

**PSYCHOLOGICAL CONSEQUENCES OF EMBODIED AND
METAPHORICAL THINKING: EMPIRICAL PROPERTIES,
THEORETICAL IMPLICATIONS, AND FUTURE DIRECTIONS**

by

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DEDICATION

To Grandma, for believing me when I talked nonsense throughout childhood, making me fried fish for lunch every day, singing me Hakka songs during afternoon naps, and always smiling.

To my dear Baba, Mami, and Gorgor, for encouraging me early on to think like a scientist, never getting tired of my questions, putting up with my bad temper for years, saving every dollar to buy me yummy food and everything I want, giving me full autonomy in deciding my future, supporting me lovingly no matter where I am, what I do, and how they feel. Thank you for showing me so palpably: “Love is patient, love is kind.... it is not self-seeking, it is not easily angered, it keeps no record of wrongs.... It always protects, always trusts, always hopes, always perseveres. Love never fails.” (1 Corinthians 13:4-8)

To my Father,
whose thoughts are higher than my thoughts,
who makes a way where there seems to be no way.

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Distilling all the richness into a few sentences is like trying to describe a 5-way Person x Situation x Event x Feeling x Time interaction in three words. How do you even begin?

I want to begin with Norbert. I came into grad school with no confidence in my thinking and writing. Even though I loved big ideas to the point of having Psych Review papers as bedtime reading, I didn't feel comfortable talking to people about my ideas. It might be a first-year thing, a culture thing, a language thing, or a mix of them all.

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ABSTRACT

The nature of mental life, especially its relation to the physical body, has intrigued philosophers of mind for centuries. It is at the core of psychological interest, too. Perspectives varied over the years, and only recently have we been able to make a wide range of precise predictions about which bodily experiences relate to which mental processes. As it turns out, these relations are reliably captured by the metaphors we use. Prolific experimental research in the past few years has demonstrated the diverse psychological consequences of embodied and metaphorical thinking. They challenge cognitive sciences' prevailing assumptions that mental life is disembodied and that metaphors matter little for ordinary thinking.

This body of work, while advancing the paradigmatic view on mental processes, remains in its infancy. So far researchers have focused on demonstrating the existence of metaphorical effects but have done little to explore their empirical complexity and theoretical relations to well-established principles of social cognition. The primary goal of my dissertation is to tackle these problems and advance theoretical integration. To begin, I put the current work in historical perspective by outlining how psychological interests in mental processes have changed over the last century. After identifying what we know and what we need to know to make progress, I present three papers including eleven experiments that go beyond demonstration and reveal some boundaries,

mechanisms, and other unknown properties of metaphorical effects. Using the *moral purity* metaphor as an example, I found that metaphorical effects can be (1) conceptually generalized from one abstract domain to another (from *washing away your sins* to a broader notion of *wiping the slate clean*) and (2) sensitive to the modality of experiences (“dirty hands” vs. “dirty mouth”). Turning to the *something smells fishy* metaphor, I found that metaphorical effects can (3) run bidirectionally between the abstract and concrete domains (with significant effects between fishy smells and social suspicion) and (4) be mediated by the accessibility and moderated by the applicability of metaphorically associated knowledge. Throughout I highlight the implications of each property for embodiment and metaphor theorizing. I conclude with theoretical integration and promising future directions.

CHAPTER 1

INTRODUCTION

How the mind relates to the body is of major interest to philosophers of mind (Dupré, 2007; Robinson, 2011; Stoljar, 2009). They offer no shortage of musings about the whether and how of mind-body connections. Descartes, for example, addressed the issue by treating mental substance as distinct from material substance. His metaphysical view of *substance dualism* is implicit in numerous religions or worldviews involving immaterial entities in the supernatural realm such as souls and angels and demons, but it has a problem: An immaterial mind has to somehow exist and control a material body; there has to be a “ghost in the machine” (Ryle, 1949). The problem is less apparent in Spinoza’s related view called *property dualism*, where the mental and the physical are irreducibly distinct kinds of properties that describe a single entity. By ascribing both mental and physical aspects to an individual, property dualism accommodates mind-body connections. However, the central claim of dualism—two kinds of things exist and are related in some way—left many philosophers discontented. The alternative approach, monism, assumes the existence of only one kind of things, either mental or physical. At one end of monism, Berkeley’s *idealism* assumes the existence of nothing beyond minds and their ideas. At the other, *physicalism* assumes that mental phenomena are fully reducible to physical terms, hence publicly accessible and objectively analyzable. While physicalism resonates with modern neuroscience research, it leaves out the subjective

nature of conscious experience, arguably the essential element of mental phenomena (e.g., Nagel, 1974, 1979). For centuries, the debate about various possible relations between mental and physical events has been a thorny issue in the philosophy of mind.

The nature of mental processes certainly piqued psychologists' interests, too, right from the dawn of the discipline. Psychology, after all, "is the Science of Mental Life" (James, 1890, p. 1). Unlike philosophical work, psychological investigation into mental life has to rely on actual studies and empirical data rather than thought experiments and metaphysical claims. For philosophers, hypothetical relationships between mental and physical processes may suffice as the judge of the debate; for psychologists, observable relationships have the final say. Indeed new research on these relationships has something to say about the richly philosophized topic of mind-body connections. As it turns out, mental processes are influenced by bodily experiences, and such influences are not random, but can be systematically predicted by the metaphors we use. For example, recalling immoral acts ("dirty" behavior) rather than moral ones activates cleansing-related thoughts and desires, and actual cleansing effectively reduces guilty feelings ("washing away your sins"; Zhong & Liljenquist, 2006). Metaphorical effects of this sort are accumulating quickly (Landau, Meier, & Keefer, 2010; Williams, Huang, & Bargh, 2009). They challenge two traditional assumptions in Western philosophy, linguistics, and cognitive sciences: (1) mental phenomena are exclusive to the brain and independent of features of the body (see Wilson, 2002); and (2) metaphors are merely linguistic devices that express but not influence thought (see Lakoff & Johnson, 1980, 1999). Contrary to these assumptions, empirical data consistently reveal how mental life is predictably influenced by bodily experiences along metaphorical lines.

While experimental research on the psychological consequences of embodied and

metaphorical thinking has been prolific in the past few years, this body of work is still in its infancy. Demonstrations abound, but boundary conditions, mechanisms, individual and cultural differences have yet to be investigated (Meier, Schnall, Schwarz, & Bargh, in press). The cuteness and newsworthiness of these effects may also have distracted researchers from trying to tie new findings to well-established principles of social cognition (Strack, 2012). Recognizing these gaps, my primary goal in this dissertation is to advance theoretical integration. To do that, I will begin by outlining how psychological interests in mental processes have changed over the last century, with an emphasis on social psychology as an area that has always been in some way cognitive. This historical perspective is intended to deepen our appreciation of the meta-theoretical significance of the embodied and metaphorical nature of thinking. I will identify what we know and what we still need to know in order to make theoretical progress. Then, as the main part of this dissertation, I will present three papers consisting of eleven experimental studies that go beyond demonstrations and reveal some boundaries, mechanisms, and other previously unknown properties of metaphorical effects. I will discuss their implications for embodiment and metaphor theorizing throughout the dissertation. I will conclude with theoretical integration and promising future directions.

Psychological Interests in Mental Processes: A Historical Tour

How do psychologists study the human mind? Depending on when and whom you ask, you would get very different answers. If you lived at the turn of the century, structuralists like Titchener (1901-1905) would train you to introspect and analyze the structure of your mental experience in its basic components, much as a chemist would examine a natural substance and classify its chemical elements. In contrast, gestaltists

such as Wertheimer (1912), Koffka (1922), and Köhler (1929) would experimentally study the totality of your conscious experience and the organizing principles underlying its complexity. Functionalists like James (1890) would also study your stream of consciousness, but the focus would shift from its internal structure or organization to its functional value for behavior. Freud (1899/1913, 1901/1965, 1917/1920) and other psychoanalysts would rather identify your unconscious drives and conflicts through free association, fantasy, and dream interpretation.

In reaction to these paradigms, behaviorism emerged and gained dominance in the early 20th century. It rejected introspection as an invalid method; it discounted unconscious processes, conscious experience, and thought–behavior relations as unworthy topics of investigation. In the works of behaviorists such as Pavlov (1897/1902, 1923/1927), Watson (1913, 1919), Thorndike (1911, 1932), and Skinner (1938, 1953), psychology was narrowly defined as the scientific study of how environmental stimuli produced overt, observable, and objectively quantifiable behavioral responses in humans and animals alike. It allowed no place for mental experiences, for they were considered intractable. As such, behaviorists would leave you with the impression, “never mind the mind.”

Displeased with psychoanalysts’ and behaviorists’ deterministic, passive, fragmented, and incomplete view of human capacities, humanist and existentialist psychologists such as Maslow (1943), Rogers (1951), May (May, Angel, & Ellenberger, 1958), and Frankl (1959) turned to the subjective meanings of the whole-person experience. They would use more qualitative methods such as phenomenology and first-person categories to study your free will, personal growth, death anxiety, life meanings, and other concerns unique to human existence. Therefore, while behaviorists were

interested in the mechanistic patterns of your overt behaviors, humanists and existentialists were interested in the subjective meaning of your life experience, and neither was particularly interested in the precise workings of your mental processes.

Things changed dramatically with the cognitive revolution, and mental processes could no longer be ignored. It began with Miller's (1951) and Chomsky's (1959) attack on behaviorists' severe limitations in explaining complex human behavior like language (Skinner, 1957). With the advent of computer science and artificial intelligence at the time, cognitivists like Broadbent (1958) and Miller (Miller, Galanter, & Pribram, 1960) likened the brain to a computer (hardware), mental processes to information encoding, storage, and retrieval (software). The use of a computer metaphor to conceptualize mental structures and processes led the information processing approach to emphasize hardware- and software-like mental properties (Lachman, Lachman, & Butterfield, 1979). For example, bigger long-term memory or crystallized intelligence, just like bigger hard-drives, store more information. Better working memory or fluid intelligence, just like better CPUs, process more information. And just as computations could be done without being shown on the monitor, unconscious processes such as implicit memory and subliminal priming seemed plausible to occur without conscious awareness. Rigorous experimental tests of these and many other ramifications of the information processing approach made significant progress in documenting the tractable consequences of memory, intelligence, language, learning, reasoning, problem-solving, decision-making, and other mental states, representations, or functions. Neisser's 1967 book *Cognitive Psychology* gave this approach another push. It would become dominant in psychology, and information-processing constructs would formally appear in theories in other areas of psychology from clinical and developmental to personality and social.

But Wasn't Social Psychology "Cognitive" All Along?

With the prominence of cognitivism, Zajonc (1980a) pointed out, perceptively, that "[s]ocial psychology has been cognitive for a very long time. It was cognitive long before the cognitive revolution in experimental psychology" (p. 186). More specifically,

"Cognition pervades social psychology at various levels: It enters at the level at which the problem is formulated; it provides significant components of our methods and designs; it participates at the assumptive level in theories and hypothesis building; and finally, one aspect of cognition—social cognition—represents a field of interest in its own right" (p. 181).

Why does cognition pervade social psychology? Because our field represents "an attempt to understand and explain how *thought*, feeling, and behavior of individuals are influenced by the actual, *imagined*, or *implied presence* of other human beings" (Allport, 1954a, p. 5, italics added). Thought is cognitive. Imagined or implied presence of others is cognitive. Also cognitive is our field's truism that "people are not governed by the passive reception and recognition of some invariant objective reality, but by their own subjective representations and constructions of the events that unfold around them" (Griffin & Ross, 1991, p. 320). Therefore, many variables and processes of interest to social psychologists are measured, manipulated, and defined in cognitive ways. As early examples, Bartlett (1932) studied how cultural history shapes the recollection and interpretation of events. Sherif (1936) revealed how a group's frame of reference powerfully shifts perceptual judgment. Lewin (1936) defined a person's life space as the interdependence between himself and his subjectively construed environment. Numerous other core topics in the history of our field—even before the cognitive revolution—were studied through the cognitive lens, such as attitude and attitude change (Allport, 1935;

Petty & Cacioppo, 1986), prejudice and stereotypes (Katz & Braly, 1933; LaPierre, 1934; Allport, 1954b; Brigham, 1971), person perception (Asch, 1946; Heider, 1946; Wishner, 1960; Anderson, 1962), social comparison and cognitive consistency (Festinger, 1954, 1957), attribution and inference (Heider, 1958; Jones & Davis, 1965; Kelley, 1967; Bem, 1965, 1972; Lepper, Greene, & Nisbett, 1973), heuristics and biases in social judgment and decision-making (Jones & Nisbett, 1972; Miller & Ross, 1975; Ross, 1977). The cognitive revolution brought information processing constructs, which began appearing in formal models of social cognition, and the methodologies for testing them (Fiske & Taylor, 1984), all of which continued to gain prominence in social psychology.

The Information Processing Approach Has Its Limits

While the information processing approach was keeping social cognition in high gear and pervading other areas of psychology, Neisser (1976) started criticizing information processing cognitive psychologists' lack of ecological validity and heavy methodological reliance on linear programming. This was a decade after Neisser published his 1967 landmark *Cognitive Psychology*, and now he considered the information processing approach to be limited and Gibson's (1979) ecological approach to direct perception and information pickup from the environment to be crucial. It resonated with Lachman, Lachman, and Butterfield's (1979, p. 9) recognition that "[information processing] is not the only approach to cognitive psychology, nor will it last forever."

Their prediction turned out to be correct. The information processing approach did not dominate forever. An important reason, other than Neisser's critiques, is the use of the computer metaphor for the human mind. It was a cool metaphor, but it might be

too “cool.” It left out important “hot” aspects of mental life. A computer has no need or desire, no mood or emotion, no cognitive or metacognitive feeling, no awareness of bodily sensation or motor action. A person has all of these things—and they have predictable effects on mental processes. That is the crux of the experimental research beginning in the 1980s on the causal effects of feelings and goals and desires on cognition (Zajonc, 1980b; Schwarz & Clore, 1983; Kunda, 1990; Kruglanski & Webster, 1996). Hot processes influence cool ones. Such influences should not occur if the mind worked just like a computer. Of particular relevance to the mind-body problem, if thinking was merely computation in a bodiless machine without awareness of its subjective experiences and thoughts were represented only as abstract amodal symbols, then judgment and cognitive processing should not be systematically influenced by bodily experiences such as physiological arousal (Zillman, 1978), head movement (Wells & Petty, 1980), gestures (Krauss, 1998), and muscle contraction (Friedman & Förster, 2000). But they are. These influences cast doubt on the sufficiency of the computer metaphor for the human mind and challenge the information processing approach’s key assumption that thoughts are represented only as abstract amodal symbols (see Wilson, 2002). This challenge can be formulated in different strengths. The weak version of the challenge says we need to recognize that amodal thoughts receive modal inputs like bodily experiences. The strong version of the challenge says we need to reject that thoughts are represented amodally; rather, they are represented modally. Which version to endorse is up for debate (e.g., Barsalou, 1999, and open peer commentary), but both make it abundantly clear that the prevailing information processing approach has its limits, that mental processes are not entirely disembodied. Instead, thinking is susceptible to bodily influences.

