



Is motor representation a potential answer to the problem of causal deviance?

¿Es la representación motora una posible potencial respuesta al problema de la desviación causal?

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DOI <https://doi.org/10.48204/2805-1815.8474>

INFORMACIÓN DEL ARTÍCULO	ABSTRACT/RESUMEN
Recibido el: 6/6/2015 Aceptado el: 31/8/2025 Keywords: Philosophy of action, intention, action, casual deviance, motor representation Palabras clave: Filosofía de la acción, intención, acción, desviación causal, representación motora	Abstract: This paper examines the problem of causal deviance in theories of intentional action and the role of motor representations in trying to solve it. The problem arises when an agent's intention and action correspond to an outcome, but there is a deviance in the causal chain causing the outcome accidental rather than intentional. Four current theories that involves proposing motor representations as a solution are critically analysed: the Deferral View, Motor Schema View, Dual Content View, and Same Format View. While insightful, I then present a case study involving causal deviance for motor representations themselves, arguing that even with motor representations, the accidental nature of action outcomes cannot be ruled out under a causalist framework. Finally, I suggest moving beyond causalist views, drawing inspiration from an alternative view that cognitions merely bias rather than causally produce motor representations and actions. Resumen: Este artículo examina el problema de la desviación causal en las teorías de la acción intencional y el papel de las representaciones motoras en el intento de resolverlo. El problema surge cuando la intención y la acción de un agente corresponden a un resultado, pero hay una desviación en la cadena causal que causa que el resultado sea accidental en lugar de intencional. Se analizan críticamente cuatro teorías actuales que proponen representaciones motoras como una solución: la Visión del Aplazamiento,

la Visión del Esquema Motor, la Visión del Contenido Dual y la Visión del Mismo Formato. Si bien esclarecedor. Luego presento un estudio de caso que involucra la desviación causal para las propias representaciones motoras, argumentando que incluso con representaciones motoras, la naturaleza accidental de los resultados de la acción no puede descartarse bajo un marco causalista. Finalmente, sugiero ir más allá de las visiones causalistas, inspirándome en una visión alternativa de que las cogniciones simplemente sesgan en lugar de producir causalmente representaciones y acciones motoras.
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The problem of causal deviance

Intentional actions are those executed by agents who own agency over their bodily movements. An essential aspect of elucidating intentional actions is agent's intention, which typically refer to the mental states of committing to action plans, thereby causing the actions. However, explaining actions in terms of intentions is complicated by the problem of causal deviance, a notorious problem proposed by Davidson (1963). It arises in cases where an agent has the intention to act, but there seems to be a deviance in the causal chain leading to the action execution. Davidson's famous example involves a man named Jones who intentionally administers a lethal dose of poison to another man, Smith, with the intention of killing him. However, unknown to Jones, Smith unexpectedly dies from an unrelated heart attack moments before the poison could take effect. In this scenario, the expected cause of death (the poisoning) never occurs. But it still seems intuitive to attribute the death to Jones due to his intentional action of administering the poison with the aim of killing Smith.

In this case, the standard conditions of the causalist views (e.g., Davidson, 1971/2002a, 1978/2002b); Paul, 2009; Bratman, 1984, 1987) for an intentional action are met –Jones' intention to kill, as well as his bodily movements successfully administered the (ineffective) poison, and the outcome of Smith's death. But there is an intuitive sense that their action did not cause the death in the right way for it to truly count as an intentional action. Arguably, this problem shows an explanatory gap between agents' intentions and actions. Many answers have been proposed, but there is ongoing debate about how to best handle such counterexamples within theories of intentional action. One of the widely disputed answers appeals to a type of low-level mental state, motor representations, aiming to bridge the explanatory gap with it, and provide an explanation of what it is to cause an action "in the right way."

However, according to Butterfill & Sinigaglia (2012), theories employing the motor representations are subject to the interface problem: how do the intentions with propositional contents transform into the motor representations with non-propositional, motoric contents? I will review four theories that try to solve the interface problem, thereby the problem of causal deviance in the current literature:

1. The Deferral View from Butterfill & Sinigaglia (2012).
2. The Motor Schema View from Mylopoulos and Pacherie (2017, 2019).
3. Dual Content View from Shepherd (2017a, 2017b).
4. The Same Format View by Ferretti & Caiani (2018, 2019).

