In: Psychology of Self-Control ISBN 978-1-61470-881-0
Editor: A. Durante, C. Mammoliti, pp. 145-159

Chapter 6

THE 'WHAT' OF DOING: INTROSPECTION-BASED EVIDENCE FOR JAMES'S IDEOMOTOR PRINCIPLE

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Abstract

Science has begun to illuminate the mechanisms underlying self-control and its phenomenology. One prevalent hypothesis regarding self-directed, 'voluntary' action is that of *ideomotor processing* – that both the guidance and knowledge of one's voluntary actions are limited to

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perceptual-like representations of action outcomes (e.g., the 'image' of one's finger flexing), with the motor programs/events actually responsible for enacting actions being unconscious. To further examine this basic notion empirically, participants performed simple actions (e.g., sniffing) while introspecting the degree to which they perceived certain body regions to be responsible for the actions. Consistent with ideomotor theory, participants perceived regions (e.g., the nose) associated with the perceptual consequences of actions (e.g., sniffing) to be more responsible for the actions than regions (e.g., chest/torso) actually generating the action. We then examined participants' lay intuitions about perceptual consequences. In addition to supporting ideomotor theory, these findings unveil lay intuitions about the nature of action, perception, and self-control.

> In perfectly simple voluntary acts there is nothing else in the mind but the kinesthetic idea…of what the act is to be.
>
> – James (1890, p. 771).

INTRODUCTION

The television program *60 Minutes* recently presented a news story about how patients can today control robotic arm/limb prostheses. In the episode, the interviewer was surprised to learn that a soldier who had lost his lower arm in combat could, in just a few trials, control the grasping motions of a robotic hand, a prosthesis that was connected to electrodes attached to the muscles of the remaining part of the soldier's upper arm. The interviewer asked the soldier how he knew which muscles to activate in order to enact the action. The soldier replied that he had no idea regarding which muscles to activate, nor what the muscles were actually doing; rather, he claimed that, to enact the action on the part of the robotic arm, all he had to do was imagine the grasping action. This image (or *Effektbild*; Harleß 1861) was somehow translated (unconsciously) into the kind of muscular activation that would normally result in the grasping action. Is this how people generally guide and perceive their own actions?

According to James's (1890) popularization of *ideomotor processing*, the answer is yes. Originating in the times of Lotze (1852), Harleß (1861), and

Carpenter (1874), the hypothesis states that action guidance, and action knowledge, are limited to perceptual-like representations (or, *event codes*; cf., Hommel, Müsseler, Aschersleben, & Prinz 2001) of action outcomes (e.g., the 'image' of one's finger flexing), with the motor programs/events actually responsible for enacting the actions being unconscious (Gray 1995; Gray 2004; Jeannerod 2006; Rosenbaum 2002; Rossetti 2001). (See neuroimaging evidence for the ideomotor principle in Melcher, Weidema, Eenshuistra, Hommel, & Gruber 2008). From this standpoint, conscious contents regarding an ongoing action are primarily of the perceptual consequences of that action (Jeannerod 2006). (For a computational explanation of why motor programs must be unconscious, and explicit memories should be not formed for them, see Grossberg 1999.) Thus, one is unconscious of the complicated programs that calculate which muscles should be activated at a given time, but is often aware of their proprioceptive and perceptual consequences (e.g., perceiving a finger flex). Consistent with contemporary ideomotor-like approaches (e.g., Greenwald 1970; Hommel 2009; Hommel & Elsner 2009; Hommel, Müsseler, Aschersleben, & Prinz 2001), James (1890) proposed that the conscious mind later uses these conscious perceptual-like representations to voluntarily guide the generation of motor efference, which itself is an unconscious process.

