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Can the Mind Command the Body?

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Abstract

People naturally intuit that an agent's ethereal thoughts can cause its body to move. Per intuitive physics; however, one body can only interact with another. Are people, then, covertly puzzled by the capacity of thoughts to command the body? Experiment 1 first confirms that thoughts (e.g., thinking about a cup) are indeed perceived as ethereal—as less detectible in the body (brain), and more likely to exist in the afterlife relative to matched percepts (e.g., seeing a cup). Experiments 2–5 show that thoughts are considered less likely to cause behavior than percepts (e.g., thinking of a cup vs. seeing one). Furthermore, mind–body causation is more remarkable when its bodily consequences are salient (e.g., moving an arm vs. brain activation). Finally, epistemic causes are remarkable only when they are ascribed to mental- (e.g., "thinking") but not to physical states ("activation"). Together, these results suggest that mind–body interactions elicit a latent dualist dissonance.

Keywords: Dualism; Mind–body dissonance; Causal reasoning; Intuitive psychology

1. Introduction

When we seek to explain what makes people tick, we spontaneously invoke their mental states—their thoughts, beliefs, and goals. For example, upon seeing a person reach out for their coffee mug, we assume that it is their *desire* (for coffee) and their *belief* (that there is coffee in the mug) that caused their arm—their body—to stretch towards that object. Thoughts, then, command the body.

This intuition is so ingrained in us that we typically take it for granted. But there are reasons to believe that it is nonetheless problematic. The problem arises because interactions between minds and bodies create a conflict between several systems of intuitive reasoning—theory of the mind (ToM), on the one hand, and intuitive Dualism and intuitive physics, on the other.

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If this analysis is correct, then, familiar as it is, the notion that thoughts cause behavior may not be perfectly comfortable for people to entertain—such mind–body interactions ought to elicit a *cognitive dissonance*. Here, I outline how this dissonance might arise. The series of experiments that follows explores whether such a dissonance exists.

1.1. How we reason about agents' behavior: ToM, dualism, and intuitive physics

From an early age, people consider agents as distinct from objects. For example, eight-month-old infants seem to expect self-propelled agents to have insides, but they do not expect the same of inanimate objects (Setoh, Wu, Baillargeon, & Gelman, 2013). Furthermore, people (adults and infants) invoke different principles to explain the trajectories of objects and agents.

When we see a stationary object launch, we expect its motion to arise from contact with another object. Furthermore, we expect the moving object to be cohesive and to proceed on a continuous path. So do young infants (Spelke, 1994; Spelke & Kinzler, 2007; Spelke, Breinlinger, Macomber, & Jacobson, 1992) and indeed, newborns (Mascalzoni, Regolin, Vallortigara, & Simion, 2013). In our minds, then, objects abide by the laws of *intuitive physics*—contact, cohesion, and continuity (Spelke, 1994; Spelke et al., 1992; Spelke & Kinzler, 2007). And there is ample evidence that these intuitive physical principles continue to guide reasoning in adults (McCloskey & Kohl, 1983; Shtulman, 2017).

But when we reason about agents, we are not the least surprised to see them move on their own accord. Infants do the same. Infants do not expect agents to move by contact or to follow continuous paths—an expectation that stands in sharp contrast to the one they apply towards objects (Kuhlmeier, Bloom, & Wynn, 2004; Spelke, Phillips, & Woodward, 1995). The behavior of agents, then, seems to arise from distinct causes.

We consider agents as different from objects because we are equipped with an intuitive *theory of mind* (ToM; Baron-Cohen, Leslie, & Frith, 1985; Leslie, 1987; Leslie, Friedman, & German, 2004). People, including young infants (Onishi & Baillargeon, 2005), believe that agents possess minds, distinct from one's own, and they ascribe the behavior of agents to their mental states—to their knowledge, beliefs, and goals. For example, when infants see a hand reach towards an object, they would expect the hand to consistently approach the same object even when its location has changed, but they would not expect the same if the hand were replaced by a similar-looking object (a moving rod; Woodward, 1998). Infants further distinguish certain agents from others, depending on their presumed attributes. Infants prefer "helpers" to "hinderers" (Hamlin, Wynn, & Bloom, 2007, 2010; Hamlin, Ullman, Tenenbaum, Goodman, & Baker, 2013; Hamlin, Wynn, Bloom, & Mahajan, 2011), and this preference is best explained by the hypothesis that infants attribute to agents mental states (Hamlin et al., 2013). Thus, from an early age, people recognize that the actions of agents depend on their mental states, and that mental states can command bodies to act.

The different core principles we invoke to reason about objects and agents could explain why people (adults and children) are demonstrably intuitive dualists—why they tacitly consider the mind as immaterial, distinct from the body (e.g., Bloom, 2004). For example, people believe that a duplicate of a person would only maintain the person's physical traits (e.g.,

hair color), not their thoughts (e.g., knowing their name; Forstmann & Burgmer, 2015). But when people consider the afterlife (Bering, McLeod, & Shackelford, 2005), or "mind-switching" scenarios (Cohen & Barrett, 2008; Cohen, Burdett, Knight, & Barrett, 2011), now it is thoughts that are considered more likely to persist (in the afterlife) or transfer (in mind-switching scenarios). Dualist beliefs can be further manipulated experimentally, and when people are primed to consider bodies and minds as distinct, they are less likely to engage in healthy behaviors (Forstmann, Burgmer, & Mussweiler, 2012) and more likely to entertain the afterlife (Heflick, Goldenberg, Hart, & Kamp, 2015).

This intuitive dualist perspective arises already in young children (Bering & Bjorklund, 2004; Hood, Gjersoe, & Bloom, 2012), across cultures (Astuti & Harris, 2008; Bering, Blasi, & Bjorklund, 2005; Boyer, 2018; Cohen & Barrett, 2008; Cohen et al., 2011; Harris & Giménez, 2005; Lane, Zhu, Evans, & Wellman, 2016; Slingerland & Chudek, 2011; Watson-Jones, Busch, Harris, & Legare, 2017), and even in a society that does not engage in discussions of people's minds (i.e., in a "mind opacity" society; Chudek, McNamara, Birch, Bloom, & Henrich, 2018). These results suggest that like ToM and intuitive physics, dualism is an intuitive, and possibly, universal human belief that guides our understanding of agents. And as noted, we attribute agents' behavior to their mental states.