In the following, I will begin by further clarifying the interface problem using the DPM model of intentions. I will then introduce the four theories that try to solve this interface problem- outlining the key arguments and objections for each. Next, I will present a case of causal deviance for motor representations that poses a challenge to all four of these theories, under the causalist tradition of trying to establish the right causal chain between intentions and actions, and I will show how they all fail to fully resolve the problem of causal deviance. Finally, I will conclude by hinting at a potential alternative approach, inspired by Wu (2016), that cognitions (i.e., intentions) bias actions rather than causing them directly. This suggests moving beyond the causalist framework to reconceptualize how cognitive states interface with motor representations, while still preserving the key role of motor representations in action production. The overall goal of the paper is to motivate the need for a new theory by revealing how current causalist approaches cannot adequately handle cases of causal deviance for motor representations.

Interface problem, DPM model, and four current theories

I start with introducing the DPM Model, for it helps to clarify the interface problem. The DPM model categorizes the intention of an action into three layers, viz., D(istal)-intentions, P(roximal)-intentions, and M(otor)-intentions, hence the shorthand DPM model (Pacherie, 2006, 2007, 2008; Mylopoulos & Pacherie, 2019).

The D-intention of a moral action is a general form of intentions directed toward the intended goal, e.g., Sam's intention to attend the conference. It will be formed after a specific goal has been determined by the agent and then forms as well as controls the

general means of achieving the goal in a rational way. D-intention is also hierarchical structured within the same layer, as it usually, if not always, needs several more specific D-intentions serving as means to achieve the intended goal. The P-intention implements general goal-directed means inherited from the D-intention in the current situation of action. It forms based on an integration of the general means and the perceptual information of the situation, which allows monitoring and controlling the action a more localized way as it unfolds in the current perceptual situation. Thus, it is a more definitive representation of the action, which includes both the intended goal and more specific means for the situation of action at hand. The M-intention is a motor representation of an action, plus promoting the execution of that action. It stands for the intended goal of an action and the motoric means suitable for direct execution of the action and automatically watches and controls the action on a fine time scale. In this way, the motor representations further decompose the intended goals into motor goals with motoric contents (Grafton & Hamilton, 2007; Jeannerod, 2006; van Elk, van Schie, & Bekkering, 2014).

According to Butterfill & Sinigaglia (2012), while introducing motor representations aids in ensuring ongoing control over the unfolding of actions, a key challenge lies in explaining how intentions with propositional contents can connect and coordinate with motor representations that own motoric, non-propositional formats. Here is how they explain:

There are cases in which a particular action is guided both by one or more intentions and by one or more motor representations. In at least some such cases, the outcomes specified by the intentions match the outcomes specified by the motor representations. Furthermore, this match is not always accidental. How do non-accidental matches come about? (pp. 131-132)

This leads to what they refer to as the interface problem: how can the cognitive system's representations interface with the motor system's representations when they employ different formats? Here are four theories proposed to solve it:

First, the Deferral View proposed by Butterfill & Sinigaglia (2012): this view draws a parallel between the relationship of propositional to pictorial representations and the relationship of D-intention to motor representations. They argue that it seems that we can use the sentence "follow that route" to refer to a route, where the demonstrative concept

“that” (i.e., the propositional representation) refers to the route by means of deferring to the pictorial line of the map (i.e., the pictorial representation). If so, we can also use the D-intention with the propositional contents “do that” to refer to the outcome of an action, where the demonstrative concept “that” (i.e., the intentional representation) refers to the outcome by means of deferring to the motor representations of this action outcome. Then, D-intentions can connect with motor representations via a demonstrative concept within the propositional contents of intentions.

This concept of deferral can sidestep a hypothetical translation between intentions and motor representations, about which Butterfill & Sinigaglia (2012) argue, “nothing at all is known about” and “nor about how it might be achieved, nor even about how it might be investigated” (p.133). However, one critic to Deferral View is that a translation process is still presupposed. The agents must independently know which the *right* motor representations are selected for their D-intentions to defer to. But it would involve a translation process between the D-intentions and the *right* motor representations that are selected, which they have argued is impossible to establish (See detailed critic in Mylopoulos & Pacherie, 2017).