Embodied and Metaphorical Thinking

Bodily experiences influence thinking, but can we predict what bodily experiences influence what kind of thinking? One approach is to examine individual cases, imagine for each case some conceivable mind-body correlations in daily life, and hypothesize a case-specific effect. For example, it is conceivable that in daily life arm flexion tends to correlate with the retrieval of desirable stimuli and arm extension with the removal of undesirable stimuli, so it is hypothesized that arm flexion can elicit positive attitude and arm extension can elicit negative attitude (Cacioppo, Priester, & Berntson, 1993). This approach seems to have driven early embodiment research in social psychology (for a review, see Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005).

Another approach is to examine numerous cases, identify common patterns underlying them, and hypothesize a general form of mind-body relation that is testable and applicable to each case. This approach is more parsimonious, has a wider explanatory scope and more heuristic value, but of course it requires that we first have a roadmap of the underlying patterns. Exactly this was offered by Lakoff and Johnson's (1980) conceptual metaphors. It may seem surprising that something as peculiar and idiosyncratic as metaphors could be of any help to the daunting problem of mind-body connections. Such sentiment was apparent in the traditional view that metaphorical language was something of imaginative and extraordinary use. It might be used by poets and playwrights to serve decorative and artistic purposes, but it bore little if any relation to ordinary thinking. It was peripheral rather than central to routine thought.

Lakoff and Johnson challenged the traditional view by revealing highly

systematic patterns underlying metaphorical expressions and their pervasive use in everyday language. By some estimates (Gibbs, 1994), English speakers utter six metaphorical expressions per minute in spoken conversation, and they do so quickly, effortlessly, and unintentionally. Such systematicity, frequency, and automaticity would be unlikely if metaphorical language was nothing more than fancy talk invoked idiosyncratically on limited occasions. Through the window of linguistic patterns, Lakoff and Johnson viewed the conceptual system as itself metaphorical, where thoughts about abstract domains (e.g., morality, love) are guided by the schematic and inferential structures of relatively concrete domains (e.g., cleanliness, journey)—domains that involve more direct bodily experience with the physical world, that are easier to understand, that have greater inferential richness.

In essence, Lakoff and Johnson's cognitive linguistics analysis assumed that "since communication is based on the same conceptual system that we use in thinking and acting, language is an important source of evidence for what that system is like" (p. 3). They drew inferences about the conceptual system "on the basis of linguistic evidence" (p. 4), which exhibits a strong tendency of talking about abstract domains metaphorically in terms of concrete domains. Their linguistic data were sizeable, provocative, and certainly stirred interest (with over 20,000 Google Scholar citations of their 1980 book). It led to such recognition as Pinker's (2007, p. 6): "Metaphor is so widespread in language that it's hard to find expressions for abstract ideas that are *not* metaphorical." Meanwhile, however, linguistic patterns cannot be mistaken for mental processes; they are different things (e.g., Murphy, 1996, 1997). No matter how impressive and suggestive the linguistic patterns appear, without experimental evidence the causal relationship between linguistic metaphors and cognitive structures or processes remain unclear.

Fortunately and only recently, experimental research on the psychological consequences of metaphors has caught on. In the past few years, cognitive, social, and consumer psychologists have garnered ample evidence that concrete domains do project their schematic and inferential structures to abstract domains as specified by metaphors. Subtle incidental bodily experiences in the concrete domain can unconsciously influence processes in the abstract domain. For example, simply holding a warm rather than cold cup of coffee leads people to perceive a target person as having “warmer” personality (Williams & Bargh, 2008a). Recalling immoral acts (“dirty” behavior) rather than moral ones activates cleansing-related thoughts and desires, and actual cleansing effectively reduces guilty feelings (“washing away your sins”; Zhong & Liljenquist, 2006). Numerous metaphorical effects of this sort have been documented (see Table 1 and recent reviews by Landau, Meier, & Keefer, 2010; Williams, Huang, & Bargh, 2009) and continue to accumulate quickly. This body of work goes beyond the use of linguistic patterns to infer the cognitive validity of metaphors. It provides experimental confirmation of metaphorical effects of bodily experiences on a variety of psychological outcomes, from basic attention and memory to social perception, attitude, inference, and judgment. It suggests that metaphors meaningfully reflect how bodily experiences project their schematic or inferential structures to guide mental processes.

What We Know and What We Need To Know

The embodied *and metaphorical* nature of thinking advances the paradigmatic view of mental processes. It highlights the empirical validity of mind-body connections and makes specific predictions about these connections. As such, it challenges two prevailing assumptions of the human mind: (1) the mind works just like a computer, so

Table 1. Examples of conceptual metaphors, their linguistic expressions, and citations for experimental research on their psychological consequences.

Conceptual metaphor	Example of its linguistic expression	Examples of experimental research on its psychological consequences
Morality is Cleanliness	His reputation is tainted	Zhong & Liljenquist, 2006; Schnall, Benton, & Harvey, 2008; Liljenquist, Zhong, & Galinsky, 2010; Zhong, Strejcek, & Sivanathan, 2010
Affection is Warmth	She's a warm person	Williams & Bargh, 2008a; Zhong & Leonardelli, 2008; Bargh & Shalev, 2012
Intimacy is Closeness	We're close friends	Williams & Bargh, 2008b
Importance is Weight	That's a heavy topic	Jostmann, Lakens, & Schubert, 2009; Schneider, Rutjens, Jostmann, & Lakens, 2011
Future is Front / Past is Back	I look forward to it	Miles, Nind, & McCrae, 2010
Duration is Distance	It's a long meeting	Casasanto & Boroditsky, 2008; Casasanto, Fotakopoulou, & Boroditsky, 2010
Good is Bright / Bad is Dark	That's a bright idea	Meier & Robinson, 2004; Song, Vonasch, Meier, & Bargh, 2012
Good is Up / Bad is Down	He's in high spirits	Meier, Robinson, & Clore, 2004; Crawford, Margolies, Drake, & Murphy, 2006; Weger, Meier, Robinson, & Inhoff, 2007
Divine is Up / Evil is Down	God is the most high	Meier, Hauser, Robinson, Friesen, & Schjeldahl, 2007
Powerful is Up	Climb up the corporate ladder	Schubert, 2005; Giessner & Schubert, 2007

thoughts are just like computations, represented as abstract amodal symbols, independent of bodily experiences (see Wilson, 2002); and (2) metaphors are merely figures of speech

with little or no relevance to ordinary thinking (see Lakoff & Johnson, 1980, 1999).

Contrary to both assumptions, empirical work reveals how the mind is influenced by or “grounded” in the body (Barsalou, 1999, 2008). And metaphors are not just occasional food for thought; they constitute key aspects of thought.

Although the experimental work on the psychological consequences of embodied and metaphorical thinking has been prolific and has made a theoretically significant point, it remains an early enterprise. The database has more breadth than depth. Most notably, there have been numerous demonstrations, but few investigations into boundary conditions, mechanisms, individual and cultural differences (Meier, Schnall, Schwarz, & Bargh, in press). Metaphorical effects tend to be cute and newsworthy enough to elicit a “wow,” but less is known about their “how” (Strack, 2012). More has been done to highlight their novelty than to forge their conceptual relations to well-established principles of social cognition. Theoretical advances and integration are needed. That is the overarching goal of my dissertation.

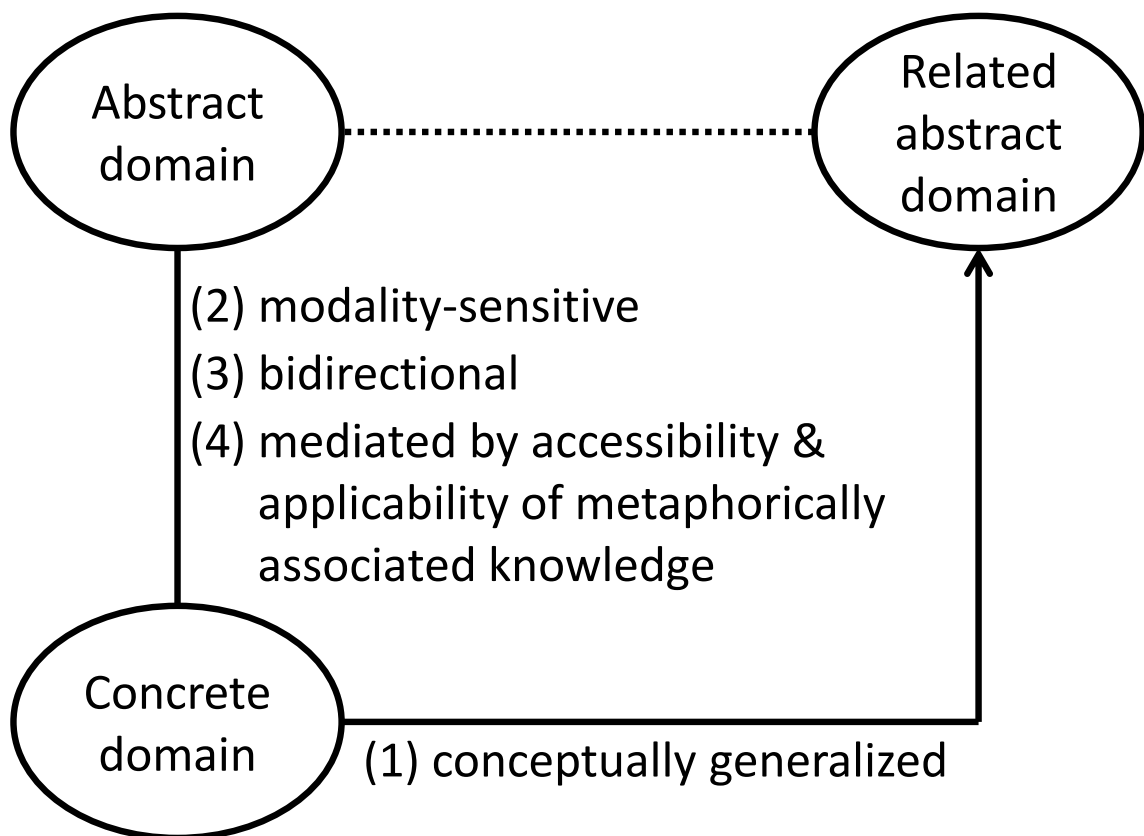
Specifically, to go beyond simply demonstrating that “metaphors work,” I ask four second-generation questions about the empirical properties of metaphorical effects. They are summarized in Figure 1 and detailed below.

Question 1: Can metaphorical effects be conceptually generalized from one abstract domain to another? I use the bodily experience of cleansing to address this question (Lee & Schwarz, 2010a, *Science*). Two studies tested whether the metaphorical notion of “washing away your sins” is generalizable beyond the moral domain to a broader notion of “wiping the slate clean,” with important consequences for decision-making.

Question 2: Can metaphorical effects be sensitive to the modality of experiences

in the abstract and concrete domains? I use the “moral purity” metaphor to address this question (Lee & Schwarz, 2010b, *Psychological Science*). Two studies tested whether immorality elicits stronger desires for products that cleanse the “dirty” body part than for products that do not cleanse it. Answers to Questions 1 (what people can remove by cleansing) and 2 (how people want to cleanse) suggest that metaphorical effects may be more general in scope while more specific in form than shown in prior work.

Figure 1. Conceptual model summarizing four empirical properties of metaphorical effects



Question 3: Can metaphorical effects run bidirectionally between the abstract and concrete domains? I highlight the theoretical significance of this issue for Lakoff and

Johnson's (1999) conceptual metaphor theory in the final paper (Lee & Schwarz, in press-a, *Journal of Personality and Social Psychology*). I use the "something smells fishy" metaphor to test for bidirectional effects between fishy smells and social suspicion (Studies 1-3 & 7).

Question 4: Can metaphorical effects be mediated by the accessibility and applicability of metaphorically associated knowledge? I use an experimental causal chain approach to unpack an assumed mechanism mediating metaphorical effects (Studies 4-6). Answers to Questions 3 and 4 (whether metaphorical effects are bidirectional and how they are mediated) highlight the desirability and plausibility of integrating well-established social cognitive principles of knowledge activation and use with new insights into the embodied and metaphorical nature of thinking.

Finally, I will integrate the theoretical implications of these properties and conclude by identifying promising future directions.

CHAPTER 2

CAN METAPHORICAL EFFECTS BE CONCEPTUALLY GENERALIZED FROM ONE ABSTRACT DOMAIN TO ANOTHER? (QUESTION 1)

Note. This work was published in Lee, S. W. S., & Schwarz, N. (2010a).

Washing away postdecisional dissonance. *Science*, 328, 709.

Abstract. After choosing between two alternatives, people perceive the chosen alternative as more attractive and the rejected alternative as less attractive. This postdecisional dissonance effect was eliminated by cleaning one's hands. Going beyond prior purification effects in the moral domain, physical cleansing seems to more generally remove past concerns, resulting in a metaphorical "clean slate" effect.

Hand-washing removes more than dirt—it also removes the guilt of past misdeeds, weakens the urge to engage in compensatory behavior (Zhong & Liljenquist, 2006), and attenuates the impact of disgust on moral judgment (Schnall, Benton, & Harvey, 2008). These findings are usually conceptualized in terms of a purity-morality metaphor that links physical and moral cleanliness (Lakoff & Johnson, 1999); however, they may also reflect that washing more generally removes traces of the past by “wiping the slate clean.” If so, washing one's hands may lessen the influence of past behaviors that have no moral implications at all. We test this possibility in a choice situation. Freely choosing between two similarly attractive options (e.g., Paris or Rome for vacation) arouses cognitive dissonance, an aversive psychological state resulting from conflicting cognitions. People

reduce dissonance by perceiving the chosen alternative as more attractive and the rejected alternative as less attractive after choice, thereby justifying their decision (Festinger, 1957; also Cooper, 2007). We test whether hand-washing reduces this classic post-decisional dissonance effect.