But while this mentalistic reasoning comes to us naturally, it might nonetheless present a challenge to intuitive cognition. The challenge arises because the attribution of agents' behaviors to their mental states puts three intuitive systems on a direct path to collision: ToM, intuitive dualism, and intuitive physics.

1.2. The dualist dissonance

Consider, again, the intuitive constraints that govern our understanding of agents. Per ToM, the behavior of agents arises from their mental states. And given our intuitive dualist stance, we consider mental states as ethereal, distinct from the body.

So when the dualist attributes agents' behavior to their thoughts, they effectively presume that the immaterial mind (e.g., the agent's thoughts) can cause motion in matter (the agent's hand; see Fig. 1).

This presumption, however, is problematic because the bodies of agents can also be seen as objects, much like a ball (Bloom, 2004). And, as noted, per intuitive physics, one object (e.g., a hand) can move only by contact with another object (Spelke, 1994). Interactions between the disembodied mind and matter are thus impossible—they ought to elicit a mind–body dissonance, summarized in (1).

1. The dualist dissonance.
   a. Per ToM, the behavior of agents (i.e., changes in their bodies) is caused by their mental states.
      • Per *dualism*, the mind is ethereal, distinct from the body.
   b. Per *intuitive physics*, bodies can only interact by contact with other bodies.
   c. Mental states cannot cause behavior.

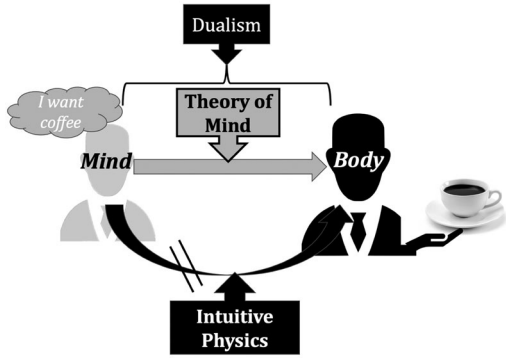

Fig 1. The putative mind–body dissonance.

Are people, then, covertly puzzled by their own presumption that thoughts can command the body? At first blush, this possibility seems unlikely, as mentalistic explanations (ones that invoke mental causes) are ubiquitous. Still, ubiquity does not prove that mentalistic explanations are dissonance-free. Instead, mentalistic explanations might be endorsed simply because they are the best available. So, although people ultimately endorse mentalistic explanations of behavior, these explanations might still incur a hidden psychological cost. In Appendix I (in the Supplementary Information), I detail how this cost might be captured within the computational framework of optimality theory (Prince & Smolensky, 1993/2004; Smolensky, 2006). Our goal here is to evaluate whether this cost—the hallmark of the putative mind–body dissonance—indeed exists.

1.3. The instigators of the mind–body dissonance

To evaluate whether a mind–body dissonance exists, we ought to take a closer look at its instigators. We expect factors that accentuate the mind–body dissonance to elicit stronger puzzlement. To the extent that people's responses to mentalistic causation are lawfully predicted by these factors, this would provide evidence that a dissonance exists. Here, we consider three such factors.

One factor is the perception of mentalistic causes as ***disembodied.*** Past research has shown that people do not consider all mental states as equally ethereal (Berent, Platt, & Sandoboe, 2021). In these studies, the embodiment of psychological traits was gauged by asking participants to intuit whether these traits would likely "show up" in a brain scan, or transfer to a replica of a donor's body (Berent et al., 2021). Results showed that epistemic traits (e.g., abstract concepts) were perceived as less embodied than non-epistemic traits, such as sensations, actions, and emotions. In contrast, when participants were asked to reason about the afterlife (after the demise of the body), they now considered epistemic traits as more likely to persist. The double dissociation between the probe (embodiment in the brain/replication vs. persistence in the afterlife) and trait (epistemic or not) suggests that epistemic traits are indeed perceived as disembodied (relative to non-epistemic traits).

Now, if the ethereal mind cannot command the body, and if thoughts are perceived as ethereal (i.e., disembodied), then the effect of *thoughts* (i.e., epistemic states) on behavior (i.e., on the body) should be particularly puzzling, more so than matched sensory causes. For example, the notion that thinking about a cup can command one's arm to move should appear more puzzling than the notion that seeing a cup can elicit the same behavior. Our principal prediction, then, is that *epistemic causes of behavior should elicit the strongest dissonance*, hence, puzzlement.

The dissonance theory advanced here further predicts that the puzzlement at mind–body interactions (i.e., dissonance) should depend on two additional factors. One is the ***salience*** of mind–body interactions: salient interactions between mind and body (e.g., the effect of thoughts on moving one's arm, externally) should be more surprising than covert interactions (e.g., the effect of thoughts on internal brain activation). Finally, this puzzlement should only emerge when the cause of behavior is described in ***mentalistic*** terms (e.g., as thoughts) but not when the cause is captured in physicalist terms (e.g., the states of the brain, or computer hardware).

Before we can evaluate these three predictions, Experiment 1 first shows that thoughts are indeed perceived as less materially embodied than percepts. The previous results of Berent et al. (2021) suggest that might be the case, but their findings are limited, inasmuch as epistemic and non-epistemic states were not strictly matched for their semantic properties. Moreover, non-epistemic states were heterogeneous (including percepts, actions, and emotions), not thoughts and percepts specifically. To demonstrate that the specific traits that inform our present inquiry indeed differ with respect to their perceived embodiment, Experiment 1 first seeks to replicate the previous findings of Berent et al. for this new set of materials.

Experiments 2–5 next evaluate whether thoughts are more puzzling causes of behavior and whether this puzzlement depends on both the salience of the bodily effect and the mentalistic status of its cause.

2. Are thoughts more ethereal than percepts?

2.1. Experiment 1: Brain activation versus the afterlife

Experiments 1 tested the hypothesis that thoughts are considered more ethereal than matched percepts. For example, is seeing a cup considered less material than thinking about one?

To find out, Experiment 1 asked two groups of participants to evaluate the anchoring of matched percepts (seeing an object) and thoughts (thinking about an object) in the material body. One group was asked to indicate whether thoughts and percepts manifest in the body—in the brain. To determine whether these responses reflect embodiment (rather than other features of these traits, such as complexity and abstraction), a second group of participants was invited to evaluate the converse—how likely thoughts and percepts are to exist in the afterlife, upon the body's demise.