Second, the Motor Schema view proposed by Mylopoulos & Pacherie (2017, 2019): this theory introduce “executable action concepts” that initiates motor schemas serving as an intermediary layer between the P-intentions and motor representations. Note that motor schemas are more stable and abstract motor representations, and fine-grained parameters of action executions that encode the invariant and general features of the actions with respect to their temporal ordering, spatial configurations, relative speeds, and forces (Mylopoulos & Pacherie, 2017, p. 290).

Executable action concepts are formed based on agents’ previous action executions in sense that they have the ability to execute the actions. These concepts can function as both contents of P-intentions and directly lead to motor representations of actions via their connections between related motor schemas. Therefore, P-intentions can stipulate the motor schemas in terms of executable action concepts towards motor representations, which cause the motor representations. This, without presupposing any translation process, establishes a content-preserving causal process between the propositional contents of intentions and the motoric contents of motor representations.

However, the critic to the Motor Schema view mirrors that to the Deferral view. (2017a) argues that presupposing “executable action concepts” as concepts with propositional formats that can connect with motor schemas with motoric formats revives the interface problem instead of solving it. It requires agents independently know which motor schemas should be selected for direct employment by motor representations. This seems to require a translation process between intentional representations and motor representations (see also Ferretti & Caiani 2019, p.309).

Third, the Dual Content view proposed by Shepherd (2017a, 2017b): this view posits at least some P-intentions have both propositional and motoric representational contents. As Shepherd (2017a, p.10) writes, “the solution to the interface problem is that intentions lead a double life. Intentions can take propositionally formatted contents that enable their integration with propositional thought. And intentions have motorically formatted contents that communicate in a fairly direct way with the operations of motoric-level action implementation.” He argues that this view is supported by empirical evidence regarding intentions and implicit learning in target-approaching tasks. For example, Day et al. (2016) conducted an experiment where participants had to aim at a target on a rotating circle on the screen by moving a cursor. However, the visual feedback provided to the participants was perturbed and non-veridical, meaning it did not accurately stand for the actual position of the hand that controlled the cursor. So, participants had to self-adjust their movements to successfully aim at the target. Before each movement, participants were asked to report the intended location they aimed at. The results showed that participants’ actual movements drifted in the direction opposite to the perturbed, non-veridical visual feedback, compensating for the sensory errors. This indicated implicit learning by the motor systems. Furthermore, when participants aimed farther from their often-reported intended locations, the magnitude of implicit learning decreased. This suggested that intentions set the locations where implicit sensorimotor adaptations occur. Collectively, these findings prove a close interaction between D-intentions and motor representations, lending support to the Dual Content view.

A major concern with this view is that while the empirical evidence directly supports a close relationship between intentions and motor representations, it only indirectly supports the Dual Content view. The Dual Content view claims more than just a close

relationship, proposing that D-intentions have a combined propositional-motoric format, rather than merely suggesting a tight coupling between the two components. Perhaps it would be more proper for Shepherd to make a more moderate claim about the connection between intentions and motor representations. As he argues (2017a), cognitions guide motor representations rather than keeping a strict causal connection with them, which better aligns with the empirical evidence he presents. This moderate stance, proposing that cognitions guide motor representations without making stronger claims about their combined format, may be a more fitting interpretation of the empirical findings. Perhaps it would be more proper for Shepherd to adopt a more moderate stance on the connection between intentions and motor representations, akin to his argument (2017b) that cognitions guide motor representations rather than staying in a strict causal connection with them. This moderate claim of cognitions guiding motor representations, without making stronger claims about their combined format, better aligns with the empirical evidence he presents and may be a more fitting interpretation of the results.