Study 1

Method

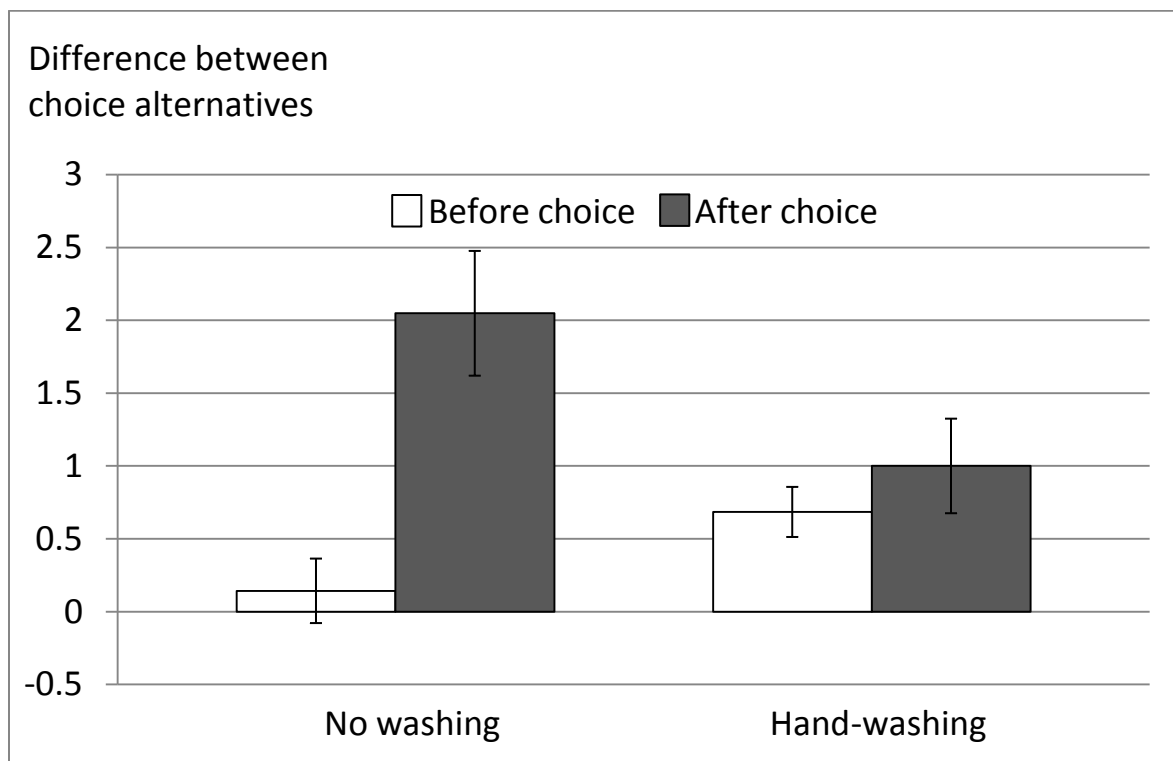
In individual sessions, 40 undergraduates browsed 30 CD covers as part of an alleged consumer survey as if they were in a music store. They selected 10 CDs they would like to own and ranked them by preference. Later, the experimenter offered them a choice between their 5th and 6th ranked CDs as a token of appreciation from the sponsor. Following the choice, participants completed an ostensibly unrelated product survey that asked for evaluations of a liquid soap; half merely examined the bottle before answering, whereas others tested the soap by washing their hands. After a filler task, participants ranked the 10 CDs again, allegedly because the sponsor wanted to know what people think about the CDs after leaving the store (Brehm, 1956; Kitayama, Snibbe, Markus, & Suzuki, 2005).

Results

Can washing one's hands attenuate the need to justify a recent choice? Yes (Figure 2). For those who merely examined the soap, the preference for the chosen over the rejected alternative increased from before choice ($M = 0.14$, $SD = 1.01$) to after choice ($M = 2.05$, $SD = 1.96$) by an average of 1.9 ranks ($F(1, 38) = 20.40$, $p < .001$, for the simple effect), replicating the standard dissonance effect. In contrast, for those who

washed their hands, preferences were unaffected by their decision (before choice, $M = 0.68$, $SD = 0.75$; after choice, $M = 1.00$, $SD = 1.41$; $F < 1$ for the simple effect). Thus, hand-washing significantly reduced the need to justify one's choice by increasing the perceived difference between alternatives ($F(1, 38) = 6.74$, $p = .01$, for the interaction of time and hand-washing manipulation).

Figure 2. Post-decisional dissonance after hand-washing or no hand-washing (Lee & Schwarz, 2010a, Study 1)



Note. Each bar represents the rank difference between the chosen and rejected alternatives, with higher values indicating higher preferences for the chosen alternative. Error bars represent standard errors.

Study 2

Method

A study with a different choice task, cleaning manipulation, and measure replicated this finding (see Appendix for materials and methods in detail). In individual sessions, 85 students responded to an alleged consumer survey about four fruit jams (shown in pictures). They were subsequently offered a choice between two jars as a sign of the sponsor's appreciation. Following their choice, participants completed an ostensibly unrelated product survey about an antiseptic wipe; half merely examined the wipe, whereas others tested it by cleaning their hands. Next, they rated the expected taste of the four jams (0 = not good at all; 10 = very good).

Results

Participants who did not clean their hands after making a choice expected the chosen jam to taste much better ($M = 8.00$, $SD = 1.65$) than the rejected jam ($M = 6.43$, $SD = 1.81$), ($F(1, 83) = 27.54$, $p < .001$, for the simple effect); hand-cleaning attenuated this difference to non-significance ($M_s = 7.63$ and 7.23 , $SD_s = 1.56$ and 1.25 ; $F(1, 83) = 1.79$, $p = .19$, for the simple effect). Thus, hand-cleaning significantly reduced the classic post-decisional dissonance effect ($F(1, 83) = 7.80$, $p = .006$, for the interaction of product and hand-cleaning manipulation).

Discussion

These findings indicate that the psychological impact of physical cleansing extends beyond the moral domain. Much as washing can cleanse us from traces of past immoral behavior, it can also cleanse us from traces of past decisions, reducing the need to justify them. This observation is not captured by the purity-morality metaphor and highlights the need for a better understanding of the processes that mediate the

psychological impact of physical cleansing. To further constrain the range of plausible candidate explanations, future research may test whether the observed “clean-slate” effect is limited to past acts that may threaten one’s self-view (e.g., moral transgressions, potentially poor choices) or also extends to past behaviors with positive implications.

Appendix: Materials and Methods in Detail

Study 1

Forty University of Michigan undergraduates (25 female) were randomly assigned to conditions (hand-washing vs. no hand-washing) and run individually.

Participating in two allegedly unrelated consumer surveys, they flipped through 30 CD covers and marked those they already owned and 10 they would like to own. They examined the 10 CDs as if in a music store, ranked them (1st rank = most preferred) and answered questions about music taste. Next, they were offered a choice between their 5th and 6th ranked CDs as a token of the sponsor’s appreciation.

After receiving their chosen CD, participants completed a product survey about a bottle of hand soap; they either examined the soap (“no hand-washing”, $n = 21$) or tested it by washing their hands (“hand-washing”, $n = 19$). Following filler questions about their lifestyle, they ranked the 10 CDs again, allegedly to inform the sponsor about customers’ thoughts after leaving the store. Participants were debriefed and probed for suspicion (Bargh & Chartrand, 2000); no participant indicated awareness of the experiment’s purpose. In both studies, participants returned the products to the experimenter after debriefing.

The rank difference between CDs (chosen minus rejected CD) served as dependent variable in a 2 (hand-washing vs. no hand-washing) x 2 (before vs. after

choice) mixed-model ANOVA.

Study 2

Eighty-five University of Michigan students (47 female) were approached on campus and randomly assigned to conditions (hand-cleaning vs. no hand-cleaning).

Participating in two allegedly unrelated consumer surveys, they answered questions about four fruit jams (shown in pictures). As a sign of the sponsor's appreciation, they were offered a choice between two jars. Next, they evaluated an antiseptic wipe, either after merely examining it ("no hand-cleaning", $n = 42$) or after testing it by cleaning their hands ("hand-cleaning", $n = 43$). Afterwards, they rated the expected taste of the four jams (0 = not good at all; 10 = very good); this question was not asked earlier, avoiding potential problems with the repetition of identical questions. Finally, participants were debriefed and probed for suspicion; no participant indicated awareness of the experiment's purpose.

The post-choice rating of expected taste served as dependent variable in a 2 (hand-cleaning vs. no hand-cleaning) x 2 (chosen vs. rejected jam) mixed-model ANOVA. No differences between conditions were observed on pre-choice evaluations of the two jams.

CHAPTER 3

CAN METAPHORICAL EFFECTS BE MODALITY-SENSITIVE? (QUESTION 2)

Note. Part of this work was published in Lee, S. W. S., & Schwarz, N. (2010b). Dirty hands and dirty mouths: Embodiment of the moral-purity metaphor is specific to the motor modality involved in moral transgression. *Psychological Science*, 21, 1423-1425.

Abstract. Abstract thoughts about morality are grounded in concrete experiences of physical cleanliness. Noting that natural language use expresses this metaphorical link with reference to the body part involved in an immoral act (e.g., “a dirty mouth”; “dirty hands”), we address the role of motor modality in the embodiment of moral purity. We find that conveying a malevolent lie on voicemail (using the mouth) increases the desire to clean one’s mouth, but not the desire to clean one’s hands; conversely, conveying the same lie on email (using one’s hands) increases the desire to clean one’s hands, but not one’s mouth. Additional findings suggest that conveying a benevolent message may decrease the desire to clean the involved body part. Secondary analyses of earlier studies further support the assumption that the embodiment of moral purity is specific to the motor modality involved in the act.

Water and soap remove more than dirt, microbes, and contaminants -- they also attenuate moral guilt (Zhong & Liljenquist, 2006) and the impact of disgust on moral

judgment (Schnall, Benton, & Harvey, 2008). These findings are consistent with a “moral purity” metaphor through which abstract thoughts about morality are grounded in concrete experiences of physical cleanliness (Lakoff & Johnson, 1980, 1999). In natural language use, this metaphor is often associated with the specific body part involved in a moral transgression, as speakers refer, for example, to “dirty hands” or a “dirty mouth.” This suggests that the motor modality (“manual” vs. “oral”; Anderson, Qin, Jung, & Carter, 2007) involved in a transgression may figure prominently in the embodiment of the moral purity metaphor, potentially prompting people to purify the specific body part involved. While this conjecture is compatible with the core theme of embodiment (e.g., Barsalou, 1999, 2008; Lakoff & Johnson, 1999; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005), it has not received attention. Research thus far has treated the embodiment of the moral purity metaphor rather generically: washing one’s hands (the only cleaning manipulation used to date) is assumed to restore purity independent of the specific body part involved in the “dirty” act.

We explore whether motor modality might play a role in the embodiment of the moral purity metaphor, beginning with a reanalysis of Schnall, Benton, and Harvey’s (2008) findings. Their participants evaluated six moral transgressions overall less harshly after they had washed their hands. However, a closer analysis of the transgressions shows that hand-washing had the strongest effect on severity judgments of transgressions that primarily involved the use of hands (stealing; hitting a switch to kill one person instead of five; typing false information on a resume), with effect sizes ranging from $d = 0.61$ to 0.81 , p ’s $< .01$ to $.06$. When hands were not involved in the transgressions, or were involved along with other body parts, the impact of hand-washing was weaker (d ’s = 0.28 to 0.45) and not significant (p ’s $> .15$).

To provide a more direct test of the relevance of motor modality, we conducted a preliminary study by asking participants to recall an unethical act that involved either only their hands or only their mouth. Building on the earlier observation that immoral acts increase the attractiveness of cleaning products (Zhong & Liljenquist, 2006), we assessed participants' preference for cleaning products that target either the hands or the mouth (as part of an allegedly unrelated marketing study). As expected, participants rated hand sanitizer as more desirable after recalling a transgression that involved only their hands, but rated mouthwash as more desirable after recalling a transgression that involved only their mouth. This observation is consistent with our conjecture that embodiment of the moral purity metaphor is specific to the motor modality involved in the immoral act. Unfortunately, however, only one fourth of the participants could recall transgressions involving only the hands, whereas all could recall transgressions involving only the mouth, which introduces a self-selection problem.

The present study avoids self-selection issues by inducing participants to perform an immoral act (conveying a malevolent lie) or a moral act (conveying a benevolent message) in the lab, either on voicemail (using the mouth) or on email (typing it with the hands). This design allows us to test several possibilities of theoretical interest. First, if motor modality is irrelevant to the operation of the moral purity metaphor, conveying a lie should increase the attractiveness of hand sanitizer as well as mouthwash, independent of whether the lie is conveyed on voicemail or email. Second, if the metaphorical link is sensitive to motor modality, lying on voicemail should increase the attractiveness of mouthwash but not of hand sanitizer, whereas lying on email should increase the attractiveness of hand sanitizer but not of mouthwash. Third, much as people avoid contact with morally tainted objects and individuals but seek contact with moral

exemplars (Rozin & Nemeroff, 1990), they may not only seek to wash away the negative traces of immoral acts but may also avoid washing away the positive traces of virtuous acts. If so, leaving a benevolent message should decrease the attractiveness of cleaning products; this effect may also be specific to the motor modality of the moral act. Finally, the attractiveness of cleaning products may be affected by the mere salience of the body part to which they are applicable. If so, acts that involve the mouth (or hands) should increase the attractiveness of mouthwash (or hand sanitizer), independent of whether the act is moral or immoral.

Method

Participants and Procedure

Eighty-seven University of Michigan undergraduates (53 female, age 18 to 23) were randomly assigned to the conditions of a 2 (Ethicality: ethical vs. unethical act) x 2 (Modality: hands vs. mouth) between-subjects design.

As part of an ostensible study on verbal cues of personality, participants read and enacted a brief scenario. The scenario, written in the first-person singular, asked them to imagine being a junior partner in a law firm, up for promotion and competing with a colleague named Chris (cf. Zhong and Liljenquist, 2006, Study 2). Chris has lost an important document, which might jeopardize his case and hence his chance of promotion. The boss asked everyone to look for the document. Participants imagined finding the document in a file drawer, realizing that helping Chris would threaten their own career. At this point, the scenario manipulated modality and ethicality by asking participants to leave Chris a voicemail (involving the mouth) or to write him an email (involving the hands), “telling who you are and explaining to him that *you have looked through all your*

cabinets and could not find his document” (unethical) or “*as you looked through the cabinet, you found his document*” (ethical). Participants actually called Chris and left a voicemail or sent him an email, allegedly providing verbal data in spoken or written format for the personality analysis that served as the cover story.

Next, participants completed an ostensibly unrelated marketing questionnaire. They saw a list of consumer products with picture and name, rated each product’s desirability ($1 = \text{completely undesirable}$, $7 = \text{completely desirable}$), and reported how much they were willing to pay (WTP) for it in an open response format. The two products of interest, embedded among fillers, were mouthwash and hand sanitizer. Finally, participants were funnel-debriefed (Aronson, Ellsworth, Carlsmith, & Gonzales, 1990; Bargh & Chartrand, 2000); no participant indicated suspicion about the true purpose of the experiment.

Analyses

WTP data were positively skewed and log-transformed (Maxwell & Delaney, 2004). Desirability and log-transformed WTP data were standardized and submitted to a 2 (Ethicality: ethical vs. unethical) \times 2 (Modality: hands vs. mouth) \times 2 (Product: hand sanitizer vs. mouthwash) \times 2 (Measure: desirability vs. WTP) mixed ANOVA. The last two factors were within-subjects.