If thoughts are perceived as relatively disembodied, then participants should consider thoughts as less likely to "show up" in the brain, but as more likely to exist in the afterlife (relative to matched percepts). If percepts are further embodied, then they should be more detectible in the bodily (i.e., in the "brain") than the "afterlife" probe. Thoughts, by contrast, should be less affected by the probe, as educated participants link thoughts to the brain. Accordingly, the experimental probe (brain vs. afterlife) should exert a stronger effect on percepts than on thoughts.

2.1.1. Methods

2.1.1.1. Participants Experiment 1 included two groups of 40 participants (a total of 80 participants). Participants were adult native English speakers, and they were recruited from Prolific.

The selection of sample size was informed by related research (Berent et al., 2021). In this and subsequent experiments, the sample size was set to $N = 40$ per group. For experiments that involve between-group comparisons, the total sample size was set accordingly ($N = 80$, for two-group, between-subject designs); all experiments using a single group (i.e., within-subject designs) employed 40 participants each. Experiments 1–5 each employed a unique set of participants.

2.1.1.2. Materials Experiment 1 invited two groups of participants to compare matched thoughts and percepts. One group evaluated the likelihood that a particular sensory percept (seeing coffee brewing on the kitchen counter) and a matched thought (thinking "I'm dying for some coffee") would each elicit a specific pattern of activation in the brain. A second group of participants considered the afterlife. The instructions acknowledged that "whether the afterlife exists is unknown. Here, however, we invite you to suppose that the afterlife exists." With this in mind, participants were asked to evaluate the likelihood that a person in the afterlife would be able to see an object, such as a particular cup, or think about that object (without actually seeing it).

2.1.1.3. Procedure Participants first rated (on a 1–7 scale; 1 = very unlikely; 7 = very likely) percepts and thoughts; one group indicated the likelihood that the percepts/thoughts would elicit a specific pattern of activation in the brain; the second group rated their likelihood to exist in the afterlife. After making the rating responses, participants made a forced choice as to which of the two (percepts/thoughts) would be more likely to be detected/exist. For each task, the order of the two options was randomized. To protect against bot responses, participants were asked to provide a brief justification of their response. The materials for all experiments are provided in Appendix II in the Supplementary Information.

2.1.2. Results

2.1.2.1. Rating results Fig. 2 plots the ratings of thoughts and percepts; in this and all subsequent experiments, error bars for the rating data are normalized standard errors (Morey, 2008).

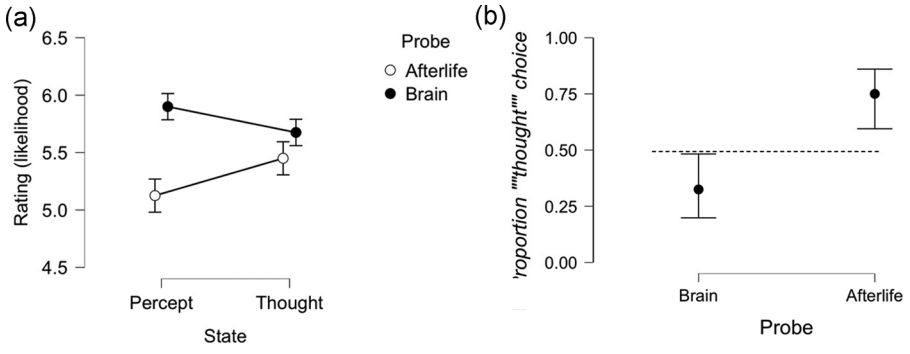

Fig 2. The perceived materiality of percepts and thoughts. Panel A plots the mean ratings; Panel B plots the proportion of "thoughts" choices. In this and all subsequent figures, the dotted line indicates chance level.

An inspection of the means suggests that the experimental probe—whether participants considered the brain or the afterlife—strongly affected responses to percepts, but not to thoughts. Additionally, thoughts were somewhat less likely to be detectible in the brain but somewhat more likely to persist in the afterlife (relative to percepts).

A 2 Mental State (Percept/thought) × 2 Probe (Brain/Afterlife) ANOVA yielded a reliable interaction ($F(1,78) = 4.46$, $p = .04$, $\eta^2_p = 0.054$). The main effects of Probe ($F(1,78) = 3.00$, $p = .09$, $\eta^2_p = 0.037$) and Mental State ($F < 1$) were not significant.

The simple main effect of Probe (i.e., the Brain vs. Afterlife probes) was reliable for percepts ($F(1,78) = 5.78$, $p = .02$, $d = 0.545$), as people considered percepts more likely to be detected in the Brain than in the Afterlife probe. Probe type, however, did not modulate responses to thoughts (for the simple main effect of Experiment, $F < 1$). Additionally, the simple main effect of Mental State was significant for the Afterlife ($F(1,78) = 3.12$, $p = .04$, one-tailed $d = 0.195$), but not for the Brain probe ($F(1,78) = 1.49$, $p < .23$, $d = 0.248$).

2.1.2.2. Forced choice Fig. 2 provides the forced choice response. In this and all subsequent experiments, error bars for the forced choice data are 95% confidence intervals.

When asked to make a forced choice, participants considered thoughts as less likely to be detected in the brain than percepts, as the proportion of "thought" responses was significantly lower than chance ($M = 0.33$, $p = .04$; Exact binomial test). In contrast, when participants considered the Afterlife, the proportion of "thought" responses was significantly higher than chance ($M = 0.75$, $p = .002$; Exact binomial test). Additionally, the proportion of "thought" responses was significantly higher for the Afterlife relative to the Brain probe ($Z = -3.81$, $p < .0001$; $H = 0.881$).

2.1.3. Discussion

Experiment 1 shows that thoughts and percepts dissociate with respect to their perceived anchoring in the body. Replicating past research (Berent et al., 2021), participants considered percepts more likely to be detected in the body (in the brain), whereas thoughts were considered more likely to persist upon the body's demise—in the afterlife (e.g., Bering &

Bjorklund, 2004). The present results, however, are the first to demonstrate this double dissociation when thoughts and percepts are strictly matched.

This dissociation indicates a psychological bias, as science shows that all mental states are brain states. That educated adults exhibited such bias is remarkable: even children know that the brain is the home of thoughts (Gottfried, Gelman, & Schultz, 1999). This formal knowledge can explain why participants explicitly deemed thoughts as disembodied only when pressed to make a forced choice.

Free ratings, however, still indicated that thoughts are equally likely to be detected physically (in the brain) and metaphysically (in the afterlife). While these afterlife rating responses do not necessarily mean that people endorse the afterlife (as the experimental task instructed them to presume that the afterlife exists), it is nonetheless remarkable that afterlife metaphysical convictions were stronger for thoughts than for percepts.