Fourth, the Same Format view proposed by Ferretti & Caiani (2018). They argue that D-intentions and motor representations share the same non-propositional, motoric format, allowing them to interact directly. Three groups of behavioural and neurobiological evidence seem to support this claim. First, some propositional representations and action executions influence each other bi-directionally, with the former modulating the latter, and impairments in the latter affecting the formation of the former. For example, Gentilucci and Gangitano's study (1998) showed that when participants reached out and grasped rods labelled "long" or "short," the words affected their arm movement parameters. Second, they rely on the grounded cognition hypothesis, which states that propositional representations are deeply grounded in sensorimotor systems. For example, Hauk et al.'s study (2004) found that reading verbs involving hand, foot, and mouth movements elicited activation in corresponding motor regions of the brain. Third, propositional representations of action are argued to be part of the motor systems' activity. For example, Buccino et al.'s study (2005) used TMS and found that listening to action-related sentences modulates motor system activity, particularly in muscle groups associated with the action that is mentioned in the sentence.

However, it seems that for agents to independently know which propositional representations the right ones are to share the motoric format with motor representations, a translation process is needed. As Christensen argues “they tacitly abandon the assumption of no translation, and it is therefore not clear why intentions and motor representations need to be in the same format.” (2020, p.548), One plausible account is that the translation process might already be implicit in the Same Format view when they argue that some propositional contents can be represented in motor systems. If so, it simply transforms the interface problem into a new form: how is it possible for intentions to interact with motor representations within the motor systems?

All four theories discussed above hold that intentional actions can be constitutively caused by propositional attitudes “in the right way,” by virtue of motor representations serving as mediators in different but similar senses. They are considered causalist views of intentional action. While they provide innovative and promising insights into the interface problem, each faces internal challenges that either render the theory itself flawed or cause it to fall back into the same problem about a mysterious translation process. In the next section, I will argue that even if we grant that these theories succeed in offering an account with the help of motor representations, they still fall short of solving the problem of causal deviance.

Cases of causal deviance for motor representations

I will now argue that in addition to the internal objections each of the above four views faces, there is a further type of objection that none of them can adequately respond to, rendering it even more devastating. As we have seen, all four views attempt to set up a causal process between intentions and the motor representations of actions, with the goal of eliminating the accidental connection between intentions and their caused events, thereby addressing the problem of casual deviance. However, even if such a connection exists, it cannot guarantee the non-accidental nature of the connection because it is easy to introduce accidental components into the connection. The following cases will demonstrate this point.

As long as motor representations are well preserved in a deviant causal chain, it is always possible to devise situations where:

- a. The agent intended to execute action A

- b. The outcome of their intending to execute A corresponds to the agent's intentional representation of what will happen.
- c. The outcome of their intending to execute A corresponds to the agent's motor representations of what will happen.
- d. The outcome of their intending to execute A, while caused by their intending to execute A, should be considered accidental rather than intentional.

To illustrate this, let us consider several cases involving different actions and agents.

Case 1: Proposing

John intended to get down on one knee to propose marriage. However, as he arrived in front of his beloved, a sudden wave of cramps overtook him, brought on by the overwhelming stress he had endured. These cramps directly caused John to lower himself to his knee. Although the action appeared smooth, and John was unaware of the cramps. His motor representation of getting down on his knee was so normal that it did not detect any disruption in the action. To John's intention and motor representations, his kneeling remained part of his intended causal process.

Here, the cramps, not John's intention, were the direct cause of his lowering to one knee. This case proves how the current four theories fail to account for why having the correct intention combined with the appropriate motor representations does not necessarily guarantee that the resulting outcome was caused by an intentional action. Let us examine how each of the four current theories would respond in Case 1 and see why they do not provide a satisfactory explanation.

First, the Deferral view posits that intention defers to motor representations. In Case 1, let us assume John also has the intention "do that," as presupposed by the Deferral View, where "that" refers to the action of getting down on his knee. According to this view, this intention should defer to the motor representations of unfolding of that action. However, John already had the appropriate motor representations for his action, which the intention can successfully defer to.

Secondly, the Motor Schema View proposes that "executable action concepts" initiate motor schemas, serving as intermediaries between intentions and motor representations. Presumably, John could have these unique concepts of getting down on

his knee, capable of starting the motor schemas constituting the action in question. His motor systems might store the motor schemas for that action from executing similar actions, such as “getting down to pick something up.” If so, it seems to meet the criteria of the Motor Schema View’s account of intentional actions.