In today's renaissance of action research (Agnew, Carlston, Graziano, & Kelly, 2009; Hommel et al. 2001; Morsella 2009; Nattkemper & Ziessler 2004), ideomotor processing is one prevalent hypothesis regarding how cognition influences action (Hommel et al. 2001). Although widely accepted, what one can (and cannot) introspect about according to ideomotor theory has never been examined directly. Previous research (e.g., research on 'imageless thought'; Ach 1905/1951; Woodworth 1939) has examined the conscious contents preceding voluntary action, but little if any research had as its focus what one can introspect about while performing an action. Thus, this fundamental aspect of human nature, in which one is conscious of action outcomes but not of action *means*, has never been explored in the psychology laboratory.

Interestingly, not everyone agrees with this overarching hypothesis (see list of four 'dissenters' in James, 1890, p. 772). For instance, in a lively debate, one of us (EM) was recently challenged by an expert on biofeedback who claimed that James (1890) and the ideomotor theorists after him got it wrong: The actor *is* aware of the efference to the muscles (Wundt's *feeling of innervation*; cf., James 1890, p. 771) that are responsible for action outcomes (see review in Scheerer 1987). (Wundt later abandoned the feeling of innervation hypothesis; Klein 1970.) In contrast, James (1890) staunchly proclaimed, "There is no introspective evidence of the feeling of innervation" (p. 775). Our point is that, though most researchers in the field may agree with James's stance, there needs to be straightforward and citable empirical evidence for this important tenet of ideomotor theory. Thus, we believe that the time has come to provide some additional introspection-based evidence for James's (1890) proposal.

According to ideomotor theory, one is unconscious of the motor efference/events responsible for an action. Hence, experimental participants should introspect that the regions associated with the perceptual consequences of such efference/events are 'where the action is primarily happening' and where the primary generators of the action reside. *Specifically, participants should perceive that the body regions/events associated with the perceptual consequences of an action are more responsible for the action than other regions, even if the other regions are in fact chiefly responsible for causing the action.*

To test this hypothesis, in Experiment 1 we had participants perform simple actions (sniffing, humming, flexing a finger, flexing the arm) and asked them to introspect about the degree to which they believed that certain body regions were responsible for the action. We chose actions that represent the two major body regions—that of the limbs and head-trunk. To not bias participants to focus on only a subset of regions, participants were asked to rate the degree to which every primary body region was responsible for the action. According to ideomotor theory, participants should perceive bodily regions that are most associated with action consequences (e.g., the nose for sniffing) to be more responsible for an action than regions actually responsible for the action (e.g., the chest/torso area). For sniffing and humming, participants should believe that the actions are engendered more by the nose and mouth, respectively, than by abdominal sources, even though the latter play an essential role in the constitution of these actions (Tortora 1994). Likewise, regarding finger and arm flexing, participants should believe that the finger tip or a point on the hand, respectively, is more responsible for the action than more proximal muscular regions (e.g., *m. brachioradialis*), which are responsible for the changes in bodily state (Tortora 1994).

To further investigate introspections about the perceptual consequences of action, we took the opportunity in Experiment 2 to examine lay intuitions regarding simple acts of perceptual inquiry—what it is like to view or touch something for a short period of time.

Together, these studies test an overarching theory about the nature of human action while revealing lay beliefs about the nature of action and perception. It is our hope that these data will complement knowledge of folk beliefs regarding other natural phenomena (cf., Keil 2003; McCloskey 1983).

EXPERIMENT 1

Methods

Participants. San Francisco State University undergraduate students (n = 108) participated for course credit. These participants have taken at least one course in psychology and may have learned about the actual mechanisms of action production, knowledge which could bias self-reports. If anything, such a bias should lead to data at odds with ideomotor theory.

