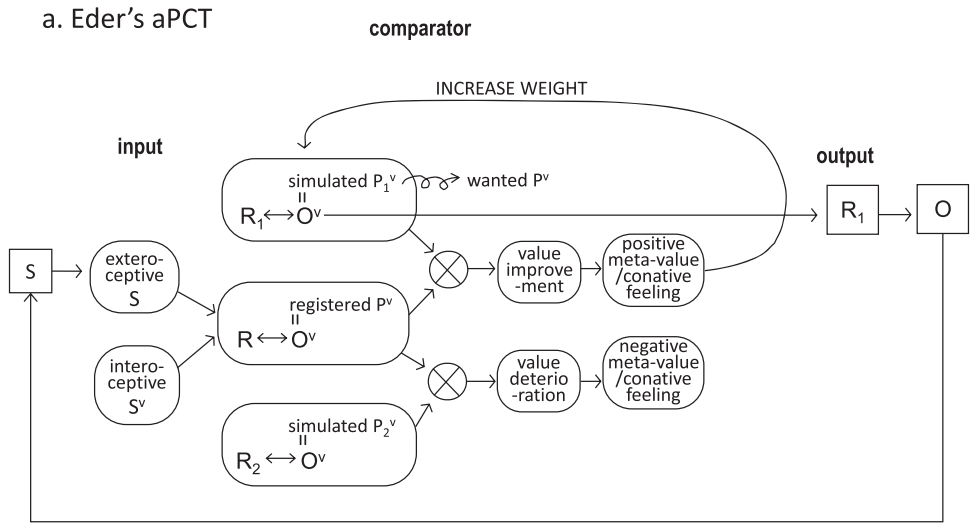
I start with a concise description of *my own interpretation* of the aPCT. I felt that Eder (this issue) presented us with pieces of a puzzle without fully completing it. The description reflects my attempt at completing it. For this, I rely on Eder's (this issue) target paper as well as on personal communication with him (15 June 2023). Following this, I provide a brief outline of my own GDT. Finally, I examine the points of convergence and divergence between the aPCT and the GDT.

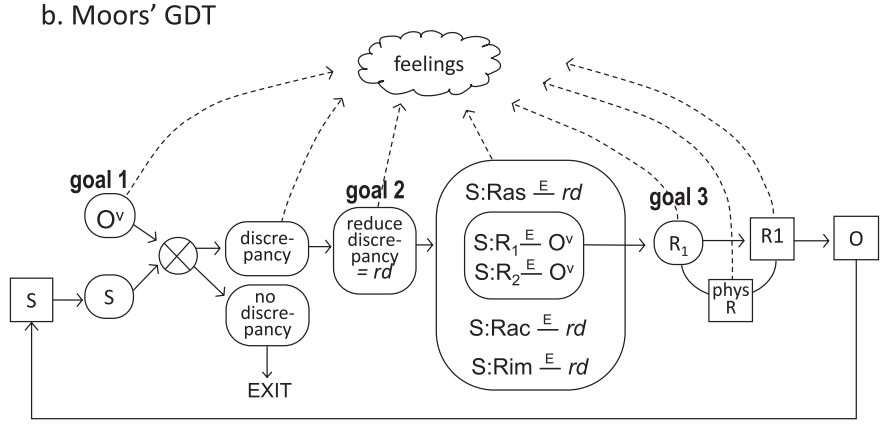
Eder's aPCT

The aPCT proposes that actions are generated in a cycle comprised of three steps: an input step, a comparator step, and an output step. After this, negative feedback from the output to the input closes the loop (see Figure 1(a)).

In the input step, a stimulus (object, event) generates or activates the representation of this stimulus, known as the exteroceptive signal. This is integrated with the representation of bodily changes, known as the interoceptive signal or "raw feelings". The output of the integration process is the representation of a current state, called the current or *registered perception*. While the theory refrains from taking a specific stance on the mechanism that generates the interoceptive signal, it does emphasise that this signal carries an intrinsic value (positive or negative) that is felt. Furthermore, this value is also conferred to the entire registered perception.