Results

Indicating a significant role of motor modality, an Ethicality \times Modality \times Product interaction emerged, $F(1, 81) = 10.29$, $p = .002$, $p_{rep} = .98$. This interaction was not moderated by Measure ($F < 1$, *ns*, for the 4-way interaction) and both measures were

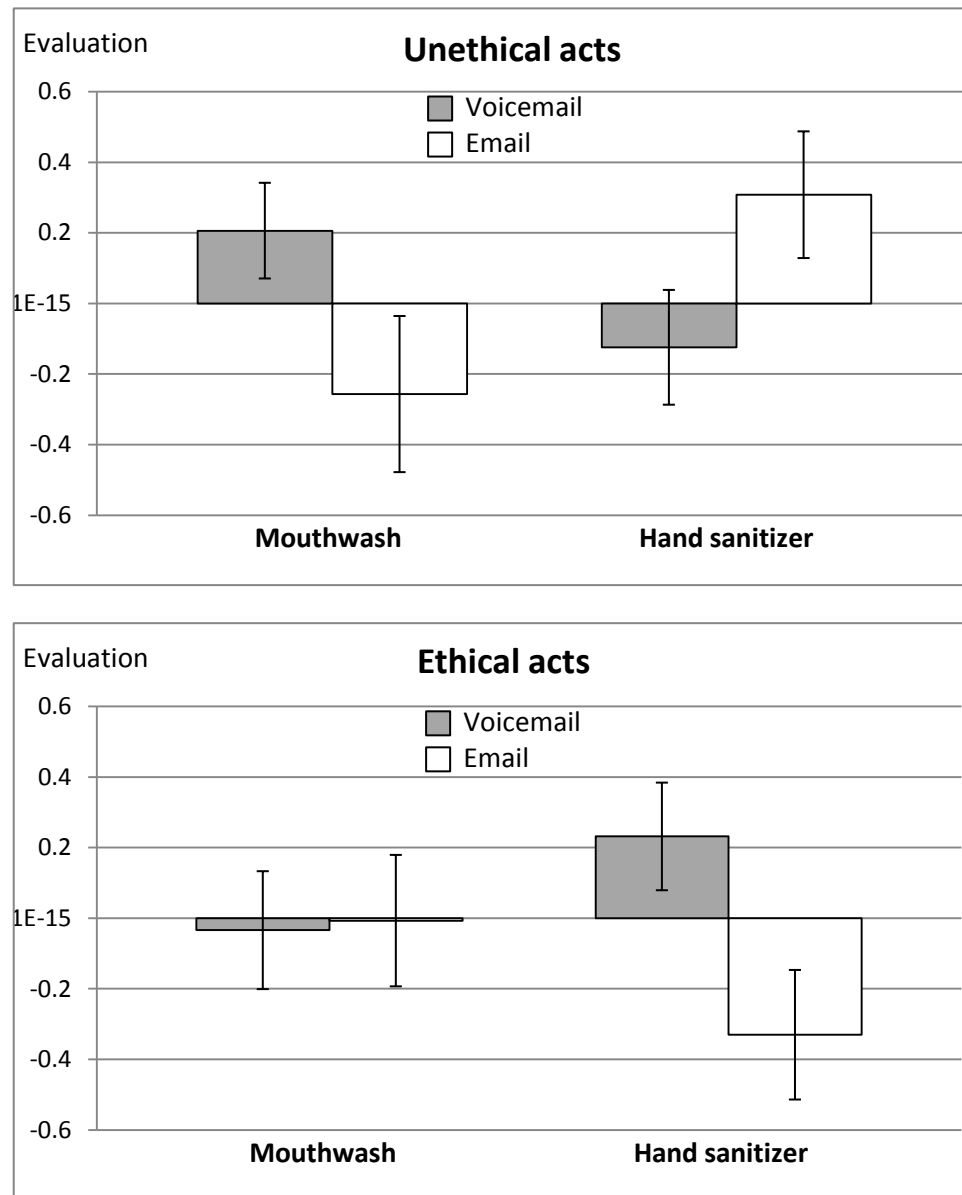
averaged to form an evaluation index, with higher values indicating higher desirability and WTP.

As predicted, participants who had acted malevolently to their colleague in order to advance their own career (Figure 3a) evaluated mouthwash more positively after telling the lie on voicemail ($M = 0.21$, $SD = 0.72$) than after typing it on email ($M = -0.26$, $SD = 0.94$), $F(1, 81) = 2.93$, one-tailed $p = .03$, $p_{rep} = .91$, $d = 0.55$. Conversely, they evaluated hand sanitizer more positively after typing the lie on email ($M = 0.31$, $SD = 0.76$) than after telling it on voicemail ($M = -0.12$, $SD = 0.86$), $F(1, 81) = 3.25$, one-tailed $p = .04$, $p_{rep} = .90$, $d = 0.53$. These effects are reflected in a significant Modality x Product simple interaction under unethical conditions, $F(1, 81) = 7.45$, $p = .008$, $p_{rep} = .96$.

Participants who had acted benevolently to their colleague at the risk of hurting their own career (Figure 3b) evaluated hand sanitizer less positively after telling the truth on email ($M = -0.33$, $SD = 0.82$) than after doing so on voicemail ($M = 0.23$, $SD = 0.70$), $F(1, 81) = 5.02$, $p = .03$, $p_{rep} = .91$, $d = 0.74$. However, motor modality had no effect on their evaluation of mouthwash, $F < 1$. These effects are reflected in a marginally significant Modality x Product simple interaction under ethical conditions, $F(1, 81) = 3.29$, $p = .07$, $p_{rep} = .85$.

Finally, simply using a body part (mouth or hands) did not increase the attractiveness of the corresponding cleaning product, as there was no significant Modality main effect for either mouthwash ($F(1, 81) = 1.28$, ns) or hand sanitizer ($F < 1$, ns).

Figure 3. Evaluation of mouthwash and hand sanitizer as a function of the motor modality of (a) unethical acts and (b) ethical acts (Lee & Schwarz, 2010b, Study 2)



Note. Error bars represent standard errors.

Discussion

The present findings converge with our reanalysis of Schnall et al.'s (2008) results and our preliminary study, lending support to the hypothesis that the embodiment

of the moral purity metaphor is specific to the motor modality involved in the act. First, participants who enacted an immoral act primarily wanted to clean the “dirty” body part (Figure 3a). Second, this motor modality effect under unethical conditions is not driven by the mere salience of the respective body part; if it were, ethical acts should similarly increase the desire for applicable cleaning products, which was not the case. Instead, third, enacting a moral act left participants’ desire for mouthwash unaffected and selectively decreased their desire for hand sanitizer when their virtuous deed involved the use of hands (Figure 3b).

Grounded Cognition and the Specificity of Embodiment

Abstract thoughts about morality are metaphorically grounded in concrete experiences with physical cleanliness (Lakoff & Johnson, 1980, 1999). Natural language use suggests that this grounding often implies a specific body part (“dirty hands”, “dirty mouth”). To the extent that a moral transgression involves a specific motor modality, it selectively increases the desire to clean the respective body part. Moreover, our reanalysis of Schnall et al.’s (2008) data suggests that people’s moral judgments of others’ transgressions are most strongly affected when they have cleansed the specific body part involved in the described act. Following this logic, immoral acts in one’s environment may increase the desire to clean the external world, consistent with metaphorical references to “dirty business”, “dirty politics” or “dirty money”. Zhong and Liljenquist (2006, Study 2) had participants copy a story about an immoral other (the unethical scenario of the present study). Their manipulation did not require participants to enact the scenario and thus did not imply any unethical acts or motives of the participants themselves. While this manipulation increased the overall desirability of five cleaning

products (average $d = 1.00$), a reanalysis shows stronger effects on products that clean the external world (Tide detergent, $d = 1.15$; Lysol disinfectant, $d = 0.75$) than on products that clean one's own body (Dove soap, $d = 0.37$). The specificity observed across these studies is compatible with the logic of metaphorical grounding (Lakoff & Johnson, 1999) and embodiment (Barsalou et al., 2003); it has theoretical and empirical implications for moral thought, magical thinking, and priming.

Morality and Magical Thinking

The desire to wash away one's guilt, and the efficacy of doing so (Zhong & Liljenquest, 2006, Study 4), entails magical thinking: immoral acts leave a (metaphorical) residue of impurity that can be cleansed away. Moreover, this residue is seen as contagious and people avoid contact with possessions of immoral others (Rozin & Nemeroff, 1990); conversely, they seek contact with possessions of awe-inspiring figures and prefer their possessions with the residue maintained rather than washed away (Bloom, 2009). Such observations raise the possibility that actors may also avoid removing the (metaphorical) residue of their own positive deeds. Suggestively, participants in our experiment showed weaker desires for cleaning products under the ethical conditions, although only one of two products was affected. Future research may fruitfully address the conditions under which doing good leaves positive residues that people may avoid washing away.

Ongoing work further indicates that the power of cleaning behavior extends beyond the moral domain. Washing one's hands can eliminate traces of past events that have no moral connotations. For example, it can wash away the cognitive dissonance that results from choosing between equally attractive options (Lee & Schwarz, 2010a) and

attenuate the impact of past streaks of good or bad luck (Xu, Zwick, & Schwarz, 2012). These findings suggest that people may not only wash their hands of past moral transgressions, but may more generally attempt to reap the psychological benefits of cleanliness whenever a “clean slate” seems desirable.

Embodied Metaphors and the Power of Priming Procedures

Many abstract concepts are comprehended and represented as embodied metaphors (Lakoff & Johnson, 1999) and a growing number of studies illustrates the impact of physical attributes such as temperature (Williams & Bargh, 2008a; Zhong & Leonardelli, 2008), weight (Jostmann, Lakens, & Schubert, 2009), and physical distance (Williams & Bargh, 2008b) on judgments of metaphorically related psychological attributes such as affection, importance, and social distance. While the accumulating findings (for a review, see Williams, Huang, & Bargh, 2009) challenge approaches that conceptualize the context dependency of human judgment within amodal models of knowledge representation and activation (for reviews see Förster & Liberman, 2007; Higgins, 1996), the predictive power of an embodied approach may be enhanced by paying closer attention to the motor modality involved in a given act. For example, contextual influences should be stronger when the motor modality of the independent variable matches rather than mismatches the motor modality of the dependent variable. In a seminal study, Bargh, Chen, and Burrows (1996) used a scrambled sentence task to prime participants with rudeness or politeness concepts and found that rudeness-primed participants were faster to interrupt others. Would such effects be more pronounced if the motor modality of the priming procedure (e.g., pronouncing the scrambled sentences vs. typing them) matched the motor modality of the interruption (e.g., speaking up vs.

pressing an alarm button)? Exploring such possibilities may advance our understanding of the role of motor modality in embodied cognition beyond the morality domain addressed in the present study.

CHAPTER 4

CAN METAPHORICAL EFFECTS RUN BIDIRECTIONALLY BETWEEN THE ABSTRACT AND CONCRETE DOMAINS? (QUESTION 3) CAN METAPHORICAL EFFECTS BE MEDIATED BY THE ACCESSIBILITY AND MODERATED BY THE APPLICABILITY OF METAPHORICALLY ASSOCIATED KNOWLEDGE? (QUESTION 4)

Note. This work was published in Lee, S. W. S., & Schwarz, N. (in press-a).

Bidirectionality, mediation, and moderation of metaphorical effects: The embodiment of social suspicion and fishy smells. *Journal of Personality and Social Psychology*.

Abstract. Metaphorical effects are commonly assumed to be unidirectional, running from concrete to abstract domains but not vice versa. Noting that metaphorical effects are often found to be bidirectional, we explore how they may be mediated and moderated according to the principles of knowledge accessibility and applicability. Using the example of “something smells fishy” (a metaphorical expression of social suspicion), seven experiments tested for the behavioral effects of fishy smells on social suspicion among English speakers, the reversed effects of suspicion on smell labeling and detection, and the underlying mechanism. Incidental exposure to fishy smells induced suspicion and undermined cooperation in trust-based economic exchanges in a trust game (Study 1) and a public goods game (Study 2). Socially induced suspicion enhanced the correct labeling of fishy smells, but not other smells (Studies 3a-c), an effect that could be mediated by the accessibility and moderated by the applicability of metaphorically associated concepts (Studies 4-6). Suspicion also heightened detection sensitivity to low concentrations of

fishy smells (Study 7). Bidirectionality, mediation, and moderation of metaphorical effects have important theoretical implications for integrating known wisdom from social cognition with new insights into the embodied and metaphorical nature of human thinking. These findings also highlight the need for exploring the cultural variability and origin of metaphorical knowledge.

Many constructs in social cognition are metaphorical. For example, a friendly person has a warm personality; a powerful CEO is high up in the hierarchy; a moral figure has clean hands and a pure heart. *Warm*, *high*, and *clean* are but a few examples of a wide variety of terms with both physical and psychological referents. Decades ago Asch (1955, 1958) noted the dual and metaphorical nature of physical experiences, but systematic investigation into their psychological consequences has only recently come to the fore. This work was motivated by conceptual metaphor theory in cognitive linguistics (Lakoff & Johnson, 1980) and has gained momentum in the past few years, showcasing numerous novel phenomena: Holding a warm cup of coffee promotes affectionate behavior (Williams & Bargh, 2008a), presenting targets in high location makes them look powerful (Schubert, 2005), and cleaning one's hands restores one's sense of moral purity (Zhong & Liljenquist, 2006). These metaphorical effects were surprising at first, but with accumulating evidence they now seem to be recognized as the rule, not the exception.

A common assumption about metaphorical effects is their unidirectional nature. Lakoff and Johnson (1980, p. 112) made this point plainly: "there is directionality in metaphor.... Specifically, we tend to structure the less concrete and inherently vaguer concepts (like those for the emotions) in terms of more concrete concepts, which are more clearly delineated in our experience." Similarly, social psychologists doing

metaphors research argue that “early sensorimotor experiences serve as the foundation for the later development of more abstract concepts and goals” (Williams, Huang, & Bargh, 2009, p. 1257). In the most recent and comprehensive review of the psychological consequences of conceptual metaphors, Landau, Meier, and Keefer (2010, p. 1052) remarked, “Cognitive linguists stress that... metaphorical mappings between dissimilar concepts tend to go in the direction of a concrete source concept to a relatively more abstract target concept, but not the other way around.” These observations lead one to expect that in a conceptual metaphor the concrete domain should affect the abstract domain, but not vice versa.

In stark contrast to this interpretation, behavioral research on conceptual metaphors consistently reveals bidirectional effects. Most studies in this literature examine either concrete-to-abstract or abstract-to-concrete effects but not both, so bidirectionality only becomes obvious when separate studies are juxtaposed. For example, physical temperature influences interpersonal affection (Williams & Bargh, 2008a); conversely, social exclusion changes estimates of physical temperature and desires for warm beverages (Zhong & Leonardelli, 2008). Vertical movement or location in physical space influence perception of power relations (Schubert, 2005); conversely, knowledge about power relations changes estimates of vertical location (Giessner & Schubert, 2007). Physical cleanliness influences moral judgment and behavior (Liljenquist, Zhong, & Galinsky, 2010; Schnall, Benton, & Harvey, 2008; Zhong, Strejcek, & Sivanathan, 2010); conversely, moral thought and behavior change desires for cleaning products (Lee & Schwarz, 2010b; Zhong & Liljenquist, 2006). Similar bidirectional effects have been found between weight and importance (Jostmann, Lakens, & Schubert, 2009; Schneider et al., 2011), vertical position and affective valence (Crawford, Margolies, Drake, &

Murphy, 2006; Meier & Robinson, 2004; Weger, Meier, Robinson, & Inhoff, 2007), and more.