Procedure. Each participant gave informed consent before participating in the study. Each participant was provided with a paper-and-pencil packet containing instructions for four action tasks as well as pages on which to jot down introspections about the actions. Each of the tasks was a simple everyday action, involving breathing (sniffing, humming) and fine (finger) and gross (arm) movements. In Task 1, participants were asked to “sniff in and out through your nostrils in six quick bursts.” We predicted that participants would believe that the nose region (where action-consequences are felt most) is more responsible for the action than the torso and chest, regions which, like the bag of a bag pipe, are primarily responsible for the passage of air through the nose, an essential component of the action. Likewise, in Task 2, participants were asked to “hum the ‘mmmm’ sound for four seconds”. We predicted that participants would perceive the throat and mouth regions, regions where action-consequences are felt most (and which do participate in action production), to be more responsible for the action than the torso and chest, regions generating the air flow passing through the vocal apparatus and the resonant chambers of the throat (Denes & Pinson 1993). Tasks 3 and 4 involved actions of the hand and arm. To instruct participants to flex the finger without mentioning the body part(s) involved (which would bias participants’ responses), for Task 3 participants were instructed to “perform the action that one would perform to spray perfume or cologne in one location on this paper four times”. Similarly, to instruct participants to flex their arms without mentioning body parts, for Task 4 participants were instructed to “perform the action that one would perform to raise and lower a hammer four times”. We predicted that the finger (Task 3) and hand (Task 4) regions would be perceived as more responsible for the actions than areas of the forearm and upper arm, respectively, even though these areas are critical for generating the actions (Tortora 1994).

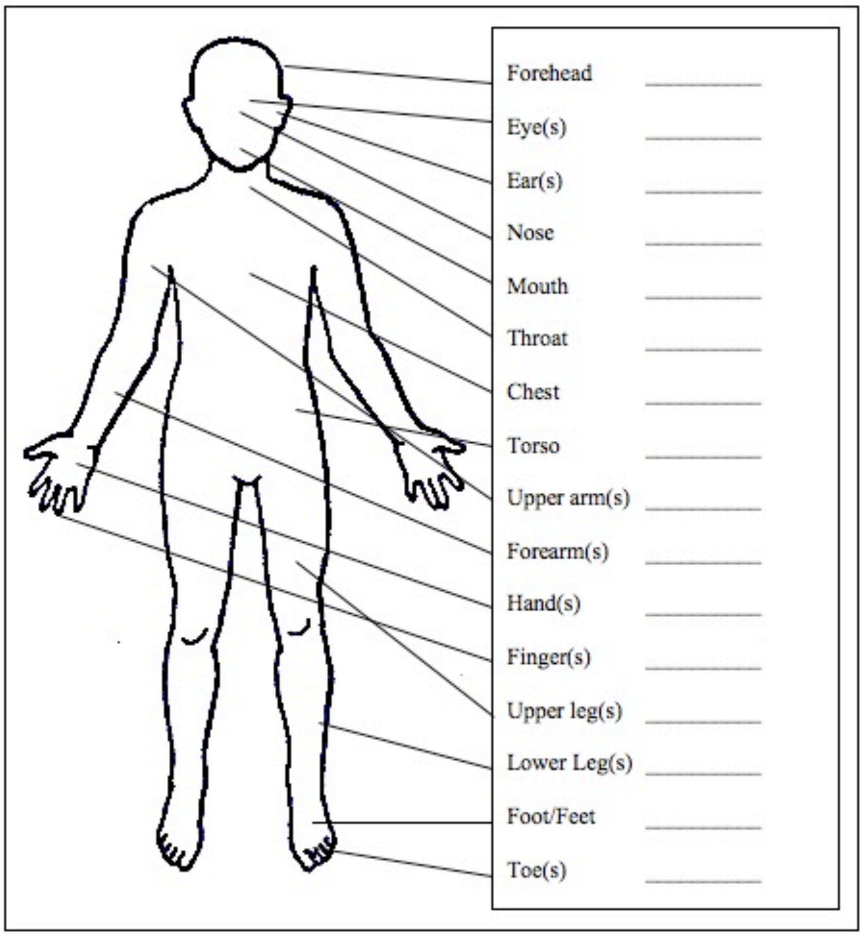


Figure 1. Diagram of the body on which participants rated how responsible they felt each body region was for the action they performed.

Following each task, participants turned to the next page, which displayed a diagram of the human body (Figure 1). On this figure, participants were instructed to "please rate how much you feel each of these regions listed below was responsible for the action on a scale from 1 to 8 (1 = not responsible and 8

= entirely responsible)". Participants were told to "be sure to give a rating for each body part below". It is important to note that, during each task, care was taken to ensure that no reference was made to any body parts, which could bias participants' introspections. In addition, to not bias participants to focus on just a subset of all body regions, participants were asked about the degree to which they felt each body region was responsible for the action. It is important to note that it was emphasized to participants that judgments should be based, not on previously-learned knowledge about action production, but solely on their introspected experience.