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Rectangular boxes stand for observable entities
Rounded boxes stand for mental entities = representations
Clouds stand for conscious representations

⊗ = comparison operation
O = outcome
O^v = outcome with value v = desired state
E = expectancy that an action leads to a certain outcome
S = stimulus = current or anticipated state
P = perception
P^V = perception with felt value

R_1 = action 1, R_2 = action 2
R_{as} = strategy of assimilation
R_{ac} = strategy of accommodation
R_{im} = strategy of immunization
phys R = physiological responses

Figure 1. Schematic presentation of Eder's [a]PCT and Moors's GDT.
Note: [b]Adapted from Moors (2022).

In the comparator step, the registered perception is compared to several *simulated perceptions*. A simulated perception is the representation of a future possible state of the world. Just like the registered perception, each simulated perception results from the integration of exteroceptive and interoceptive signals and the interoceptive signal endows the simulated perception with a felt value. The comparison of

the registered perception with each of the simulated perceptions produces a difference signal. A difference signal codes for whether the transition from the registered to the simulated perception would lead to an improvement, a status quo, or a deterioration in felt values. The felt value change resulting from this comparison is a felt meta-value, also called a conative feeling. Simulated perceptions that constitute an improvement relative to the current perception receive a positive meta-value, those that constitute a status quo a neutral one, and those that constitute a deterioration a negative one. Positive meta-values act as weights that increase the activation level of a given simulated perception relative to those with a neutral or negative meta-value. The simulated perception with the highest activation level comes out as the *wanted perception*.

The output step, finally, is concerned with action execution. Based on the hypothesis of embodied cognition (Barsalou, 1999), each of the above-mentioned simulated perceptions not only represents a possible future state, but also the action that produced this state in the past. These two parts are bounded up in bi-directional links so that activation of the representation of the future state can spread to the representation of the action (or the other way around). This idea is also central to the ideomotor hypothesis that thinking of the effects of an action triggers the motor command required for execution of the action (James, 1890; Jeannerod, 2006). The actual execution takes place when activation of the motor command exceeds a certain release threshold. Given that the wanted perception is the perception with the highest level of activation, the action representation or motor command that is part of this wanted perception will be activated because it is most likely to reach the release threshold first. Although this release threshold can be modified at will, once it is reached, action execution is entirely ballistic (i.e. runs to completion without intention).

According to Eder (this issue), the actions caused by this mechanism qualify as instrumental actions. This is because the actions that get executed are those for which the organism learned in the past that they had a high expectancy of leading to outcomes with positive felt values (see Heyes & Dickinson, 1990).

Furthermore, Eder (this issue) argued that his mechanism for action causation is responsible for both emotional and non-emotional actions. This implies that emotional actions also qualify as instrumental actions. Nevertheless, Eder (this issue) does mark a difference between the two types of action in terms of their *mode of operation*, based on the idea that the weighting of simulated perceptions can be done by different factors. In the case of emotional actions (e.g. fleeing from a dangerous dog), the weighting is done by meta-values or conative feelings (as described above); in the case of non-emotional actions (e.g. typing in a left or right key in an experiment), the weighting is done via endogenous intentions. This being said, Eder (this issue) does speculate that endogenous intentions ultimately rely on conative feelings, thereby blurring the distinction somewhat.

Eder's (this issue) theoretical proposal is a commendable attempt to construct a theory of action causation and the role of feelings therein built on insights from the action domain.

Problems raised in this domain are high on the agenda (e.g. the degrees of freedom problem, the perceptual-motor integration problem, and the control precedence problem) and the solutions provided in this domain were readily incorporated. However, Eder's (this issue) attention to implementation details seems to also come at a cost. Although several ingredients of the theory were presented in great detail, I struggled to properly connect them. The personal communication certainly helped in this regard. Another, related problem is the fact that several gaps remain in the theory, as also acknowledged by Eder (this issue) himself. Although I believe it is entirely permissible to present a sketch of a high-level mechanism in which low-level implementation details are left out and postponed until a later stage (Piccinini & Craver, 2011), this is less forgivable when the gaps concern essential steps in the high-level mechanism itself. Thus, while it is acceptable to put the bones in place and add the flesh later, it is less helpful to leave out some of the bones. A first gap is that Eder (this issue) leaves open how the interoceptive signal acquires its intrinsically felt value. A second gap is that he states that goals, needs, or concerns influence the comparison process between registered and simulated perceptions, but he does not specify how. To fill in these gaps, he refers the reader to existing emotion theories such as embodiment theories (Craig, 2015), psychological constructionist theories (e.g. Barrett & Russell, 2014), and appraisal theories (e.g. Scherer, 2009). But by handing these parts over to other

theories, the ultimate, complete theory risks losing parsimony.