How can we account for such consistent bidirectional effects? And why does the issue matter? We begin by reviewing current opinions and identifying several common confusions. Clarifying them casts new light on bidirectional effects and their theoretical implications for conceptual metaphor theory. From conceptual metaphor theory, the fluid nature of perception, and the embodied nature of cognition, we derive predictions about how metaphorical effects may be bidirectional, mediated, moderated, and manifest even in perceptual sensitivity. We tested these predictions in seven experiments with the “something smells fishy” metaphor, which links a specific olfactory perception and social suspicion.

Why Is Directionality Important?

The social psychological literature on metaphors has some scattered but interesting discussion about the issue of directionality. A metaphorical effect is considered bidirectional if (a) manipulation of the concrete domain affects measurement in the abstract domain (concrete-to-abstract) and (b) manipulation of the abstract domain affects measurement in the concrete domain (abstract-to-concrete). A metaphorical effect is considered unidirectional if either (a) or (b) is true. Notably, the common assumption is that (a) should occur and (b) should not. That is probably why Williams, Huang, and Bargh (2009, p. 1263) used the term “reverse directionality” in describing these two findings: recalling one’s immoral behavior increases the accessibility of cleansing-related concepts and the desire for cleaning products (Zhong & Liljenquist, 2006); psychological pain triggers the physical pain system (DeWall & Baumeister, 2006). Both were abstract-

to-concrete effects. More abstract-to-concrete effects appeared in the review by Landau et al. (2010), who pointed out in a footnote (p. 1052), “These findings raise questions about whether, when, and how metaphors operate bidirectionally. These questions cannot be adequately addressed in this article given the available evidence.” This point, however, was taken up by IJzerman and Koole (2011, p. 356), who commented that bidirectional effects (e.g., between temperature and affection; IJzerman & Semin, 2010; Zhong & Leonardelli, 2008) “make little sense if one assumes that conceptual metaphors function like schemas” but “can be easily handled by grounded cognition theories (e.g., Barsalou, 1999, 2008)... and there is no need to postulate asymmetrical influence between metaphorically related domains.”

The same point was made by Schneider, Rutjens, Jostmann, and Lakens (2011). Finding that manipulating a book’s perceived importance changed its estimated weight, they suggested (p. 477) “the present findings seem to render an explanation from a metaphor-enriched perspective implausible because it is inconsistent with the claim that physical sensations (i.e., weight) always serve as the source domain, whereas abstract conceptualizations (i.e., importance) serve as the target domain (Landau et al., 2010). Instead, the present findings can be explained by an embodied simulation account (Barsalou, 2008). According to this perspective, the abstract concept (i.e., importance) is grounded in related bodily states (i.e., feeling weight). Because abstract knowledge and simulations of bodily states are closely intertwined, their activation co-occurs irrespective of the direction of activation.”

With these challenges, Landau, Keefer, and Meier (2011, p. 364) concurred: “IJzerman and Koole (2011) correctly pointed out that the issue of mapping direction challenges accepted views of conceptual metaphor. For them, the solution seems to lie in

abandoning consideration of metaphor, whereas we hold out the hope that future research can resolve this issue while preserving the benefits of a metaphor-enriched perspective on social cognition.” Clearly the cited authors differ in their sentiments, but they share the assumption that bidirectional effects pose a real challenge to conceptual metaphor theory. Is this assumption valid?

Bidirectionality in Conceptual Metaphor Theory

Lakoff and Johnson offered the most detailed version of conceptual metaphor theory in their 1999 book *Philosophy in the Flesh*. A careful reading of it suggests that bidirectionality is not nearly as detrimental to the theory as commonly assumed. Their framework for the emergence and operation of a primary metaphor (pp. 46-56) can be summarized as follows: Early life experience involves repeated confluences between the concrete and abstract domains. For example, mom holds you, and you feel warm, both physically and socially. Such experiential correlation causes neural coactivation of the concrete and abstract domains, which builds up cross-domain neural connections. (In fact Lakoff and Johnson only had neural models but not biological data to back up their claim of neural connections. Nevertheless, that is their assumption.) Cross-domain neural connections are supposed to provide the biological foundation for the cross-domain conceptual structure, which they call a conceptual metaphor. Within a conceptual metaphor, the concrete domain projects its image-schematic, motor-schematic, and inferential structures onto the abstract domain to make sense of it, guide inferences in it, or construct new meanings about it. A conceptual metaphor is not just a representational structure; it also has linguistic consequences (how people talk about the concept in language) and psychological consequences (how people feel, act, and reason based on the

concept).

The mechanism of concrete-to-abstract projection is probably the best-known aspect of the framework, as seen earlier in various authors' renderings of conceptual metaphor theory. Note that while projection is unidirectional, experiential correlation and neural coactivation are bidirectional. The unidirectionality of projection is assumed to result from the nature of concrete domains: Relative to abstract ones, they involve more direct sensorimotor experience, are easier to understand and acquired earlier in life, have greater inferential richness and capacity. What is understood more directly, easily, and richly structures what is less so. Presumably that is why metaphorical linguistic expressions generally use concrete domains to talk about abstract domains but not vice versa (e.g., Glucksberg, McGlone, & Manfredi, 1997). In short, Lakoff and Johnson's cognitive linguistics analysis draws inferences about a conceptual metaphor's unidirectional structure from its unidirectional linguistic consequences.

Of the many claims made in this framework, three are particularly vulnerable to confusion, leading one to expect unidirectionality where it should not be.

1. Linguistic and Psychological Consequences. A conceptual metaphor has both linguistic and psychological consequences. These are different things. Linguistic patterns should not be mistaken for psychological processes because the two do not necessarily correspond to each other (e.g., Murphy, 1996, 1997). So even though a conceptual metaphor's linguistic expressions do tend to be unidirectional, its psychological consequences do not have to be. Often they are not.

2. Representational Structure and Online Processing. The framework focuses on distal, long-term effects: Cross-domain experiential correlation in early life experience leads to neural coactivation and builds up neural connections, which over time form the

basis of conceptual structures that shape how people talk, feel, act, and reason. It says little about proximal effects such as online processing. Even when a conceptual metaphor has a unidirectional representational structure, its online processing may not show unidirectional effects. The former does not necessitate the latter. Unfortunately, the difference between structure and processing seems commonly missed. Some recognize that conceptual metaphor theory lacks specification about online processing and thus believe that “it cannot make predictions on performance in behavioural tasks of the kind used in psychological experiments” (Santiago et al., 2011, p. 46). Our reading of Lakoff and Johnson (1999) is a little different, as elaborated in the next point.

3. *Projection and Coactivation.* While their framework does not directly address online processing, it does specify two mechanisms, projection and coactivation, that produce a conceptual metaphor’s linguistic and psychological consequences over time. One can infer that the same two mechanisms are likely to remain active and thus be involved in the online processing of a conceptual metaphor. To date social psychological research on metaphors has offered numerous demonstrations, but little insight into mechanisms (Meier, Schnall, Schwarz, & Bargh, in press). Whether the demonstrated metaphorical effects are mediated by projection or coactivation remains unclear. Projection is unidirectional; coactivation is bidirectional. It takes little effort to conceptualize the demonstrated metaphorical effects through the lens of coactivation. For example, holding a warm cup of coffee causes people to judge a target person as having a warmer personality (Williams & Bargh, 2008a). This concrete-to-abstract effect may occur because warm sensation activates the neural basis of physical warmth, which coactivates the neural basis of social warmth, which shifts the judgment of a target’s ambiguous personality. Conversely, being socially rejected causes people to estimate the

ambient temperature to be lower (Zhong & Leonardelli, 2008). This abstract-to-concrete effect may occur because social rejection activates the neural basis of social coldness, which coactivates the neural basis of physical coldness, which shifts the estimation of a room's ambiguous temperature. Whether coactivation is the underlying mechanism of this and other metaphorical effects remains to be tested. If so, it would render bidirectionality possible and expected.

In sum, does the bidirectionality of metaphorical effects challenge conceptual metaphor theory? Not necessarily, because the psychological consequences of a conceptual metaphor can show both concrete-to-abstract and abstract-to-concrete effects, which are conceptually distinct from linguistic patterns, have more to do with online processing than representational structure, and may be driven by coactivation instead of or in addition to projection.

Bidirectionality, Mediation, and Moderation of Metaphorical Effects

So far we have said that bidirectional effects can occur across metaphors (e.g., Affection Is Warmth, Morality Is Cleanliness, Importance Is Weight, Power Is Up, Good Is Up). Contrary to common interpretation, they are compatible with conceptual metaphor theory because online processing of a representational structure (a conceptual metaphor) can produce psychological consequences that are independent of linguistic patterns and potentially mediated by coactivation. This dovetails with other perspectives that lead us to expect bidirectionality as well.

First, although conceptual metaphor theory designates sensorimotor experiences as “concrete” domains, people's understanding of their sensorimotor experience is rather fluid. It is attuned to motivational, emotional, conceptual, and contextual variations. As

shown in a long tradition of research dating back to the New Look (e.g., Bruner, 1957; Bruner & Goodman, 1947), a person's current goals and needs, feelings and action possibilities, stereotypes and cultural knowledge all systematically affect her supposedly "basic" perception (for reviews, see Balci & Lassiter, 2010; Gibson, 1979; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005; Norenzayan, Choi, & Peng, 2007; Proffitt, 2006; Witt, 2011; Zadra & Clore, in press). From this perspective, sensorimotor experiences and psychological states are in dynamic interaction, so sensorimotor experiences should not only change psychological states (concrete-to-abstract effects), but also be readily shaped by them (abstract-to-concrete effects).

Second, higher-order cognition presumably reuses evolutionarily older neural mechanisms for sensorimotor interactions with the environment (Anderson, 2010). It may be why thinking is action-oriented, situated, and embodied (e.g., Barsalou, 2008; Fiske, 1992; James, 1890; Schwarz, 2002; Smith & Semin, 2004). The embodied nature of cognition means that knowledge is represented in bodily states or sensorimotor modalities in the neural system, so processing sensorimotor information should activate conceptual knowledge (concrete-to-abstract effects) and processing conceptual information should invoke the bodily states or sensorimotor modalities in which it is represented (abstract-to-concrete effects).

These perspectives converge in their prediction that online processing of metaphorical knowledge structure can produce bidirectional psychological consequences. Furthermore, if metaphorical effects result from the online processing of metaphorically associated knowledge, they may operate in accordance with the basic principles of knowledge activation and use (Higgins, 1996; see also Förster & Liberman, 2007). Accordingly, metaphorical effects should be mediated by the accessibility of

metaphorically associated knowledge and moderated by its applicability to the target. And if metaphorically associated knowledge is indeed represented in bodily states and sensorimotor modalities, then processing the conceptual information in a metaphor should invoke and thus prioritize processing of the metaphorically relevant sensory information and heighten perceptual sensitivity to it.

Our primary goal in this paper is to test these predictions. In addition, we seek to extend the sensory modalities examined in metaphor research from the modalities of sight, touch, and taste to a much less studied modality: smell.

The Present Research: Something Smells Fishy

Smell is used metaphorically to indicate suspicion in at least 18 languages, from Arabic, Bulgarian, and Chinese to French, German, and Spanish (Soriano & Valenzuela, 2008). Across these languages, suspicious acts “have a smell.” The specific smell differs by language; in English it is fishy. If *suspicious* and *fishy* are not just a linguistic quirk but are metaphorically associated in English speakers’ knowledge structure, the metaphorical association should have psychological consequences. We test whether this is the case. Addressing our predictions, we further assess whether the expected metaphorical effects are (i) bidirectional, (ii) mediated by accessibility, (iii) moderated by applicability, and (iv) manifest even in perceptual sensitivity. If so, smelling something fishy should elicit suspicion, and suspicion should affect what people think they smell. This effect should occur through the activation and application of metaphorical associations between *suspicious* and *fishy*. Suspicion should also prioritize the processing of fishy smells and heighten perceptual sensitivity to it.

We tested these predictions in seven experiments. Studies 1 and 2 examined

whether incidental fishy smells make people suspicious and undermine their willingness to engage in trust-based economic exchanges, specifically, in a trust game (Study 1) and a public goods game (Study 2). Reversing the direction of influence, Studies 3a-3c tested whether socially induced suspicion enhances people's ability to correctly label fishy smells but not other smells. Studies 4-6 used an experimental causal-chain approach to test the hypothesized process of activating and applying metaphorically associated knowledge: socially induced suspicion should increase the accessibility of suspicion-related concepts (Study 4), which may increase the accessibility of fish-related concepts (Study 5) to improve the correct labeling of fishy smells but not of other smells (Study 6). Finally, Study 7 used a signal detection paradigm to investigate whether suspicion shifts the processing priority of fishy smells and sensitizes people to detecting such metaphorically related smells.

Study 1: Fishy Smells Undermine Willingness to Invest in A Trust Game

People are attuned to a wide variety of cues that signal whether to trust or suspect. These signals include attributes of the target person, such as reputation (Burt & Knez, 1996), facial features (Zebrowitz, 1997), and nonverbal behaviors (Bond et al., 1992); attributes of the perceiver, such as risk calculations (Dasgupta, 1988), oxytocin levels (Kosfeld, Heinrichs, Zak, Fischbacher, & Fehr, 2005), and neural activities (King-Casas et al., 2005); and attributes of the context, such as social distance (Buchan & Croson, 2004), task structure (Sheppard & Sherman, 1998), and risk of betrayal (Bohnet & Zeckhauser, 2004). Going beyond these, we explore whether people respond even to incidental cues that are unrelated to the target, perceiver, or task, but merely metaphorically related to suspicion: Does smelling something fishy in the environment

make people suspicious and unwilling to engage in trust-based cooperation?

To test this, Study 1 uses a trust game (modeled after Berg, Dickhaut, & McCabe, 1995), in which people are more likely to invest their own resources when they trust their partners to reciprocate. Study 2 uses a public goods game (modeled after Ledyard, 1995), in which people are more likely to invest in a pool of shared resources when they trust their partners to carry their own share of responsibility. In both cases, any suspicion that the partner may not be fully cooperative undermines the actor's cooperation. Of interest is whether exposure to incidental fishy smells is sufficient to elicit such suspicion and to undermine trust-based cooperation.

Method

Participants and Design. Forty-five students (mean age = 20.1 years, 22 female) at the University of Michigan participated in a one-shot trust game. They were approached individually on campus and randomly assigned to three smell conditions in a between-participants experimental design: fish oil ($n = 16$), fart spray ($n = 15$), or water ($n = 14$).

Procedure. While one experimenter blind to the smell condition was recruiting individual participants for a class project allegedly about investment decisions, another experimenter sprayed 0.5 ounce of fish oil, fart spray, or water in a hallway corner of a campus building. The actual participant was asked to be Decision-Maker 1 and a confederate was recruited as Decision-Maker 2. Both were escorted to the sprayed corner area, where each received 20 quarters (\$5) and an investment form with instructions: Decision-Maker 1 had the investment option of sending any number (all, some, or none) of the 20 quarters to Decision-Maker 2. Every quarter sent would be quadrupled in value,

turning a quarter into a dollar. Decision-Maker 2 could return any amount (all, some, or none) to Decision-Maker 1. Finally, each decision-maker was told that they would leave with the money in hand. Given an incentivizing factor of four, participants should invest more if they trust their partner to reciprocate but invest less if they suspect their partner to default.