Thirdly, the Dual Content view posits that some intentions have both propositional and motoric representational contents. Suppose John’s intention of getting down on his knee has a propositional representational content as well as motoric representational content involving motor representations for the movements needed to kneel. However, there seems to be nothing unusual about the motor representations of John’s action in Case 1 – it is no different than the motor representations involved when he intended to do so.

Fourthly, the Same Format View proposes that D-intentions and motor representations share the same non-propositional, motoric format. John’s motor representations are just as right as they should be. Thus, the criteria of the Same Format view’s account of intentional actions can be met. However, John ended up kneeling because of the cramp, not because of his intention. This case proves how the current four theories fail to account for why having the correct intention combined with appropriate motor representations does not necessarily guarantee that the resulting outcome was intentional.

One might question whether it is truly plausible for John to have normal motor representations in this case. After all, cramps typically disrupt normal motor control, leading to uncoordinated or spasmodic movements. However, research in motor control and neurology has shown that in certain high-stress situations, individuals can experience involuntary muscle contractions that mimic intentional actions, particularly when those actions are highly rehearsed or routine. For example, in cases of dystonia—a neurological disorder characterized by involuntary muscle contractions—patients can sometimes perform complex motor tasks with apparent normalcy, even though the underlying cause is an involuntary movement. This suggests that it is possible for John’s motor representations to remain intact, despite the cramps being the primary cause of his kneeling.

Critics might argue that a causal history exists between his cramp and intention. For example, his intention to propose causes stress, which causes cramps, and the cramps cause appropriate motor representations controlling the successful unfolding of his actions. In this sense, the cramp is not merely accidental for John but necessary to execute such action appropriately. If so, a specific cramp is always involved in the causal process of his action, in the sense that every time he intends to propose, such a cramp will occur to ensure he successfully gets on knee. Imagine an old painter with Parkinson's disease who cannot control his hands, they just keep shaking. But every time he paints, his hand with the brush does not shake because his attention is fully centred on the painting, causing an effect on his neural systems that override what is causing his hand to shake. The effect, then, is a necessary factor in the causal process of executing the action (i.e., using the brush without shaking it), without which the action cannot unfold properly.

However, this response might overlook the importance of distinguishing between what is considered an intentional action and what is merely a successful outcome. Just because the outcome appears intentional does not mean that the action itself was. The crucial point here is that John's motor representations, while appearing normal, do not alter the fact that the cramps were the actual cause of the action. This case illustrates how normal motor representations can be involved in actions that are unintentional due to deviant causal chains.

But I do not think it is the right response to explain the cramp as a factor in the causal process. It cannot account for the casual deviance when minor changes are made to Case 1. Consider a case as follows:

Case 2: Presentation

Jane intended to raise her hand to ask a question during a presentation. However, as she prepared to do so, she experienced an involuntary muscle spasm caused by a newly developing neurological condition. This spasm caused her arm to rise in a manner indistinguishable from her usual hand-raising motion. Jane's motor representations of the action were normal, and she was unaware of the spasm's influence.

The neurological condition causing the spasm is independent of Jane's intentions, blocking the reply that worked for Case 1. This demonstrates that even when motor

representations are preserved, the action can still be unintentional due to a deviant causal chain. Unlike Case 1, where one might argue that the cramp was indirectly linked to the intention through stress, Case 2 shows that the spasm is entirely unrelated to Jane's intention, thus blocking the response that could be given for John's case. Therefore, Jane's action of raising her hand was not intentional, despite being caused by her intention and corresponding to her motor representations.

Here, too, one might question the assumption of normal motor representations. While it might seem improbable that a neurological condition could produce such a precise, intentional-like movement, there is evidence in neurology that certain involuntary movements can be highly specific and controlled. For instance, in cases of focal dystonia, individuals can experience involuntary muscle contractions that replicate intentional movements, especially in contexts where the movement is well-practiced or habitual. This evidence supports the possibility that Jane's motor representations could remain normal despite the underlying involuntary spasm, reinforcing the argument that preserved motor representations do not necessarily equate to intentional actions.

Consider Case 3 to further illustrate this point.

Case 3: Golf Swing

Jun intended to swing his golf club to hit the ball. As he prepared to swing, his anxiety about his performance triggered a psychosomatic response, causing his muscles to tense and relax in a pattern that perfectly mimicked his usual golf swing. Jun's motor representations of the swing were normal, and he was unaware of the psychosomatic influence on his action.