I believe my own GDT of emotional and non-emotional action causation (Moors, 2022; Moors et al., 2017) is able to fill in the second gap while maintaining parsimony. Although the theory shares some of the conclusions drawn by Eder (this issue), it also shows notable differences.

Moors's GDT

The GDT (for an extensive description, see Moors, 2022; Figure 1(b)) proposes that actions are generated in a cycle starting with the comparison between the representation of a stimulus (i.e. a current or anticipated state) and a first goal (i.e. the representation of a desired state or valued outcome). Once a discrepancy is detected, the organism activates a second goal to reduce this discrepancy. This can be done by acting (i.e. assimilation), by replacing the first goal with a different goal (i.e. accommodation), or by reinterpreting the stimulus (i.e. immunisation; see also Rothermund & Brandstädter, 2003). If the first strategy is chosen, the organism still has to select a specific action based on a comparison of the expected utilities of the action options in the organism's action repertoire. The expected utility of an action is the product of the values of the outcomes of that action and the expectancy that these outcomes will indeed follow from the action. The action option with the highest expected utility activates its corresponding action tendency, which can be considered as a third goal. Once the action tendency is implemented in overt behaviour, an outcome is produced. This outcome is fed back as the input to the next cycle. The cycle is repeated until the discrepancy is effectively reduced or until another stimulus-goal discrepancy claims priority. To illustrate, imagine a researcher who has the goal of being successful at work (first goal), but falls short of important funding (stimulus). Then they can reduce the discrepancy via assimilation, which means that they choose to take action, for instance, rework the project and resubmit next year or try another fund. Accommodation means that they give up their goal of being successful at work and decide to focus on other goals. Immunisation means that they no longer see failure to obtain funding as a sign of lack of success at work, but as the result of a corrupt funding system.

Two types of complexity must be added. First, organisms strive to fulfil many goals, some of which may be in competition. Second, the goal-directed cycle is part of a hierarchy of cycles: The first goal in the cycle can be considered as a subordinate goal that was itself selected because it was evaluated as the most effective for reaching a superordinate goal. Conversely, the third goal in the cycle is still discrepant with the current stimulus and hence requires the selection of even more subordinate action goals or concrete action programmes before an action can be executed.

In the GDT, all steps in the cycle can in principle operate below the surface of awareness, but when they do reach awareness (or aspects of them), they are felt. For instance, the (actual or anticipated) presence of a discrepancy gives rise to negative affect; the (actual or anticipated) absence or resolution of a discrepancy gives rise to positive affect (Moors et al., 2021). Other steps in the cycle can be felt too, such as the urge to reduce the discrepancy using a specific action, the mobilisation of the body in the form of an adrenaline rush, and overt behaviour. Mental representations (rounded boxes in Figure 1) become conscious when activation reaches a certain threshold; non-mental entities (rectangular boxes in Figure 1) need to be represented first before they can become conscious. Thus, in the GDT, feelings refer to nothing else but the content of awareness at any given moment in time. Feelings can be labelled as "emotional" or "neutral" or using specific emotion labels such as "anger" or "fear", but they can also remain unlabelled.

Similarities and differences between the aPCT and the GDT

Comparator and types of feelings

Both the GDT and the aPCT are cybernetic or control theories with a comparator step and a negative feedback loop, following the example of Powers (1973). Yet the nature of this comparison process differs between the two theories and so do the resulting feelings. In the GDT, the elements to be compared are a goal (desired state or valued outcome) and a stimulus (actual or anticipated state). This comparison gives rise to first-order feelings: The presence of a discrepancy leads to negative feelings and the absence or resolution of a discrepancy to positive ones. In the aPCT, the elements to be compared are felt values

from the registered perception and felt values of a series of simulated perceptions. These comparisons give rise to second-order feelings: The improvement in feelings in the transition from registered to simulated perceptions leads to positive feelings and the deterioration in this transition to negative ones.