Finally, participants reported their mood (“How do you feel right now?”; $-4 = \text{very bad}$, $4 = \text{very good}$) and were probed for insight into the experiment’s purpose.

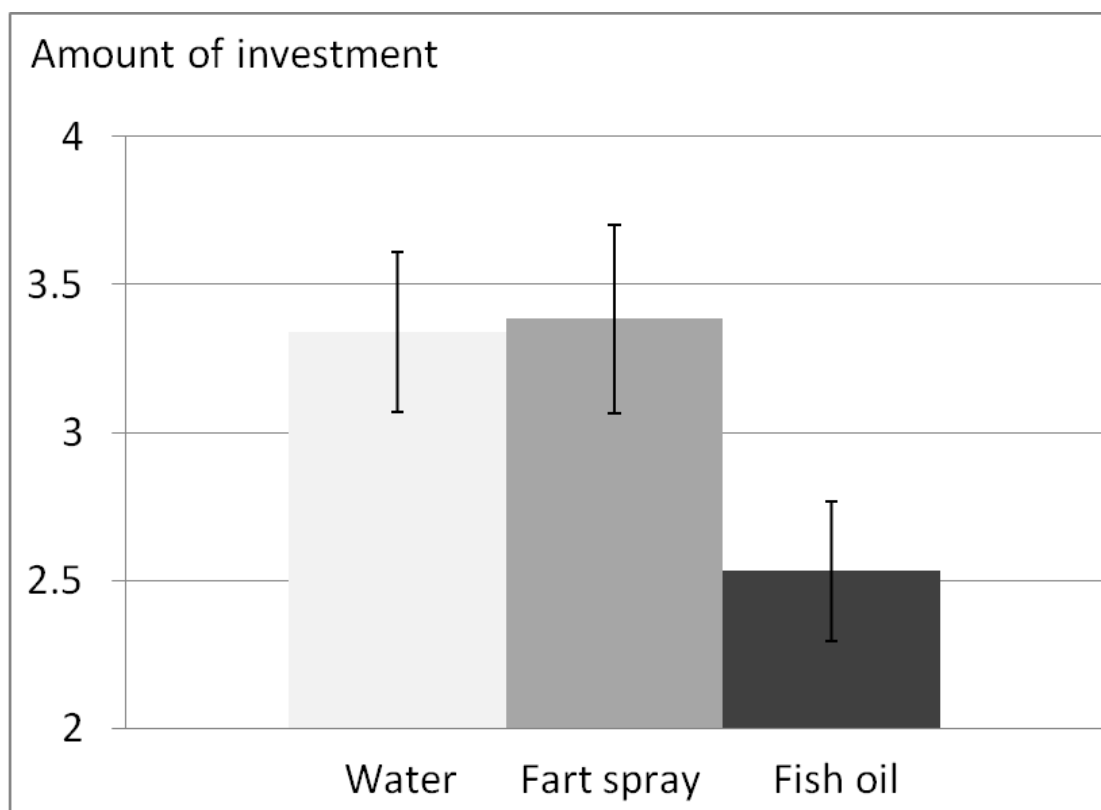
Materials. Smell substances were prepared in advance and contained in liquid form in 2-ounce spray bottles smaller than hand size so that when the experimenter sprayed smells, pedestrians would not notice. Fish oil was prepared by cutting open softgels of anchovy and sardine concentrate (brand: Nature Made) and pouring out the contents. Fart spray was a non-hazardous objectionable liquid that smells like flatus (Liquid Asset Novelties). This unpleasant but metaphorically irrelevant smell was included to test the alternative explanation that any unpleasant smell would elicit suspicion. Tap water was used as an odorless control condition.

Results and Discussion

As expected (Figure 4), participants who were exposed to incidental fishy smells invested less money ($M = \$2.53$, $SD = \$0.93$) than those who were exposed to odorless water ($M = \$3.34$, $SD = \$1.02$, planned-contrast $t(42) = 2.07$, $p = .05$, Cohen’s $d = 0.83$) or fart spray ($M = \$3.38$, $SD = \$1.23$, $t(42) = 2.22$, $p = .03$, $d = 0.78$). The amount of investment did not differ significantly between the latter two conditions ($t(42) = 0.11$, $p = .91$), and mood was unaffected by the smell conditions ($F < 1$), suggesting that the fishy effect was not driven by generic valence or mood. Upon probing, no participant

indicated awareness of the experiment's purpose. In sum, smelling something fishy reduced investment in a trust game by 25% relative to a neutral smell or an unpleasant smell without suspicion-related metaphorical meaning.

Figure 4. Amount of investment in a one-shot trust game as a function of incidental smell (Lee & Schwarz, in press-a, Study 1)



Note. Error bars represent standard errors.

When people are suspicious, they should be less willing to engage in any kind of trust-based activities, whether it requires trusting others to honor reciprocity and return benefits (as in Study 1) or trusting others to honor shared responsibilities and contribute to shared resources. If one suspects the neighbor is a free-rider, one is concerned about being ripped off and contributes less (Pruitt & Kimmel, 1977). We tested this possibility

in Study 2 to conceptually replicate the fishy effect and extend it to a different behavioral economics context, using a two-investor public goods game.

Study 2: Fishy Smells Undermine Willingness to Contribute to A Public Goods Game

Method

Participants and Design. Eighty-two students (mean age = 20.5 years, 24 female) at the University of Michigan were randomly assigned to three smell conditions in a between-participants experimental design: fish oil ($n = 28$), fart spray ($n = 26$), or water ($n = 28$).

Procedure and Materials. Using the same manipulation as in Study 1, an experimenter sprayed one of three smells in a hallway corner of a campus building while another experimenter blind to the smell condition approached two participants individually and escorted them to the corner area. Each participant received 20 quarters (\$5) and an investment form with instructions: Each investor had the option of investing any number of the 20 quarters into a common pool. Every quarter invested would be multiplied by a factor of 1.8. The total amount in the pool would be divided equally among investors regardless of their initial contributions. Finally, each investor was told that they would leave with the money in hand.

Results and Discussion

Participants exposed to fishy smells contributed less money ($M = \$2.65$, $SD = \$1.27$) than those exposed to water ($M = \$3.86$, $SD = \$1.36$, planned contrast $t(79) = 3.37$, $p = .001$, $d = 0.92$) or fart spray ($M = \$3.38$, $SD = \$1.39$, $t(79) = 2.01$, $p = .05$, $d = 0.55$).

The amount of investment did not differ significantly between the latter two conditions, $t(79) = 1.30, p = .20$. Conceptually replicating Study 1 in an investment task with different economic considerations, Study 2 showed that smelling something fishy reduced trust-based contributions to shared resources, whereas smelling an unpleasant but metaphorically irrelevant smell did not.

Studies 1 and 2 support the hypothesis that incidental exposure to fishy smells elicits suspicion and undermines social trust and cooperative investment. These effects presumably occur because fishy smells activate metaphorically associated knowledge that is brought to bear on the decision at hand—“there’s something fishy” about the situation. In both studies, the metaphorical effect runs from sensory perception to inferences about an unfamiliar situation and an unknown other’s likely behavior. The direction is concrete-to-abstract. Does the reversed direction also work? That is, does socially induced suspicion make people more likely to smell something fishy?

Studies 3a-3c: Socially Induced Suspicion Enhances Correct Labeling of Fishy Smells

Study 3a Method

Participants and Design. Eighty students (mean age = 20.7 years, 44 female) at the University of Michigan participated in a smell labeling study. They were approached individually on campus and randomly assigned to two conditions in a between-participants experimental design: suspicion ($n = 40$) or non-suspicion ($n = 40$).

Procedure. The experimenter presented a rack of five test tubes containing fragrance oil or food substance in the following order: (1) “autumn apple” fragrance oil, (2) minced onion, (3) “creamy caramel,” (4) “orange nectar,” and (5) fish oil. Participants

were asked to close their eyes, sniff each test tube sequentially, and write down any smell that came to mind. Half of the participants began the sniffing task right away (non-suspicion condition). For the other half (suspicion condition), the experimenter added to the instructions, “Obviously, it’s a very simple task and, you know, there’s... there’s nothing we’re trying to hide here.” The experimenter then suddenly noticed a document underneath the participant’s response sheet, hastily took it away, put it in her bag, came back, smiled awkwardly, and said, “Sorry, it shouldn’t have been there. But... ahem... anyway. Where was I? Oh yes, it’s all very simple. There’s nothing we’re trying to hide or anything. Any questions? Ok, good, good, you can get started whenever you’re ready.” Participants then began the sniffing task and recorded their responses. Responses that indicated any ingredient of the smell substance (e.g., fish, sardine, anchovy, in the case of fish oil) were coded as correct labeling.

Materials. Each of the five test tubes was 50 mL in volume, wrapped in aluminum foil, and contained 5 mL of fragrance oil or food substance. Test tube 1 was “autumn apple” fragrance oil, containing apples, pear blossoms, and applewood (brand: Bath & Body Works). Test tube 2 was minced onion (Meijer). Test tube 3 was “creamy caramel,” containing melted butter, caramel toffee, and vanilla (Bath & Body Works). Test tube 4 was “orange nectar,” containing mandarin, tangerine, clementine, sugared musk, and lemon flower (Bath & Body Works). Test tube 5 was the same fish oil as used in Studies 1 and 2 (Nature Made).

Study 3a Results and Discussion

As expected, participants were more likely to correctly label the fish oil if they had been induced to feel suspicious (72.5%) than if not (50.0%), $\chi^2(1, N = 80) = 4.27, p$

= .04, $d = 0.47$. Suspicion induction had no significant effect on participants' likelihood of correctly labeling any of the other four smells (Table 2 top panel).

Table 2. Percentage of participants who correctly labeled the smells as a function of suspicion vs. non-suspicion condition (Lee & Schwarz, in press-a, Studies 3a & 3b).

Smell in Study 3a	% of participants with correct labeling		$\chi^2(1, N = 80)$	p
	Non-suspicion	Suspicion		
1. Autumn apple	30.0	17.5	1.73	.19
2. Minced onion	20.0	7.5	2.64	.11
3. Creamy caramel	42.5	35.0	0.47	.49
4. Orange nectar	77.5	70.0	0.58	.45
5. Fish oil	50.0	72.5	4.27	.04

Smell in Study 3b	% of participants with correct labeling		$\chi^2(1, N = 54)$	p
	Non-suspicion	Suspicion		
1. Minced garlic	46.7	41.7	0.14	.71
2. Cinnamon stick	46.7	45.8	0.004	.95
3. Fish oil	6.7	33.3	6.28	.01
4. Autumn pumpkin	36.7	37.5	0.004	.95
5. Fart spray	30.0	33.3	0.07	.79

Several observations led us to conduct a couple of follow-up studies. First, we noticed that other than fish oil, the only aversive smell in Study 3a was onion, and even that might be aversive to some participants but not to others. Clearly aversive smells should be added. Second, fish oil was presented as the last smell, and the last item in a series can be perceived in unique ways (O'Brien & Ellsworth, 2012). Putting fish oil in a different position would be desirable. Third, we wanted to replicate the metaphor-specific nature of the observed effect and assess the extent to which it requires cognitive resources.

To address these issues, we varied the position of fish oil and included a foul smell (fart spray) and new fragrant oils in Studies 3b and 3c, added a food-related aversive smell (garlic) in Study 3b, and added a cognitive load manipulation in Study 3c.

Study 3b Method

Participants and Design. Fifty-four students (mean age = 18.7 years, 35 female) at the University of Michigan participated in individual lab sessions. They were randomly assigned to two conditions in a between-participants experimental design: suspicion ($n = 24$) or non-suspicion ($n = 30$).

Procedure and Materials. This study was included as part of an hour-long lab session (see Study 7). We used the same procedure as in Study 3a but changed the test tube contents and order. Test tube 1 was minced garlic (brand: McCormick's). Test tube 2 was "cinnamon stick" fragrance oil, containing pink peppercorn, clove buds, and nutmeg (Bath & Body Works). Test tube 3 was fish oil (Nature Made). Test tube 4 was "autumn pumpkin," containing pumpkin, ground cinnamon, brown sugar, and vanilla cream (Bath & Body Works). Test tube 5 was fart spray (Liquid Asset Novelties).

Study 3b Results

Replicating Study 3a, participants were more likely to correctly label the fish oil if they had been induced to feel suspicious (33.3%) than if not (6.7%), $\chi^2(1, N = 54) = 6.28$, $p = .01$, $d = 0.73$. Suspicion induction had no significant effect on participants' likelihood of correctly labeling the other four smells, whether fragrant or foul (Table 2 bottom panel). This replicates Study 3a. But to what extent does the observed effect require cognitive resources?

Study 3c Method

Participants and Design. Ninety-one students (mean age = 20.0 years, 54 female) at the University of Michigan participated in a smell labeling study. They were approached individually on campus and randomly assigned to a 2 (suspicion vs. non-suspicion) x 2 (low vs. high cognitive load) between-participants experimental design.

Procedure. We used the same procedure as in Studies 3a and 3b, and simply added a cognitive load manipulation right after the time of suspicion induction and before the sniffing task. Participants picked a paper slip from a bag, read the number printed on it, and had five seconds to memorize it. The number was either one-digit (low cognitive load) or eight-digit (high cognitive load) and was to be reported at the end of the study.

Materials. Test tube 1 was “warm vanilla sugar” fragrance oil, containing vanilla, coconut, basmati rice, and sandalwood (brand: Bath & Body Works). Test tube 2 was fish oil (Nature Made). Test tube 3 was onion flakes (McCormick’s). Test tube 4 was “lilac blossom,” containing lilac, muguet, heliotrope, and violets (Bath & Body Works). Test tube 5 was fart spray (Liquid Asset Novelties).

Study 3c Results and Discussion

Replicating Studies 3a and 3b, participants were more likely overall to correctly label the fish oil if they had been induced to feel suspicious (58.1%) than if not (29.2%), $\chi^2(1, N = 91) = 7.77, p = .005, d = 0.61$. This suspicious effect was significant in both the low and high cognitive load conditions (Table 3 middle and lower panels). Again, suspicion induction had no significant effect on participants’ likelihood of correctly labeling the other four smells, whether fragrant or foul (Table 3).

Table 3. Percentage of participants who correctly labeled the smells as a function of suspicion vs. non-suspicion condition in Lee and Schwarz (in press-a) Study 3c overall (top panel), in the low cognitive load condition only (middle panel), and in the high cognitive load condition only (lower panel).