Results

As predicted, participants felt that the nose (M = 7.49, SEM = .12) was significantly more responsible for sniffing than the chest region (M = 6.67, SEM = .17), $t_{paired}(106) = 4.5$, $p < .0001$, or torso region (M = 4.92, SEM = .25), $t_{paired}(106) = 10.129$, $p < .0001$. (One participant failed to provide ratings for this task.) In short, the nose was perceived as more responsible for the action than any other region, ps < .0001. (Table 1 reveals which contrasts were significant in each of the four tasks.) An omnibus ANOVA on the sniffing-related ratings for all body parts revealed a significant effect of the factor 'body region,' F (15, 1590) = 195.821, $p < .001$. Similarly, for the humming action, the mouth (M = 6.40, SEM = .22) and throat (M = 6.93, SEM = .18) were perceived to be more responsible for the action than the chest (M = 5.10, SEM = .23) or torso (M = 3.61, SEM = .25), ps < .01, as predicted. (One participant failed to provide ratings for this task.) It is important to note that, as mentioned above, the mouth and throat regions do participate in the production of this action. Thus, participants are accurate in rating that these regions are responsible. What is interesting is that, as for the sniffing task, the areas associated most with the perceptual consequences of the action (e.g., the mouth and throat) were yet again rated as most responsible for the action. An ANOVA on the humming-related ratings for all body parts revealed a significant effect of body region, F (15, 1575) = 113.66, $p < .0001$.

Table 1.

Body Part/Region	Action: Sniffing	Humming	Finger Flexion	Arm Flexion
Forehead	2.06 (.17)	2.51 (.22)	1.83 (.17)	1.81 (.16)
Eye(s)	2.43 (.21)	3.16 (.27)	4.78 (.24)	3.83 (.24)
Ear(s)	1.81 (.15)	4.00 (.25)	1.54 (.13)	1.56 (.14)
Nose	**7.49 (.12)**	**4.09 (.26)**	2.07 (.20)	1.38 (.11)
Mouth	**3.90 (.25)**	**6.40 (.22)**	1.62 (.15)	1.33 (.11)
Throat	**4.90 (.24)**	**6.93 (.18)**	1.52 (.14)	1.36 (.12)
Chest	**6.67 (.17)**	**5.10 (.23)**	1.94 (.18)	**2.56 (.20)**
Torso	**4.92 (.25)**	**3.61 (.25)**	1.99 (.18)	**2.58 (.20)**
Upper Arm(s)	1.61 (.16)	1.64 (.15)	**4.74 (.23)**	**6.41 (.19)**
Forearm(s)	1.45 (.13)	1.57 (.15)	**5.60 (.21)**	**6.96 (.14)**
Hand(s)	1.51 (.15)	1.77 (.18)	**6.88 (.18)**	**6.90 (.17)**
Finger(s)	1.50 (.16)	1.86 (.20)	**7.28 (.17)**	**6.00 (.21)**
Upper Leg(s)	1.31 (.11)	1.37 (.13)	1.27 (.10)	1.38 (.12)
Lower Leg(s)	1.29 (.11)	1.36 (.12)	1.26 (.10)	1.35 (.12)
Foot/Feet	1.36 (.13)	1.40 (.13)	1.21 (.10)	1.35 (.12)
Toe(s)	1.30 (.12)	1.38 (.13)	1.19 (.09)	1.31 (.11)

Note. Mean rating of how responsible participants felt each region of the body was for the actions they performed. Ratings stem from a 1-8 scale, in which 1 = "not responsible at all" and 8 = "entirely responsible." Bold font indicates regions of interest for that particular task. Brackets denote contrasts within the critical region that are non-significant (*p*s > .05). The table reports the mean rating of how responsible on a 1-8 (1 = not responsible at all, 8 = entirely responsible) scale participants felt each region of the body was for the actions they performed. *SEM*s are presented in parentheses.