People thus consider thought as less material than percepts. This conclusion opens the stage to asking whether laypeople are indeed puzzled by the capacity of thoughts to command the body. Experiments 2–3 evaluate this question.

3. Can one's thoughts command the body?

3.1. Experiment 2: Human versus robot

Experiment 2 invited people to evaluate the capacity of matched mental states to cause behavior—the movement of an arm in an agent. We evaluated two types of agents—human and robotic; each such agent, in turn, was considered by a distinct group of participants. Thus, one group of participants contrasted the propensity of a person's thoughts and percepts to command action in a robotic arm; another group evaluated one's command of one's own arm.

If people believe that (a) one physical body can only interact with another, and that (b) thoughts are disembodied (more than percepts), then (c) the capacity of thoughts to command bodily actions should be more remarkable than percepts.

3.1.1. Methods

3.1.1.1. Participants Two groups of participants (N = 40 each) took part in Experiment 2. These participants were adult, native English speakers, and they were recruited from Prolific. One participant submitted partial rating responses.

3.1.1.2. Materials In Experiment 2, we asked two groups of participants to contrast the capacity of two matched mental states—a percept and a thought—to cause an agent's arm to move.

(a) Robotic arm. One group of participants compared the potential of thoughts and percepts to elicit action in a **robotic arm**. Participants considered a futuristic situation in which a scientist could detect a person's mental states—their percepts and thoughts—from their brain activity. To demonstrate that science can discern what a person sees/thinks, the scientists

would download the person's brain activity and link this information to a robotic arm. If the person were to *perceive* a cup, then the robot's arm would move towards a cup (as opposed to a bowl); if the person were to *think* of a cup (without seeing one), the same action of the robot's arm would follow. In essence, then, what's in the person's mind—either the sensory impression of a cup or the specific thought of a cup—would effectively make a robot's arm move towards the cup. Participants were asked to evaluate how remarkable this possibility would be.

The robotic vignette was administered in two versions, assigned to two subgroups of participants ($N = 20$ each). These versions differed only in so far as one version explicitly noted that the robot was tested in another room, so it was clearly unable to actually see the object perceived by the person (in the other version, this fact was implicit).

(b) Human agent. A second group of participants evaluated a **human** agent. Participants were presented with a quotidian situation whereby a person's mental states cause one's own arm to move. The experiment contrasted two mental states. One captured a sensory percept, such as "you *seeing* the coffee brewing on the counter"; another featured a thought, such as "you *thinking* 'I'm dying for some coffee'." Participants were asked to evaluate how surprising it would be that these mental states could cause one's arm to move towards the coffeemaker.

Participants were told that "We are so used to the fact that our percepts and thoughts command our body to act that we rarely stop and think about it. But how is it that your perceptions and thoughts make your body move? Please think about it for a moment. We aren't asking you to come up with a scientific explanation of how this all happens. Instead, we invite you to simply connect to your gut reaction, and just tell us how it all "feels." Do you find it surprising? Furthermore, how would you compare the effect of percepts and thoughts?"

3.1.1.3. Procedure As in Experiment 1, participants first rated each of the two situations (seeing vs. thinking) on a 1–7 scale (1 = not surprising at all; 7 = astonishing); they next chose which of the two would be more surprising. To protect against bot responses, participants were asked to provide a brief justification of their response. In each task, the order of the two choices was randomized.

3.1.2. Results and discussion

3.1.2.1. Rating results Fig. 3 plots the responses for thoughts and percepts. As would be expected, the effect of one's mental states (percepts and thoughts) on the arm of a robotic agent was more surprising than on one's own arm (in the everyday scenario involving the human agent). Remarkably, people were more surprised that thoughts could cause an arm to move than percepts, and this was the case across agents.

A 2 Mental State (Percepts/thoughts) × 2 Agent (Human/Robot) ANOVA[1] yielded a reliable effect of Agent ($F(1,77) = 76.22$, $p = < .001$, $\eta^2_p = 0.497$), as people considered the

[1] Recall that responses to the "Robot" condition were obtained from two vignettes (see Methods). Before conducting the omnibus ANOVA, we thus conducted a separate analysis of the Robot condition, in order to confirm that response to the two vignettes did not differ. A 2 Trait × 2 Vignette ANOVA yielded no effect of Vignette

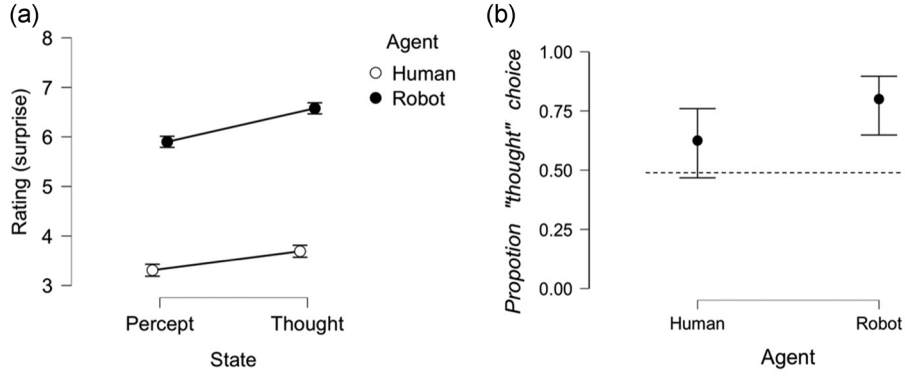

Fig 3. *The propensity of thoughts and percepts to command behavior*. Panel A plots the mean rating; Panel B presents the proportion choice of "thought" causes.

Robotic scenario more surprising than the Human agent, in the everyday situation. Critically, the main effect of Mental state was significant ($F(1,77) = 20.82$, $p < .001$, $\eta^2_p = 0.213$), as participants considered the effect of thoughts more surprising than the effect of percepts, and this was the case regardless of Agent (for the interaction ($F(1,77) = 1.56$, $p = .21$, $\eta^2_p = 0.002$). A separate analysis confirmed that the effect of thoughts on the arm was still more surprising than percepts even for the Human agent, featured in the everyday scenario ($F(1,39) = 5.07$, $p = .03$, $d = 0.201$).