Smell	Overall % of participants with correct labeling		$\chi^2(1, N = 91)$	<i>p</i>
	Non-suspicion (<i>n</i> = 48)	Suspicion (<i>n</i> = 43)		
1. Warm vanilla sugar	54.2	44.2	0.90	.34
2. Fish oil	29.2	58.1	7.77	.005
3. Onion flakes	10.4	4.7	1.06	.30
4. Lilac blossom	4.2	7.0	0.35	.56
5. Fart spray	14.6	14.0	0.01	.93
In low cognitive load, % of participants with correct labeling				
Smell	Non-suspicion (<i>n</i> = 23)	Suspicion (<i>n</i> = 20)	$\chi^2(1, n = 43)$	<i>p</i>
1. Warm vanilla sugar	60.9	40.0	1.87	.17
2. Fish oil	39.1	70.0	4.10	.04
3. Onion flakes	17.4	5.0	1.60	.21
4. Lilac blossom	4.3	10.0	0.53	.47
5. Fart spray	26.1	10.0	1.83	.18
In high cognitive load, % of participants with correct labeling				
Smell	Non-suspicion (<i>n</i> = 25)	Suspicion (<i>n</i> = 23)	$\chi^2(1, n = 48)$	<i>p</i>
1. Warm vanilla sugar	48.0	47.8	< 0.001	.99
2. Fish oil	20.0	47.8	4.17	.04
3. Onion flakes	4.0	4.3	0.004	.95
4. Lilac blossom	4.0	4.3	0.004	.95
5. Fart spray	4.0	17.4	2.30	.13

In combination, Studies 3a-3c document a robust effect of socially induced suspicion on the labeling of smells. This effect is metaphor-specific, not observed for unrelated smells, and not eliminated by cognitive load. It presumably results from the automatic activation of metaphorically associated knowledge linking social suspicion to fishy smells. This implies a process that has yet to be examined in metaphors research. We explore it in Studies 4 to 6, using an experimental causal-chain approach (Spencer, Zanna, & Fong, 2005) to test whether the observed effect of social suspicion on the labeling of fishy smells is driven by the activation and use of metaphorically associated knowledge. The findings suggest that suspicion induction can activate suspicion-related thoughts (Study 4), which can activate metaphorically associated fish-related thoughts (Study 5), which can be applied to the labeling of fishy smells but not other smells (Study 6).

Study 4: Socially Induced Suspicion Activates Suspicion-Related Thoughts

Method

Participants and Design. Forty-nine students (mean age = 19.7 years, 24 female) at the University of Michigan participated. They were approached individually on campus to participate in a word game and randomly assigned to two conditions in a between-participants experimental design: suspicion ($n = 25$) or non-suspicion ($n = 24$).

Procedure and Materials. The experimenter either first induced suspicion by acting as in Study 3 or skipped this step, and all participants received a 20-item word-fragment completion task. Embedded among fillers, 10 items could be completed with suspicion-related words (e.g., DUBIOUS, DOUBT, SUSPICIOUS; underscored letters

were blank in the original). For each item, participants wrote down the first word that came to mind.

Results

Participants induced to feel suspicious wrote down more suspicion-related words ($M = 5.00$, $SD = 1.63$) than participants not induced to feel suspicious ($M = 3.29$, $SD = 1.30$), $F(1, 47) = 16.31$, $p < .001$, $d = 1.16$, indicating that socially induced suspicion activated suspicion-related thoughts.

Study 5: Priming Suspicion-Related Thoughts Activates Fish-Related Thoughts

Method

Participants and Design. One-hundred eighteen students (mean age = 19.7 years, 93 female) at the University of Michigan participated. They were approached individually on campus to participate in a couple of word games and randomly assigned to two priming conditions in a between-participants experimental design: suspicion-related concepts ($n = 59$) or unrelated concepts ($n = 59$).

Procedure and Materials. Participants were asked to unscramble eight sentences (e.g., somewhat was memory I unprepared), using four out of five words to form a grammatical phrase (Srull & Wyer, 1979). To prime suspicion-related concepts, four of the sentences contained a suspicion-related word (*distrust*, *shady*, *uncertain*, *suspicious*); in the control-prime condition, all suspicion-related words were replaced with unrelated words (*supportive*, *own*, *well*, *confident*). Next, participants did a 20-item word-fragment completion task. Embedded among fillers, 10 items could be completed with fish-related words (e.g., FISHING, FIN, TUNA; underscored letters were blank in

the original). For each item, participants wrote down the first word that came to mind.

Results

Participants primed with suspicion-related concepts wrote down more fish-related words ($M = 2.46$, $SD = 1.38$) than participants primed with unrelated concepts ($M = 1.78$, $SD = 1.18$), $F(1, 116) = 8.24$, $p = .005$, $d = 0.53$, suggesting that priming suspicion-related thoughts activated metaphorically associated fish-related thoughts.

Study 6: Priming Fish-Related Thoughts Enhances Correct Labeling of Fishy Smells

Method

Participants and Design. Thirty-four students (mean age = 22.2 years, 16 female) at the University of Michigan participated. They were approached individually on campus to participate in a word game and a smell labeling task. They were randomly assigned to two priming conditions in a between-participants experimental design: fish-related concepts ($n = 19$) or unrelated concepts ($n = 15$).

Procedure. Participants were asked to unscramble eight sentences (e.g., somewhere are they wander going), using four out of five words to form a grammatical phrase. To prime fish-related concepts, five of the sentences contained a fish-related word (*gills, tuna, seafood, aquarium, water*); in the control condition, none of the sentences contained any fish-related words. Next, participants were given five test tubes for smell labeling, including fish oil and other fragrance oils or food substances: (1) “warm vanilla sugar”; (2) fish oil; (3) minced onion; (4) “lilac blossom”; (5) fart spray.

Materials. Test tubes were prepared as in Studies 3a-3c. Test tube 1 was “warm

vanilla sugar” fragrance oil (brand: Bath & Body Works). Test tube 2 was fish oil (Nature Made). Test tube 3 was minced onion (Meijer). Test tube 4 was “lilac blossom” (Bath & Body Works). Test tube 5 was fart spray (Liquid Asset Novelties).

Results and Discussion

Participants primed with fish-related concepts were much more likely to correctly label the fish oil (89.5%) than participants primed with unrelated concepts (26.7%), $\chi^2(1, N = 34) = 14.00, p < .001, d = 1.67$. This effect was limited to the labeling of fish oil and not observed for the other smells (Table 4).

Table 4. Percentage of participants who correctly labeled the smells as a function of fish-related vs. unrelated concepts prime (Lee & Schwarz, in press-a, Study 6).

Smell	% of participants with correct labeling		$\chi^2(1, N = 34)$	<i>P</i>
	Unrelated concepts primed	Fish-related concepts primed		
1. Warm vanilla sugar	46.7	47.4	0.002	.97
2. Fish oil	26.7	89.5	14.00	< .001
3. Minced onion	6.7	15.8	0.67	.41
4. Lilac blossom	13.3	10.5	0.06	.80
5. Fart spray	53.3	47.4	0.12	.73

In sum, when people are induced to feel suspicious, they become better at labeling fishy smells (Studies 3a-c). One possible process is that suspicion-related thoughts are made accessible (Study 4) and in turn activate metaphorically associated fish-related thoughts (Study 5), which are applicable to fish oil but not the other targets, so only fishy

smells get the boost in correct labeling (Study 6). These findings suggest that metaphorical effects may be driven by the activation and use of metaphorically associated knowledge. As such, they are governed by the principles of knowledge accessibility and applicability (Higgins, 1996), to which we will return in the General Discussion.

If the metaphorically associated knowledge of interest here is represented in bodily states and sensorimotor modalities, then suspicion should invoke and prioritize processing of fishy smells. Therefore, it should make people better not just at labeling fishy smells, but also at detecting their presence. To test this possibility, Study 7 used a signal detection paradigm (Macmillan & Creelman, 2005): Does socially induced suspicion heighten people's sensitivity in detecting fishy smells?

Study 7: Socially Induced Suspicion Heightens Detection Sensitivity to Fishy Smells

Method

Participants and Design. Fifty-four students (mean age = 18.7 years, 35 female) at the University of Michigan participated in individual lab sessions. They were randomly assigned to two conditions in a between-participants experimental design: suspicion ($n = 24$) or non-suspicion ($n = 30$).

Procedure. Participants were given three sets of 32 odor flasks, all 10 mL in volume and wrapped in aluminum foil. Set 1 contained nail polish remover, set 2 fish oil, and set 3 fart spray. Within each set, flasks contained 5 mL of the specific odor at four concentration levels in random order. Participants first smelled a baseline odor for the set and then rated their confidence that each flask contained only the baseline smell or some additional odor ($1 = \textit{sure an odor was not presented}$, $2 = \textit{fairly sure an odor was not}$

presented, 3 = fairly sure an odor was presented, 4 = sure an odor was presented).¹

Set 1 (nail polish remover) served as an assessment of comparability between participants in the two conditions before suspicion was manipulated. Overall, participants were sensitive to odor concentration, and their confidence ratings did not differ between conditions, indicating that participants in the two conditions had similar sensitivities and response biases.² After set 1, suspicion was manipulated. For half of the participants, the experimenter showed no suspicious behavior; for the other half, suspicion was induced right before set 2 (fish oil) by experimenter acting as in previous studies and was reinforced right before set 3 (fart spray) by the experimenter smiling awkwardly while saying, “Umm... no question at all? Good, good, I mean, not that you should have any questions, really. So, yeah, keep going.”

After going through all three sets, participants completed a smell labeling task (that is, Study 3b) and finally reported their mood (“Overall, my mood right now is...”; -9 = very unpleasant, 9 = very pleasant) and emotions (16 items; XX = definitely do not feel, X = do not feel, V = slightly feel, VV = definitely feel) (Table 6; Mayer & Gaschke,

¹ Confidence ratings for each odor flask served as the dependent variable in a multi-level model, with confidence rating as the level 1 intercept, participant as the level 2 grouping variable, odor concentration as a level 1 continuous factor, and condition (suspicion vs. non-suspicion) as a level 2 categorical factor. Fixed effects included odor concentration (main effect), condition (main effect), and odor concentration x condition (interaction effect). Random effect of participant as a level 2 grouping variable was also estimated because intra-class correlations were significant for nail polish remover (ICC = .200), fish oil (ICC = .181), and fart spray (ICC = .208), Wald Zs = 4.757, 4.490, and 4.584, $ps < .001$. Ignoring significant intra-class correlations would under-estimate errors; taking them into account by including the random effect of participant is appropriate and tests hypotheses conservatively (Kreft & Leeuw, 1998).

² Set 1 (nail polish remover) served as an assessment of comparability between the two conditions before suspicion was manipulated. Overall, participants' confidence ratings increased with odor concentration, $F(1, 1671) = 12.05, p = .001$. Mean ratings were not significantly different between conditions ($F(1, 122) = 1.17, p = .28$), nor was the effect of odor concentration on ratings ($F(1, 1671) = 2.51, p = .11$), suggesting that participants in the two conditions had similar response biases and sensitivities.

Overall, participants' confidence ratings for fish oil and fart spray also increased with odor concentrations (fish oil, $F(1, 1614) = 182.45, p < .001$; fart spray, $F(1, 1614) = 18.16, p < .001$), indicating that participants were sensitive to the varying concentrations of both odors.

Descriptive statistics are presented in Table 5.

1988).

Table 5. Means and standard deviations (in parentheses) of confidence ratings for sets 1 to 3 as a function of suspicion vs. non-suspicion condition and odor concentration level

(Lee & Schwarz, in press-a, Study 7).

Set	Condition	Odor concentration level			
1 (nail polish remover)		0	1/320	1/160	1/80
	Non-suspicion	2.25	2.33	2.25	2.42
		(0.64)	(0.58)	(0.58)	(0.70)
	Suspicion	2.17	2.22	2.19	2.56
(0.64)		(0.58)	(0.62)	(0.75)	
2 (fish oil)		0	1/640	1/320	1/160
	Non-suspicion	2.27	2.65	2.85	3.03
		(0.54)	(0.38)	(0.65)	(0.74)
	Suspicion	2.34	2.76	3.09	3.35
(0.76)		(0.79)	(0.77)	(0.73)	
3 (fart spray)		0	1/640	1/320	1/160
	Non-suspicion	2.04	2.37	2.22	2.38
		(0.47)	(0.36)	(0.55)	(0.44)
	Suspicion	1.98	2.23	2.23	2.26
(0.62)		(0.76)	(0.77)	(0.72)	

Materials. Prior to the experiment, new and clean pipettes were used to dilute nail polish remover (set 1) with odorless water to four concentration levels: 0 (no nail polish remover), 1/320, 1/160, and 1/80 (most concentrated).³ In the experiment, odorless water served as the baseline. Of the 32 test flasks, eight were at concentration level 0, eight at 1/320, eight at 1/160, and eight at 1/80.

Fish oil (set 2) was diluted with polyethylene glycol 400 (PEG 400) because oil was immiscible with water, but miscible with PEG 400, which served as the baseline in the experiment. One of the 32 test flasks was broken mid-way through data collection, leaving us with 31, eight of which were at concentration level 0 (no fish oil), seven at 1/640, eight at 1/320, and eight at 1/160 (most concentrated).

Fart spray (set 3) was diluted with odorless water, which served as the baseline in the experiment. One of the 32 test flasks was broken mid-way through data collection, leaving us with 31, eight of which were at concentration level 0 (no fart spray), eight at 1/640, seven at 1/320, and eight at 1/160 (most concentrated).

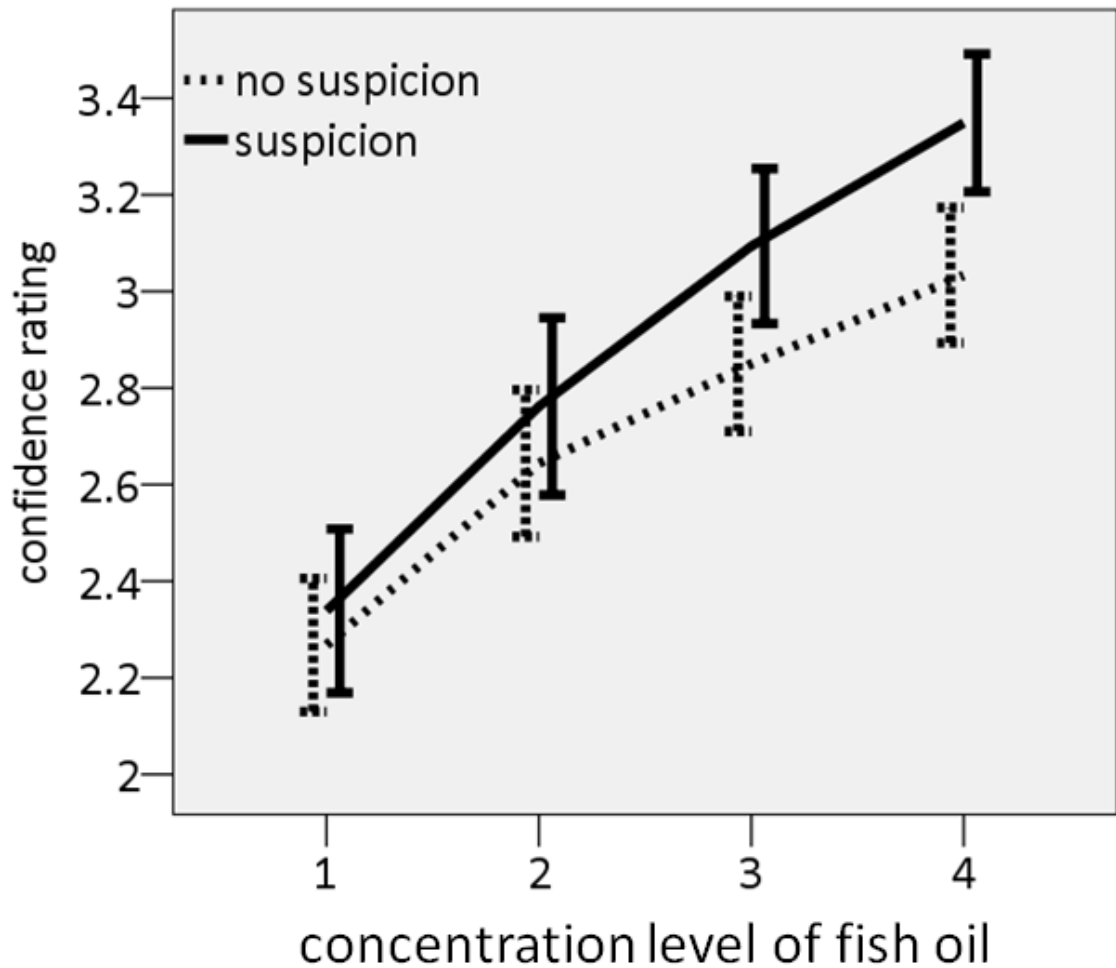
Results

Did suspicion heighten detection sensitivities to fish oil and fart spray? Compared with non-suspicious participants, suspicious participants' confidence ratings increased more sharply with the concentration of fish oil (Figure 5; Condition x Odor Concentration, $F(1, 1614) = 3.93, p = .05$) but not fart spray (Condition x Odor Concentration, $F(1, 1614) = 0.003, p = .95$). This suggests that suspicion increased detection sensitivity to fishy smells but not to an unpleasant smell with no metaphorical

³ Set 1 (nail polish remover) required the use of overall higher concentration levels than set 2 (fish oil) and set 3 (fart spray) because the latter were more easily detectable.

relevance. Furthermore, suspicion had no significant effect on the overall confidence ratings for fish oil ($F(1, 128) = 0.02, p = .88$) or fart spray ($F(1, 113) = 0.16, p = .69$), indicating that suspicion did not shift response bias. Neither mood nor any of the emotions differed significantly between the suspicion and non-suspicion conditions ($p > .16$; Table 6).