As mentioned, the aPCT dodges the issue of how the first-order feelings are caused and it does not explain how goals, concerns, or needs influence them. The GDT, on the other hand, can also account for second-order feelings. In the GDT, first-order feelings are generated by the (actual or anticipated) presence and absence of a discrepancy with some goal (e.g. autonomy, safety, competence, connectedness). Once an organism has experienced first-order feelings, it can form the hedonic goal to maximise positive first-order feelings. If a stimulus is discrepant or consistent with this hedonic goal, negative or positive second-order feelings may arise. Another noteworthy implication of the different comparison processes at the heart of the two theories is that they reveal distinct perspectives on the starting point of an action episode. In the GDT, the starting point is a first goal or wanted state. This goal can be set or chosen by an organism, but it can also be a chronic, dormant goal, activated by a stimulus in the environment. In the aPCT, on the other hand, the starting point is a set of simulations about possible future states, which only after being compared with a current state, generate a wanted state. Based on this, it could be argued that the perspective taken in the GDT is more proactive than that in the aPCT.

Role of feelings in action causation

In the GDT, feelings emerge from the various steps in the cycle and are not strictly necessary for the cycle to run to completion. A first threshold of activation is required for a representation to be processed unconsciously and pass its activation on to the next steps in the cycle. A second threshold of activation is required for the content of a representation to become conscious (see Moors, 2016). In the aPCT, on the other hand, feelings are necessary for the cycle to run to completion.

Several elements in the description of the aPCT, however, suggest that this apparent difference between the two theories might be a pseudo-difference stemming from Eder's (this issue) broad and rather unconventional usage of the term "feelings". He does not limit feelings to conscious experience, but also leaves room for unconscious feelings.[1] Some confusion arises, however, when he aligns the dichotomy between unconscious and conscious feelings with the distinction between first-order and second-order experience (Lambie & Marcel, 2002), which are typically understood as two varieties or levels of consciousness (see also Block, 1995).

I suspect that part of Eder's (this issue) motivation to accept unconscious feelings has to do with the fact that he aligns feelings with the introspection of bodily responses (see also Damasio, 1999). Introspection is a form of perception, and there is consensus that perception can be unconscious (as is supported by subliminal priming effects and changes in neural patterns with subliminal stimulation). Perception can be understood as the activation (or creation) of a representation, which can remain unconscious (yet causally efficacious) or become conscious.

Now, if we reject the notion of unconscious feelings, the difference between the aPCT and the GDT regarding the necessity of feelings seems to melt away. Indeed, Eder (this issue) first argues that feelings are necessary for action control, and then that feelings need not be conscious. For theorists who do not accept the notion of unconscious feelings, the proposal can be reformulated as follows: Feelings understood as conscious representations of value are not necessary for action control because unconscious representations of value can already be causally efficacious. This is compatible with the idea in the GDT that action causation requires the processing of values.

While Eder (this issue) advocates a broad usage of "feelings" by including "unconscious feelings", he advocates a narrow usage of "emotional feelings" by restricting them to "bodily feelings". With this alignment, Eder (this issue) places himself in the company of several philosophers who believe that emotional feelings are "best captured in terms of bodily feelings" (Deonna & Teroni, 2012, p. 79; Prinz, 2004). The GDT, on the other hand, rejects the fixed tie between feelings and the body, proposing instead that the "heat" typically attributed to emotional feelings stems from the frustration or satisfaction of goals rather than from the body per se (see Moors, 2022, p. 46, p. 206; see also Scherer & Fontaine, 2019). Since goals are understood as representations of valued outcomes, the fate of these goals should have value too. By adopting this view, I place myself in the company of other philosophers who have

argued that mental entities such as images and even abstract thoughts can also be felt, thus arguing for the existence of "real mental feelings" (Block, 1995; Helm, 2009; Mason & Capitanio, 2012; Oyama, 2000).