For finger flexing, participants rated the finger (M = 7.28, SEM = .17) as more responsible for the flexing action than one of the primary anatomical sources of the action, the forearm (M = 5.60, SEM = .21), t_{paired} (107) = 8.69, p < .001. An ANOVA on the finger-flexion ratings for all body parts revealed a significant effect of body region, F (15, 1590) = 226.234 p < .0001. Similarly, for arm flexing, participants rated the hand (M = 6.90, SEM = .17) as significantly more responsible for the action than one of the primary anatomical sources of the action, the upper arm (M = 6.41, SEM = .19), t (107) = 2.72, p < .01. An omnibus ANOVA on the arm-flexion ratings for all body parts revealed a significant effect of body region, F (15, 1605) = 305.35, p < .0001.

EXPERIMENT 2

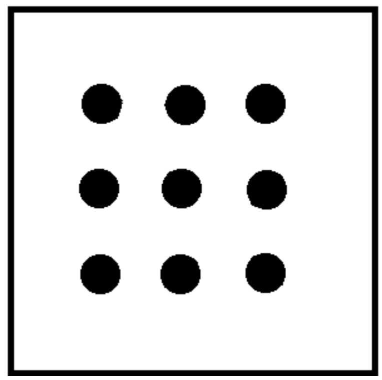
To further investigate introspections about the perceptual consequences of action, in Experiment 2 we examined the same participants' lay intuitions regarding the afference resulting from simple acts of perceptual inquiry. This study was inspired by Frijda's (2001) astute observation that one's intuition of what it feels like to see or touch something is quite different from what one actually introspects when performing the act (similar claims are found in Lotze 1852; James 1890).

Methods

Procedure. Using the same kinds of materials as Experiment 1, the experiment consisted of two introspection tasks involving basic perceptual acts, one involving vision (staring at a pattern for 30 sec) and one involving touch (touching a surface). To learn about initial views regarding the sensory experience, a question preceded each of the tasks. For the visual task, participants were first asked, "without performing this task, how strongly do you feel on a scale from 1 to 8 (1 = not strong at all, and 8 = very strongly) that you know what it is like to stare at an image for 30 seconds?" After indicating their rating, participants were instructed to stare at an image of a square containing nine dots (Figure 2) for 30 sec. The figure did not feature an illusion of any sort. After staring at the image for 30 sec, participants were asked "while you performed this task, how different was your experience from what you expected on a 1 to 8 scale? (1 = not different at all, and 8 = very different)." Participants were then provided with the opportunity to write down in an open-ended manner the way in which their experience differed from what was expected.

For Task 2 (touching something with the finger tip), participants were first asked to rate, "without performing this task how strongly do you feel on a scale from 1 to 8 (1 = not strong at all, and 8 = very strongly) that you know what it feels like to touch something with your fingertip?" Next, participants were instructed to touch with their fingertip the inside of a circle printed on the page. They were then asked the same two questions that followed Task 1.

Figure 2. Image participants were instructed to stare at for 30 sec in Experiment 2.



Results

For the visual task, participants' mean initial judgment about how well they knew what it is like to stare at an object for 30 seconds was 6.03 (*SEM* = .17). (One participant provided no ratings.) After staring at the image for 30 seconds, participants' average rating for how different their experience was from expected was 3.84 (*SEM* = .22). A single sample *t*-test revealed that participants' experience (*M* = 3.84) was significantly different from 1, the value signifying that the experience was no different from what was anticipated, $t\,(106) = 13.21$, $p < .001$. Regarding the nature of the experience, participants reported that the unanticipated aspect of the experience involved changes that were perceptual (*n* = 21 [19.6%] of 107), attentional (8 [7.5%]), time-perception related (7 [6.5%]), eye movement-based (6 [5.6%]), or 'miscellaneous' (13 [12.1%]). (Fifty-two [48.5%] provided no response.) Two judges agreed 100% about this classification of participants' open-ended responses. See Table 2 for a sample of participants' intriguing introspections about Tasks 1 and 2.