3.1.2.2. Forced choice When asked to choose which mental state—thoughts or percepts—would be a more surprising cause of a robotic arm to move, participants significantly chose thoughts ($M = 0.80$, $p < .001$, exact binomial test). But when people considered the causes of one's own behavior, here, responses to thoughts and percepts did not differ reliably ($M = 0.63$, $p = .156$; Exact binomial test), possibly because everyday behavior is unsurprising. The effect of Agent was significant by a directional test ($Z = -1.68$, $p = .04$ one-tailed, $H = 0.38$). Across Agents, however, the proportion of "thought" responses was significantly higher than chance ($M = 0.71$, $p < .0002$; Exact binomial test). Overall, then, thoughts were considered more surprising causes of behavior than percepts.

These results show for the first time that when people explain the causes of behavior (the movement of an arm), they consider thoughts as less likely causes than sensory percepts. Strikingly, people considered one's thoughts as less likely to cause one's own arm to move (relative to percepts), although this last effect only emerged in ratings (but not in forced choice).

Before moving to explore the sources of this intuition, we ought to first obtain further evidence that this phenomenon is robust, and that it is not limited to the single case of reaching

($F(1,36) = 2.48$, $p < .13$, $\eta^2_p = 0.06$). Likewise, Vignette did not interact with Mental state $F(1,36) = 1.46$, $p < .24$, $\eta^2_p = 0.30$). Accordingly, responses to the Robot condition were collapsed across the two lists.

for a cup of coffee and a single modality (seeing) and action (reaching). This is the goal of Experiment 3.

3.2. Experiment 3: Everyday scenarios

Experiment 3 seeks to demonstrate that laypeople consider the effect of thoughts more surprising than percepts using a broad range of everyday situations, and variety of sensory modalities.

As in Experiment 3, participants were presented with vignettes where the protagonist's actions (e.g., waking up, getting out of your bed, and walking towards the bathroom) is attributed to either sensory cause (e.g., hearing the alarm clock) or a specific thought (recalling your long list of things to do). We contrasted three such sensory modalities: sight, sound, and smell. Of interest is whether participants consider thoughts as more surprising causes of one's actions than percepts.

3.2.1. Methods

3.3.1.1. Participants Forty participants were assigned to this experiment; one participant did not complete the experiment, resulting in a total of 39 participants. Participants were native English speakers, and they were recruited from Prolific.

3.3.1.2. Materials The materials consisted of eight vignettes. Each such vignette featured an everyday motor act by a protagonist, which was attributed to either a sensory cause or a specific thought. Three of these vignettes attributed the action to seeing (e.g., seeing/thinking of/about an ice-cream makes you change your course and step into the ice-cream store; seeing/thinking-about the soccer goal and the goalie makes Messi's foot kick the ball; seeing/thinking about the traffic light makes your foot press the gas); two featured smell (e.g., the smell/thought of dinner makes you step into the kitchen; the smell of smoke/thought of a fire makes you run to the near exit); and two featured audition (e.g., hearing the alarm clock/thinking about your day makes you step out of your bed; hearing the kettle/thinking the water is boiling makes your step into the kitchen). The instructions to the experiment (see Supplementary Information) invited participants to revisit these quotidian scenarios, connect to their gut feelings, and consider how surprising they "feel" (as in Experiment 2).

3.3.1.3. Procedure As in Experiment 2, participants first rated each of the two situations (seeing vs. thinking) on a 1–7 scale (1 = not surprising at all; 7 = astonishing); they next chose which of the two would be more surprising. Within each of the eight vignettes, the order of the two causes (sensory vs. epistemic) was randomized. Likewise, in the forced choice task, the two alternatives were randomized.

3.2.2. Results and discussion

3.1.2.1. Rating results Fig. 4 plots the surprise associated with epistemic versus perceptual causes—sights, sounds, and smells. An inspection of the means suggests that overall,

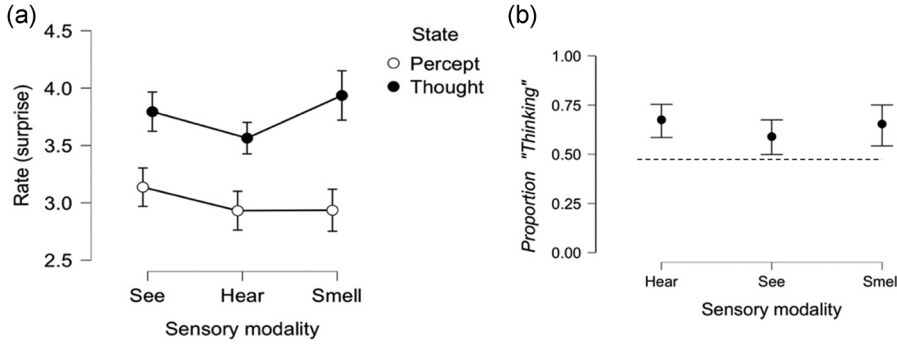

Fig 4. *The propensity of thoughts and percepts to command behavior*. Panel A plots the mean rating; Panel B presents the proportion choice of "thought" causes.

thoughts were considered more surprising causes of one's actions than percepts, and this was the case regardless of sensory modality.

3.1.2.2. Forced choice An inspection of Fig. 4 further suggests that, when participants were asked to directly contrast epistemic and perceptual states, they tended to choose "thoughts" as more surprising causes of one's action, and that was the case regardless of sensory modality. The proportion of "thinking" responses was significantly higher than chance for "seeing" ($M = 0.59$, $p < .002$; Exact binomial test), "hearing" ($M = 0.68$, $p < .0001$; Exact binomial test), and "smelling"($M = 0.65$, $p < .0001$; Exact binomial test). A logistic regression model, comparing the proportion of "thinking" responses for the three sensory modalities was not significant ($\chi^2(309) = 1.96$, $p = .37$).

Thus, the intuition that epistemic causes are more surprising than percepts is a robust phenomenon that generalizes across stimulus modalities and actions. Having demonstrated the generality of the phenomenon, in subsequent experiments, we continue to explore the paradigmatic case of "seeing" an object versus "thinking" about one (as in Experiments 1 and 2). Our goal is to shed light on why epistemic causes are more surprising.

Experiment 4 examines whether responses to percepts and thoughts depend on their perceived materiality; Experiment 5 investigates whether the phenomenon specifically depends on situating these causes at the mental level.