Instrumental actions and flexibility

The actions generated in the GDT qualify as instrumental because action selection is undergirded by a goal-directed process in which the values and expectancies of the outcomes of action options are activated and/or weighed up (Heyes & Dickinson, 1990). This is another commonality that the GDT has with the aPCT. In taking this position, both theories can be contrasted with most traditional emotion theories, which hold that emotional actions are initiated by stimulus-driven or appraisal-driven processes and that goal-directed processes only enter in the planning of concrete actions following on the initial, emotional action tendency or in emotion regulation (see Moors, 2022).

Speaking of goal-directed processes, I wish to guard against the overinclusive use of the term. An action tendency is the goal to engage in an action, but it is not a goal-directed process. Such a process involves the computation or activation of one or more action options for one or more valued outcomes (Heyes & Dickinson, 1990). Crucially, these valued outcomes are remote outcomes that are not already part of the definition of the action itself. Thus, if the action of fighting is caused by the tendency to fight (i.e. the goal to fight), it does not yet qualify as an instrumental action caused by a goal-directed process. For this, the tendency to fight should have been caused by a process in which the expectancy of fighting for reaching a remote valued outcome, such as harming another person or showing dominance, was evaluated as being high.[2]

In the GDT, the values and expectancies of outcomes will often be based on previous learning, but they can also be computed on the spot (Moors, 2022; Moors et al., 2017). The flexibility that comes with computation does not seem to be (explicitly) present in the aPCT, where simulated perceptions only contain previously learned action-outcome links.

Emotional vs. non-emotional actions

In the GDT, the goal-directed cycle is considered as the mechanism underlying all kinds of actions, whether they are taken to be emotional or non-emotional. Unlike the aPCT, the GDT does not assume that these two types of actions involve different modes of operation. Instead, the GDT explains the difference between them entirely in terms of the value of the first goal in the cycle. This value is higher in so-called emotional than in so-called non-emotional action cycles. Compare the actions that arise when a baby vs. a pen slips through one's hands. The former action is considered to be more emotional than the latter because the goal to keep the baby safe has a higher value than the goal to hold on to the pen. As a result of this difference in value, the remaining steps in the cycle will be more urgent and vigorous. The goal to reduce the discrepancy will be more urgent and so will the action tendency that is selected to do so. This also entails the more acute mobilisation of physiological responses to prepare and support action execution. Here lies the solution that the GDT proposes for the "control precedence issue" raised by Eder (this issue). It is because the goals in so-called emotional episodes have a higher value than those in so-called nonemotional ones that the former take priority over the latter.

Conclusion

The GDT and the aPCT converge in that they rely on a control cycle with a comparator step and negative feedback loop and that they emphasise the instrumental or goal-directed nature of emotional actions. They differ in the content of the representations included in the comparator step (desired and current/anticipated states in the GDT; simulated and current states in the aPCT), the types of feelings they account for (first-order feelings in the GDT; second-order feelings in the aPCT), the role they attribute to feelings in the control cycle (supervening on the other steps in the GDT; necessary in the aPCT) stemming from the way in which they demarcate the term "feelings", the degree of flexibility they grant to action selection, and the way in which they understand the distinction between emotional and non-emotional actions. I hope this comparative exercise can serve as a springboard for fruitful future discussions.

Notes

1. The term "feelings" is typically used synonymous with experience, and experience is conscious. Admittedly,

some authors have deviated from this consensus. For instance, Damasio (1999) has argued that the representation of bodily changes is already an unconscious feeling that can be made conscious. Also Prinz (2004) has explored the possibility of unconscious feelings, pointing at cases in which one feels a nagging pain when one's attention is elsewhere. However, I believe that cases like these are more easily understood as cases of phenomenal consciousness (i.e. the aspect or type of consciousness that can exist independent of attention) without access consciousness (i.e. the aspect or type of consciousness that is dependent of attention; Block, 1995) rather than as cases of unconscious feelings.

2. If this is accepted, the puzzle put forward by Eder (this issue) that emotional actions are purposive yet impulsive is no longer a puzzle. Saying that emotional actions are purposive, understood by Eder (this issue) in the sense of being caused by an action tendency, is not incompatible with saying that they are impulsive, understood by Eder (this issue) in the sense of stimulus-driven (i.e. caused by the activation of an S-R association). This is because in a stimulus-driven process, the representation of the response can be considered as an action tendency (see Moors, 2022; Moors et al., 2017).

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