For Task 2, participants' initial judgment about how well they knew what it is like to touch something with their fingertip was 6.90 (*SEM* = .13). After performing the action, introspections regarding how different their experience was 2.52 (*SEM* = .21). A single sample *t*-test revealed that participants' experience (*M* = 2.52) was significantly greater than 1, $t(107) = 7.08$, $p < .001$. Participants reported that the unanticipated aspect of the experience involved changes that were perceptual (*n* = 18 [16.7%] of 108) or 'miscellaneous' (13

[12.0%]). (Seventy-seven [71.3%] provided no response.) Two judges agreed 100% about this classification of participants' striking open-ended responses.

Together, the findings from Experiment 2 corroborate Frijda's (2001) observation that our lay intuitions about perceptual acts do not fully capture that which unfolds when performing those acts.

Table 2. Sample introspections about unanticipated perceptual changes during Tasks 1 (staring at a pattern) and 2 (touching a surface).

Task 1

1. I shifted from circle to circle and it appeared as though some of the circles were popping out while others were not.
2. I thought I was just going to be staring at a same size dots but as I focused more it seemed as if some of the dots were increasing in size.
3. My perception of the object kept shifting and I couldn't focus on the object as a whole very well.
4. After a while the dots began to gain shadows as if the dots were not crisp circles. I didn't expect that.
5. Saw patterns in the dots.
6. You lose meaning of what you are looking at after a while and it feels so much longer.
7. I thought the image would remain consistent for 30 sec, but the circles kept on getting bigger and smaller.
8. The image seemed to become more distorted while staring at it. I expected the image to remain pretty much the same throughout the timeframe.
9. The dots seemed to float at times. At first I was focused on the whole image but as the time went by different patterns in the groups of dots seemed to stand out at different times.

Task 2

1. I didn't feel the paper as much as I thought I would.
2. It was a little different because I was more in tuned to exactly how much of my fingertip was on the paper. I never thought of that before.
3. There is not as much sensation as I anticipated from just touching. It is different than stroking.
4. What I imagined is pressure on my finger tip when touch was a bit less than how it really felt.
5. It was different because I believed I was going to feel more than I did and I

imagined that what I was touching was more course than what I actually felt.

6. Less sensation than initially anticipated.

DISCUSSION

Only recently has research begun to focus on the basic mechanisms in action production (Hommel et al. 2001; Nattkemper & Ziessler 2004). Although widely held to be true, aspects of ideomotor theory have never been examined empirically. Consistent with the ideomotor principle, in Experiment 1 the nose was felt to be more responsible for sniffing than the chest or torso. This is quite striking when one considers that the tissues of the nose (e.g., cartilage) cannot really 'do much,' because they receive little if any efference. In general, participants believed that bodily processes associated with the perceptual consequences of action-related efference/events were more responsible for actions than, in some cases, the actual anatomical sources of the actions. Participants' knowledge about the true mechanics underlying action production could have influenced the judgments. However, if anything, such knowledge should have led to an opposite pattern of results, such as that it is the chest/torso region that is primarily responsible for sniffing.

Extending the research into the realm of perceptual acts, Experiment 2 provides initial evidence for the counter-intuitive view that people are less aware of what it is like to introspect a perceptual event over a short period of time. More generally, the findings of Experiment 2 are consistent with mounting evidence showing that people tend to overestimate how much they actually know about the nature of their everyday perceptual experiences (e.g., as in *change blindness*; Simons & Levin 1997) and that people are inaccurate at predicting the nature of future subjective states (e.g., as in *affective forecasting*; Wilson & Gilbert 2005).

Beyond serving as additional, citable evidence for one of the main tenets of ideomotor theory (Greenwald 1970; James 1890; Hommel 2009; Hommel & Elsner 2009; Hommel et al. 2001), it is our hope that these data will complement knowledge of lay beliefs regarding other natural phenomena (e.g., Keil 2003).

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