4. Can the mental states of one agent affect another's?

4.1. Experiment 4 (two human agents): Epistemic causes are surprising when their behavioral consequences are salient

Experiment 4 explores futuristic interactions, whereby it would be possible to have the percepts and thoughts of one agent (the transmitter) affect another (the receiver). If the transmitter sees/thinks of a cup, then this notion would be detected in the receiver—either internally (i.e., *covertly*, as activation in their brain) or externally—*overtly*, by causing the receiver's arm to move.

If people believe that immaterial mental states cannot cause changes in the material body, then reactions to mentalistic causes should depend on two factors. One is the perceived *materiality* of the ***cause***—the effect of (immaterial) thoughts should be more remarkable than (the more material) percepts. The second is the *salience* of the bodily ***consequence***: the effect of thoughts on the external body (e.g., one's arm) should be more salient, hence, more surprising than covert, internal changes (e.g., within the brain).

4.1.1. Methods

4.1.1.1. Participants Participants in Experiment 4 were adults, native English speakers, and they were recruited from Prolific. Since, in this experiment, all factors were manipulated within subjects, the sample size was set to a single group of 40 participants.

4.1.1.2. Materials Participants evaluated a futuristic situation, in which scientists are able to tell what a person sees or thinks without talking to the person or observing their actions. To demonstrate this, scientists would connect one person (the transmitter) to the brain of another person (the receiver). The goal would be to show that transmitter's percepts and thoughts can be recognized in the receiver.

The scientists evaluate such transmission in two tests. One test evaluates whether the transmitter's percepts and thoughts can lead to specific patterns of activation in the receiver's brain (i.e., covertly); another test evaluates whether the transmitter's percepts and thoughts can cause the receiver's arm to move (i.e., overtly). For each test (Brain activation vs. Arm movement), the goal is to determine whether the transmitter's percept/thought of an object (e.g., of a cup) could be detected in the receiver, either as a specific pattern of activation in the receiver's brain (for the "Brain" test) or by causing the receiver's arm to move towards that object (towards a cup, in the "Arm" test).

4.1.1.3. Procedure For each such test (Brain vs. Arm), participants first rated how remarkable it would be that the transmitter's percepts and thoughts would affect the receiver. Participants indicated how remarkable it would be that the transmitter's *seeing* a specific object (e.g., a cup) would affect the receiver; they likewise indicated how remarkable it would be that the transmitter could affect the receiver only by *thinking* of an object (e.g., a cup), without actually seeing one (on a 1–7 scale; 1 = not remarkable at all; 7 = astonishing). Next, participants made a forced choice as to which of the transmitter's two states (percepts/thoughts) would be more remarkable if it were to affect the receiver. Participants made these two responses (rating and choice) for a single test (e.g., the Brain), and next for the other (e.g., Arm test). The order of the two tests (Brain/Arm) and the two questions within a test (for thoughts and percepts) was randomized. To protect against bot responses, participants were also asked to provide a brief justification of their response.

4.1.2. Results and discussion

4.1.2.1. Rating results An inspection of the rating means (Fig. 5) suggests that, when participants considered the effect of mental states internally, on brain activation, responses to percepts and thoughts did not differ (in line with the rating results of Experiment 1). But when

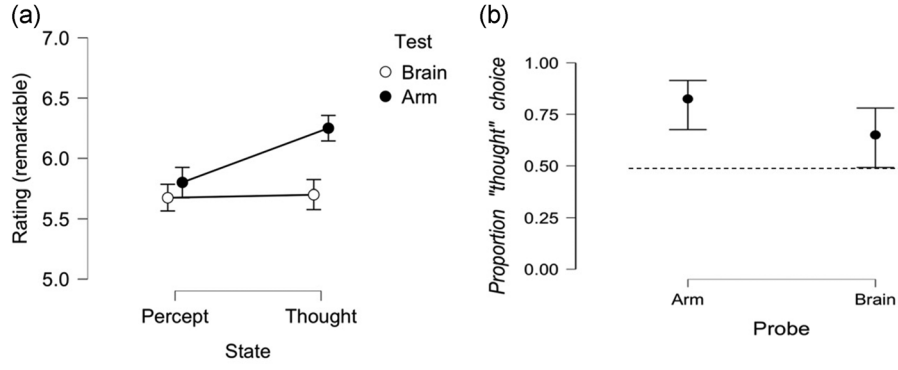

Fig 5. *Mental causation of internal and external bodily consequences (in Experiment 3)*. Panel A plots the mean rating; Panel B provides the proportion choices of "thought" causes.

mental states were shown to affect the arm, here, people considered the effect of thought more surprising than percepts (in line with Experiments 2 and 3).

A 2 Test (Brain/Arm) × 2 Mental State (Percept/thought) ANOVA yielded a reliable effect of test ($F(1,39) = 7.83$, $p < .009$, $\eta^2_p = 0.167$), as participants rated the Arm test more remarkable than the Brain test. The main effect of Mental state was not significant ($F(1,39) = 2.93$, $p < .10$, $\eta^2_p = 0.07$), but Test and Mental State interacted ($F(1,39) = 6.74$, $p = .01$ $\eta^2_p = 0.147$).

The simple main effect of State was significant for the Arm test ($F(1,39) = 7.92$, $p < .009$, $d = 0.402$), but not for the Brain test ($F < 1$). Additionally, the Arm test was more remarkable only for thoughts ($F(1,39) = 14.79$, $p < .001$, $d = 0.46$), but not for Percepts ($F < 1$).

4.1.2.2. Forced choice Participants considered thoughts more remarkable than percepts when their effect was detected externally, in the Arm test ($M = 0.83$, $p < .001$; Exact binomial test), but only marginally so when they were detected internally, in the Brain test ($M = 0.65$, $p < .08$; Exact binomial test). Additionally, people were more likely to choose thoughts as remarkable when their effect was evident externally (in the arm) than internally (in the brain, $p = .03$, McNemar test).

4.2. Experiment 5 (two robotic agents): Epistemic causes are surprising when they are ascribed to mental states

Experiment 5 examined whether epistemic causes of behavior are surprising because people perceive them as mental states. To this end, Experiment 5 re-examined interactions between two agents, a transmitter and a receiver, except that here, the agents were two robots.

The critical manipulation concerned the level of analysis, used to describe the causes of the receiver's action. One group of participants was told that the receiver's actions arose from mental states ("percepts" and "thoughts"), whereas another group was told that these actions were caused by hardware (i.e., physical) states. As in Experiment 4, the "receiver" was evaluated in two "tests"— either internally or externally, but since robotic states are

readily amenable to physicalist description (more so than humans'), the effect of Test would be likely attenuated.