Jun's psychosomatic response, while triggered by Jun's mental state, created a deviant causal chain between his intention and the action. This case further illustrates how preserved motor representations do not guarantee intentional action. Just as in Jane's case, the psychosomatic response is not directly related to the intention to swing, thereby reinforcing the point that even with intact motor representations, the action can still be unintentional due to causal deviance. Therefore, Jun's golf swing in this case, while caused by his intention and matching his motor representations, was not intentional.

Before presenting a general diagnose of these cases, I want to address the question of why we could expect normal motor representations in such cases. Motor

representations are proved to be generated and executed unconsciously, without direct conscious control. This means that even in cases of causal deviance, the underlying motor systems may continue to function normally. And the human body has many feedback systems that continuously adjust and refine movements. These systems may compensate for unusual inputs, resulting in apparently normal motor representations. Also, well-practiced actions often become automatic, with motor representations stored in procedural memory. These ingrained patterns may persist even when the causal chain is disrupted.

My diagnosis is that the motoric format of the motor representations contributes to its bottom-up nature. However, the top-down causal chains from intentions cannot necessarily guarantee the right type of motor representations is non-accidentally caused by them. Moreover, when an action execution unfolds smoothly and successfully (e.g., John is getting down on his knee appropriately), motor representations just automatically execute without “questioning” whether they were caused by intention in the right or deviant manner. In this sense, motor representations of actions are outcome-oriented -- they are not responsible for assuring the right causal chain as long as the outcome is right, namely, the action is executed properly.

If this diagnosis is correct, then all four of the theories discussed earlier still do not provide an adequate answer to the problem of causal deviance. Why do they fail? One plausible explanation is that they have not solved the interface problem. I do not deny the plausibility. As discussed in the last section, many attempts have been made in this direction. Another equally plausible explanation is that the motor representations cannot rule out the accidental factor in the causal chain. The challenge remains to specify the right causal chain that must exist between intentions and the outcomes of the action in order for the latter to qualify as intentional actions. Adding motor representations to the causal chains of intentions does not help causalists solve the problem of causal deviance.

Conclusion

In conclusion, I have critically examined four prominent theories that propose motor representations as a solution to the problem of causal deviance in theories of intentional action. While providing insightful perspectives, each theory faces internal challenges, and

more importantly, none can adequately account for cases where the motor representations link intentions to action outcomes, yet the outcome is still accidental rather than intentional.

A key diagnosis is that motor representations, by virtue of their motoric, bottom-up nature, are primarily outcome-oriented rather than ensuring the right causal chain from intentions. As long as the outcome matches the motor representations, they will execute the associated action regardless of whether the causal chain was deviant or not. The theories explored all operate within a causalist framework, attempting to establish the right kind of causal chain between intentions and motor representations of action. However, the cases of causal deviance for motor representations suggest that even with motor representations in the picture, unintentional “mismatches” can still arise, indicating the persistence of the problem of causal deviance.

Moving forward, these challenges motivate exploring alternatives that go beyond the current causalist frameworks. One possibility, inspired by Wu (2016), is to view cognitions like intentions as biasing rather than strictly causing motor representations and actions. Intentions modulate attention to bias the coupling of goal-directed perceptual information and goal-directed execution actions. The attention mechanism selects and highlights appropriate targets for action to execute on. The perceptual information prioritized by attention is then used in forming the relevant motor representations that control actions. This biasing view proposes that the rich interactions among intentions, attention, and the perception-action coupling processes explain how specific intentions arise and propagate to shape the motor representations controlling and monitoring the unfolding of actions. This could account for the tight coordination between cognition and action in empirical studies about attention, while avoiding the causalist commitment of intentions directly causing actions in a predetermined manner.

Rethinking how cognitive states interface with motoric representations, outside a causalist model, may offer a more promising path toward avoiding instead of solving the problem of causal deviance. The overall moral is that the intentional actions is not a product of being caused by prior propositional attitudes, and motor representations alone cannot be the full answer – a reconceptualization of the cognition-motor interface itself is needed.

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