Our main interest is whether the perception of this interaction depends on the mentalistic description. If epistemic causes of behavior are surprising because people ascribe them to mental states, then epistemic causes should be more remarkable than percepts only in the Mentalistic—but not in the Physicalist condition.

4.2.1. Methods

4.2.1.1. Participants Two groups of participants ($N = 40$ each) took part in Experiment 5. They were adult native English speakers, and they were recruited from Prolific.

4.2.1.2. Materials Participants in Experiment 5 were invited to consider a futuristic scenario, involving the transmission of percepts and thoughts between two robotic agents (a transmitter and a receiver).

The scientist examined whether the perceptual and epistemic state of the transmitter can cause change in the receiver. The critical manipulation concerned the level of analysis at which the cause is captured. For one group of participants, these states were described using a ***mentalistic*** language. They were told that in each test, the transmitter would either *see* a specific object (e.g., a cup) or only *think* of that object (without seeing one). Another group of participants read a description that referred to these states in strictly ***physicalist*** terms—as the detection of an object in the environment or as the activation of information about a particular object, without actually detecting the object in the environment.

To determine whether the transmission was effective, the scientists would administer two tests. The **localization** test would examine whether the transmitter's mental states (percepts or thoughts) had caused the receiver's hardware to turn on the appropriate circuit for that particular object (e.g., a cup) in the receiver's robotic hardware. The **action** test would examine whether the transmitter's mental states had caused the robot's arm to move towards the corresponding object (e.g., a cup).

4.2.1.3. Procedure As in previous experiments, participants first rated how remarkable it would be that the transmitter's percept/thought could turn on a circuit/move the arm of the receiver (1 = not remarkable at all; 7 = astonishing); next participants made a forced choice as to which of the two states (percept/thought) would be a more remarkable cause for these internal or external consequences. Participants first made these two responses (rating and choice) for one test (e.g., the localization test) and then considered the other test (e.g., the action test). The order of the two tests and the two mental states (percepts/thoughts) within it was randomized. To protect against bot responses, participants were also asked to provide a brief justification of their response.

4.2.2. Results and discussion

4.2.2.1. Rating results. An inspection of the means (Fig. 6) suggests that, when the transmitter's states were described in physicalist terms, responses to percepts and thoughts did not differ. But when these states were described in mentalistic language, participants

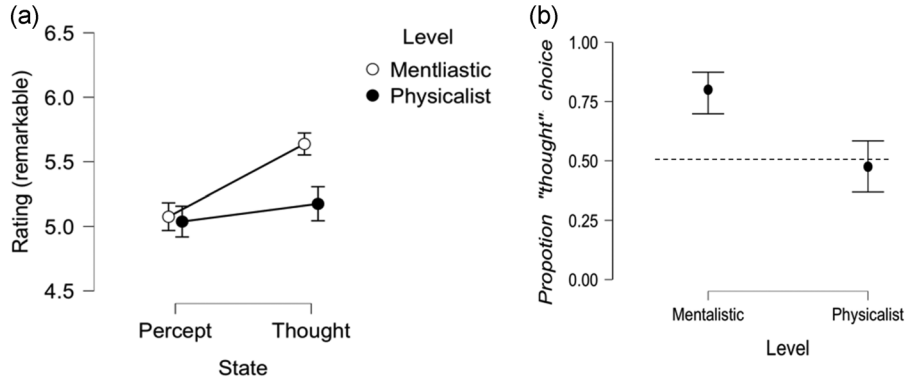

Fig 6. *The effect of mentalistic description on evaluating the causes of behavior* (in Experiment 4). Panel A plots the rating of percepts and thoughts; Panel B plots the proportion choices of "thought" as the cause of behavior.

considered the effect of the transmitter's thoughts more remarkable than percepts. Additionally, the "mentalistic" manipulation only affected responses to thoughts, but not to percepts (for the cell means, see Table 1).

A 2 Level (Mentalistic/Physicalist) × 2 Mental state (Percepts/thoughts) × 2 Test (Localization/Action) ANOVA yielded a reliable effect of Mental states ($F(1,78) = 12.11, p < .001$, $\eta^2_p = 0.134$) as thoughts were considered more remarkable than percepts. The effect of test was not significant ($F < 1$) nor did it interact with any other factor (all $p > .11$). Critically, there was a reliable interaction of Level × Mental state ($F(1,78) = 4.47$, $p = .04$, $\eta^2_p = 0.054$).

A simple main effect analysis showed that the transmission of thoughts was considered more remarkable than percepts only when these states were described using mentalistic level ($F(1,78) = 26.44, p < .001, d = 0.774$), but not when these states were described in physicalist terms ($F < 1$). Additionally, Level (i.e., the contrast between the Mentalist and Physicalist conditions) modulated responses to thoughts ($F(1,78) = 3.97$, $p = .05$, $d = 0.442$) but not to percepts ($F < 1$)

Table 1
Mean ratings in Experiment 5

		Test			
		Activation		Action	
		Percept	*Thought*	*Percept*	*Thought*
Mean	Physicalist	5.05	5.08	5.03	5.28
	Mentalistic	5.13	5.8	5.03	5.48
SD	Physicalist	1.30	1.29	1.14	0.96
	Mentalistic	1.18	1.30	1.27	1.09

4.2.2.2. Choice analysis. When asked to choose between percepts or thoughts, participants in the Mentalistic condition considered the transmission of thoughts more remarkable than percepts, as the proportion of "thought" choices was reliably higher than chance ($M = 0.80$, $p < .001$; Exact binomial test). But when states were described in Physicalist terms, participants did not consider the transmission of thoughts particularly remarkable, as the proportion of "thought" responses did not differ from chance ($M = 0.48$, $p = .74$).

The proportion of "thought" responses was next submitted to a 2 Experiment × 2 Test Generalized Linear Model. The effect of Level was significant ($\chi^2 = 17.22$, $p < .001$), as people considered the transmission of thoughts more remarkable in the Mentalistic relative to the Physicalist conditions. The effect of Test and the interaction were not significant ($\chi^2 < 1$; in the Mentalistic condition: $M = 0.80$, $M = 0.20$; for the Physicalist condition: $M = 0.45$, $M = 0.50$, for the Activation and Action tests, respectively)

Thus, when participants considered whether the states of one robotic agent could affect another, their conclusions varied, depended on the appeal to the mind. Epistemic states were considered less likely to affect action when they were described in mentalistic terms (as thoughts), but not when were described as physical states (as hardware activation).

5. General discussion

People routinely explain the behavior of agents by appealing to their thoughts. Behavior, however, entails changes in the body (e.g., moving one's arm), whereas people are known to be dualists—they consider thoughts as ethereal, distinct from the body (e.g., Bloom, 2004; Chudek et al., 2018; Forstmann & Burgmer, 2015). Are people, then, tacitly puzzled by the capacity of thoughts to command the body?

Experiments 1 first confirmed that thoughts (e.g., thinking about a cup) are indeed considered more ethereal than matched sensory percepts (e.g., seeing a cup). When forced to choose among percepts and thoughts, participants considered thoughts as less likely to manifest in the body (in the brain), and as more likely to exist without it (in the afterlife).

Experiments 2–5 next evaluated whether people consider thoughts as less likely to command the body (relative to percepts). Experiment 2 showed that participants were more surprised by the capacity of one's thought to cause an arm to move—either one's own arm, or the arm of a robot; Experiment 3 confirmed that this phenomenon is robust: epistemic causes are more surprising than percepts, and this was the case across multiple scenarios and percepts from multiple sensory modalities. Experiment 4 further demonstrated that, unlike perceptual causes, epistemic causes (thoughts) are more puzzling when their effect is salient (external arm movement vs. internal brain activation). Turning to robotic agents, Experiment 5 showed that epistemic causes are puzzling only when they are described in mentalistic terms (as thoughts, but not as hardware activation). Together, these results establish that laypeople are indeed covertly puzzled by the capacity of thoughts to command action in the body.

Why are people puzzled? It does not appear that people simply find epistemic causes confusing. First, people did not consider thoughts as uniformly less likely to play a role. As in previous research (e.g., Bering & Bjorklund, 2004), participants considered thoughts as

more likely to persist in the afterlife. Second, their puzzlement with epistemic causation was selective—it only occurred when epistemic causes were salient and mentalistic.

Another possibility is that epistemic causes (thinking causes action) are surprising because people believe that, to act on an object (e.g., grab a cup), one ought to perceive it (e.g., see the cup), but our epistemic vignettes do not list this perceptual information. Epistemic causes, then, might be surprising not because they are disembodied but rather because in these conditions, the agent acts without having the requisite perceptual information.

This explanation, however, does not fully capture the results. While it is true that action typically requires perception, action also requires goals, and in these vignettes, perceptual causes listed no such motives for behavior. So it is unclear why the absence of perceptual information (in the "thinking" condition) would be inherently more surprising than the absence of goals (in the "perception" condition). Furthermore, this proposal fails to explain why epistemic causes are more surprising only in the Mentalistic, but not in the Physicalist condition (in Experiment 5).

Quite possibly, people are puzzled because the possibility that thoughts can cause action elicits a dissonance between three systems of intuitive cognition: ToM, intuitive dualism, and intuitive physics. Per ToM, the behavior of agents is caused by their mental states (Leslie, 1987; Leslie et al., 2004). Per dualism, however, thoughts seem ethereal, distinct from the body (Bloom, 2004). Thus, for the dualist, the effect of thoughts on behavior implies that the ethereal mind can affect the body. But since bodies are material objects (chunks of matter), and since per intuitive physics, objects can only interact by immediate contact (Spelke, 1994), ethereal thoughts cannot cause motion in bodies.

This conflict—between ToM and dualism, on the one hand, and intuitive physics, on the other—does not necessarily mean that epistemic explanations of behavior are utterly inconceivable. Indeed, the constraints of dualism and intuitive physics could be violable (see Appendix I in the Supplementary Information). If so, epistemic explanations could be endorsed even if they violate intuitive physics. Critically, such violations ought to incur a measurable cost—the notion that thoughts can command behavior ought to be surprising, just as the results indeed show.

The present results, however, do not establish whether the puzzling effect of thoughts indeed arises from dualism and intuitive physics. While the results make it clear that participants consider epistemic states as relatively disembodied (in line with dualism, and contrary to modern science), the source of participants' dualist intuitions and their generality are uncertain.

One limitation arises from the experimental instructions. Because the instructions explicitly pointed out to participants that it is surprising that thoughts and percepts can cause behavior, one cannot rule out the possibility participants' surprise arose, in part, from the experimental instructions. This fact alone, however, can hardly account for the present findings. Indeed, the key outcome, here, is not merely that participants are surprised at mind–body interactions. Rather, it is that they consider the effect of thoughts *more* surprising than percepts. The experimental instructions offer absolutely no hint of this possibility. Likewise, the instructions do not explain why such interactions are surprising only when they are described in mentalistic (but not physicalist) terms. Moreover, related results (Sandoboe & Berent, 2021) suggest that

a mind–body dissonance emerges when participants are merely asked to contrast brain- and behavioral tests for various clinical conditions (without any reference to mind–body interactions at all). Accordingly, it is highly unlikely that the mind–body dissonance is an artifact of the experimental task.

A second limitation of our current findings relates to the generality of the present results. Because these data obtain solely from Western, Educated, Industrial, Democratic (WEIRD) participants, we cannot ascertain whether the participants' dualists tendencies arise from intuitive psychology or from Western culture. Likewise, the data from WEIRD participants do not allow us to determine whether the physicalist intuitions of these participants reflect their intuitive physical understanding or their formal training in science. Past research, however, has shown that the mind–body dichotomy is not limited to WEIRD participants (Chudek et al., 2018; Kuhlmeier et al., 2004). Other results show that the physical intuitions of Western adults are shaped by intuitive physics, and these principles can interfere with science learning (e.g., McCloskey & Kohl, 1983; Shtulman, 2017). Still, whether these results would extend to small-scale societies remains to be seen.

Notwithstanding these limitations, the present findings are nonetheless striking. Mentalistic explanations are at the center of our intuitive psychology: this is how we understand ourselves and others. Despite their quotidian and ubiquitous use, mentalistic explanations are not fully satisfactory. People are covertly puzzled by the capacity of thoughts to command the body.

The discomfort with mentalistic epistemic causes could further explain why laypeople are seduced by neuroscience (Weisberg, Keil, Goodstein, Rawson, & Gray, 2008). Since neuroscience attributes behavior to the body (brain), it alleviates the mind–body dissonance that is inherent in the mentalistic account (Berent, 2020; Sandoboe & Berent, 2021). Future research ought to further evaluate this possibility.

Acknowledgments

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix I
Supporting Infomation