Figure 5. Confidence ratings for smell presence as a function of fish oil concentration in the suspicion and no suspicion conditions (Lee & Schwarz, in press-a, Study 7)



Note. Error bars represent 95% confidence intervals.

Table 6. Means and standard deviations (in parentheses) of mood and emotions as a function of suspicion vs. non-suspicion condition (Lee & Schwarz, in press-a, Study 7).

Item	Condition		<i>F</i> (1, 52)	<i>p</i>
	Non-suspicion	Suspicion		
Overall mood	4.50 (3.08)	4.96 (2.64)	0.32	.57
Lively	2.43 (0.68)	2.63 (0.71)	1.02	.32
Happy	3.17 (0.70)	3.17 (0.76)	0.00	1.00
Sad	1.70 (0.75)	1.67 (0.57)	0.03	.86
Tired	3.30 (0.84)	3.13 (0.85)	0.56	.45
Caring	3.03 (0.72)	2.92 (0.65)	0.38	.54
Content	3.17 (0.59)	3.33 (0.76)	0.82	.37
Gloomy	1.60 (0.68)	1.71 (0.86)	0.27	.61
Jittery	1.73 (0.79)	1.54 (0.72)	0.85	.36
Drowsy	2.77 (0.86)	2.67 (1.01)	0.16	.70
Grouchy	1.70 (0.70)	1.54 (0.66)	0.72	.40
Peppy	1.87 (0.63)	1.96 (0.75)	0.24	.63
Nervous	1.53 (0.63)	1.63 (0.77)	0.23	.63
Calm	3.27 (0.52)	3.38 (0.58)	0.53	.47
Loving	2.73 (0.94)	2.67 (0.82)	0.08	.79
Fed up	1.90 (0.85)	1.58 (0.78)	2.01	.16
Active	2.53 (0.78)	2.46 (1.10)	0.09	.77

In sum, socially induced suspicion sensitized people to detecting the metaphorically associated fishy smells, an effect that was unlikely to result from generic valence, response bias, or affective changes.

General Discussion

When something smells fishy, something suspicious is going on. The present findings suggest that this is not merely fancy language, but reflects the use of metaphorically associated knowledge that has behavioral, cognitive, and perceptual consequences. Incidental exposure to fishy smells elicits suspicion about others' intentions and undermines cooperative behavior in trust-based economic activity, whether it requires trusting others to reciprocate resources (Study 1) or to share responsibilities (Study 2). Conversely, suspicion induced by others' behavior increases people's accuracy in labeling fishy smells (Studies 3a-3c), presumably because suspicion activates metaphorically associated knowledge (Studies 4 and 5) that enhances correct labeling of the applicable smell of fish oil (Study 6). Suspicion can even heighten people's detection sensitivity to fishy smells (Study 7). Post-experimental debriefing indicates that these metaphorical effects occur outside of conscious awareness.

The presence of metaphorical effects across all studies is compatible with conceptual metaphor theory's (Lakoff & Johnson, 1980, 1999) general claim that metaphors are both linguistic *and conceptual* devices. But the more nuanced properties of metaphorical effects have further theoretical implications.

Bidirectionality of Metaphorical Effects

The present findings highlight the bidirectional nature of metaphorical effects.

This challenges the simplistic interpretation of conceptual metaphor theory that metaphorical effects can run only from concrete to abstract domains. Indeed, empirical work consistently reveals bidirectional metaphorical effects—between smell and suspicion (present studies), cleanliness and morality, temperature and affection, weight and importance, verticality and power, verticality and valence (see introduction for citations). Contrary to a common misinterpretation, these bidirectional effects are compatible with conceptual metaphor theory because even if a conceptual metaphor has a unidirectional representational structure, its use can produce bidirectional psychological consequences (Ijzerman & Koole, 2011). These psychological effects are also conceptually distinct from linguistic patterns, which typically are unidirectional and become nonsensical when the two domains are swapped (e.g., Glucksberg, McGlone, & Manfredi, 1997). The same cannot be said of the processing of conceptual metaphors and their psychological consequences.

Bidirectionality is also compatible with the fluid nature of perception. The latter has been highlighted by research since the New Look (e.g., Bruner, 1957; Bruner & Goodman, 1947) showing how people's understanding of their "concrete" sensorimotor experience is sensitive to motivational, emotional, conceptual, and contextual variations (e.g., Balciotis & Lassiter, 2010; Gibson, 1979; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005; Norenzayan, Choi, & Peng, 2007; Proffitt, 2006; Witt, 2011; Zadra & Clore, in press). Because sensorimotor experiences and psychological states are in dynamic interaction, sensorimotor experiences should not only change psychological states (concrete-to-abstract effects), but also be readily shaped by them (abstract-to-concrete effects).

Furthermore, higher-order cognition presumably reuses evolutionarily older

neural mechanisms for sensorimotor interactions with the environment (Anderson, 2010) and is action-oriented, situated, and embodied (e.g., Barsalou, 2008; Fiske, 1992; James, 1890; Schwarz, 2002; Smith & Semin, 2004). Because knowledge is represented in bodily states or sensorimotor modalities, processing sensorimotor information should activate conceptual knowledge (concrete-to-abstract effects) and processing conceptual information should invoke the bodily states or sensorimotor modalities in which it is represented (abstract-to-concrete effects).

In line with the predictions based on conceptual metaphor theory, the fluid nature of perception, and the embodied nature of cognition, smelling something fishy makes people suspicious and being suspicious makes people more likely to smell something fishy. Future research may explore the conditions in which metaphorical effects are unidirectional—perhaps when the phenomenon of interest is primarily driven by projection (of the schematic and inferential structure from the concrete to the abstract domain), when sensorimotor experiences are insensitive to psychological forces, or when one domain is chronically or temporarily much more accessible than the other.

Accessibility and Applicability in Metaphorical Thought

Sensory experience in any modality can have downstream metaphorical effects. For example, olfactory cues can elicit social suspicion (present studies), visual distance can elicit psychological distance (Williams & Bargh, 2008b), and tactile hardness can increase rigidity in negotiation (Ackerman, Nocera, & Bargh, 2010). The present findings indicate that the influence of sensory experience can be driven by the activation and use of metaphorically associated knowledge. Once accessible, knowledge can affect people's perception of, feelings about, and behavior toward an applicable target (Higgins, 1996;

also Förster & Liberman, 2007). The same principles may apply to the psychological consequences of conceptual metaphors. Accordingly, sensorimotor experience should affect metaphorically associated psychological experience (and vice versa) only if the metaphorical knowledge is available to the person, accessible in the context, and applicable to the target.

Exploring these issues will deepen our understanding of both metaphorical thought and knowledge accessibility. For example, actual cleansing (Zhong & Liljenquist, 2006) or visualizing oneself as cleansed (Zhong, Strejcek, & Sivanathan, 2011) attenuates one's guilt and makes one feel morally pure and righteous, but simply being primed with purity concepts without cleansing does not produce the same effects (Lee & Schwarz, 2011). It suggests that for some metaphorical effects, merely making the concepts accessible may be insufficient; the action requirements need to be fulfilled. (In fact merely making the concepts accessible may even backfire because thinking about purity without a chance to cleanse may make one feel impure, a possibility that awaits testing.) In contrast, the presence of fishy smells is sufficient to elicit the metaphorically associated experience of suspicion, much as the accessibility of trait concepts is sufficient to affect the encoding of person descriptions (e.g., Higgins, Rholes, and Jones, 1976; Srull & Wyer, 1979). Why such different results? The critical factor may be what sensation or motor action is implied by the metaphor of interest (Lee & Schwarz, in press-b). To be clean, one typically needs to cleanse. To smell something fishy, one simply needs to smell. Such bodily nuances go beyond the principles of accessibility and applicability in the activation and use of non-embodied knowledge.

Cultural Variation and Origin of Metaphorical Knowledge

Knowledge can be accessed only if it is available. If metaphorical effects require the availability of metaphorical knowledge, then the psychological consequences of some metaphors are likely to vary by culture. As a case in point, the smell that indicates suspicion is fishy for English speakers, but unspecified in many other languages. This raises the possibility, also noted by Lakoff and Johnson (1980, p. 19), that a metaphor may have a universal structure (e.g., smell–suspicion, documented in at least 18 languages) with culture-specific content (e.g., fishy in English, unspecified in Chinese and German) and thus culture-specific psychological consequences. Different processes may be responsible for the universal structure and the variable content.

A universal structure is unlikely to be a mere linguistic accident. Why does the smell–suspicion metaphor “feel right” to people with widely different life experiences? Where does it come from? While metaphors are generally assumed to result from higher-order cognition’s reuse of and grounding in sensorimotor processes (e.g., Landau, Meier, & Keefer, 2010; Williams, Huang, & Bargh, 2009), little is known about the origin of *specific* metaphors. One account, based on cognitive linguistic analysis, is that metaphorical mappings select deeper properties that are shared between smell and suspicion (Ibarretxe-Antunano, 1999; Sweetser, 1990). When people are suspicious, they sense something problematic but cannot say for sure what it is; if they were sure, they would *know* rather than *suspect* that there is a problem. Suspicion thus involves detection but uncertain identification. People may or may not be able to figure out the problem, and figuring it out takes time. Furthermore, people can become suspicious by involuntarily detecting something problematic; they can also be actively suspicious by voluntarily trying to detect signals of the problematic situation. These properties are shared by the sense of smell. People can be involuntary or voluntary in detecting smells. When a person

says “I smell something,” it usually means she detects an odor but cannot identify it with certainty. Smell labeling and naming are difficult (Buck, 1949; Engen, 1960; cf. Doty, 2001). Just like suspicion, it takes time to figure out what a smell is, and people may or may not find out in the end. These shared properties may be the basis for the use of “smelling” to metaphorically express “suspecting” in all of the 18 languages that have been analyzed (Soriano & Valenzuela, 2008). Tellingly, every language matches the valence of perceptual and social experience by using only *unpleasant* smells to indicate questionable character or dislikeable characteristics.

But it still leaves open the question: Why is the suspicious odor fishy in English but something else in other languages? It could be the result of recent evolutionary history, which is capable of generating cultural differences in genome-wide biological processes, including smell perception (Akey, 2009). Ecological and social contexts can exert “geographically restricted selective pressures” and produce “local adaptation” (Ronald & Akey, 2005, p. 113), so different contexts may render different smells relevant to suspicion. We note that suspicion arises in social interactions and that odors indicating suspicion are organic and usually related to spoiled food (e.g., fishy, rotten). Accordingly, our speculation is that suspicion may be particularly relevant to the trading of valuable products that are organic, decayable, and smelly when decayed, like fish and meat. Encoding such cultural knowledge in language (Chiu, Leung, & Kwan, 2007) might have given rise to local variants of the smell–suspicion metaphor that reflect local differences in the consumption of perishable items.

Clearly, empirical evidence rather than speculation is needed to better understand the cultural variability and origin of metaphorical knowledge. It would have further implications for the boundary conditions of metaphorical effects. For example, if

suspicion is universally and neurally grounded in smell, then across cultures a suspicious state of mind may activate the olfactory bulb and other networks for smell processing. If a metaphor has culture-specific variants, the same perceptual experience may have different—but predictable—effects depending on the person’s metaphorical knowledge acquired from cultural exposure. Multicultural people may show multiple effects. Finally, some metaphorical constructs in social cognition seem universal (e.g., “warm personality,” “high status”, “pure heart”) while others seem variable (e.g., fishy). Examining whether and why such difference exists will help impose some conceptual structure on the burgeoning variety of metaphorical effects.

CHAPTER 5

THEORETICAL INTEGRATION AND FUTURE DIRECTIONS

What do we know about the nature of mental processes? We have come a long way in this pursuit—from philosophers’ musings about mind-body relationships to pre-experimental psychologists’ introspective analysis, to behaviorists’ rejection of anything mental, to cognitivists’ computer metaphor for a symbolic information-processing mind, to early embodiment psychologists’ scattered demonstrations of mind-body connections, to current embodiment/metaphor psychologists’ specific predictions about which mental and bodily processes are related to each other.

Psychological theories are valuable insofar as they can describe, explain, predict, and control psychological phenomena. The emerging perspective that thinking is both embodied and metaphorical not only describes and explains a wide range of bodily effects on mental and behavioral processes, but perhaps most significantly, it also predicts them. Just a few years ago, metaphorical effects on judgment and behavior were novel and surprising (e.g., Williams & Bargh, 2008a; Zhong & Liljenquist, 2006). But now, with demonstration after demonstration (Landau, Meier, & Keefer, 2010), this first wave of research has made it clear that metaphorical effects are real and reliable.

Beyond this general point, however, little is known about metaphorical effects’ empirical properties, less about their conceptual relations to standard models of social cognition. I set out to tackle these problems by first finding in eleven experiments that

metaphorical effects can be (1) conceptually generalized from one abstract domain to another (e.g., from “washing away your sins” to “wiping the slate clean”); (2) sensitive to the modality of experiences in the abstract and concrete domains (e.g., “dirty hands” and “dirty mouth”); (3) bidirectional between the abstract and concrete domains (e.g., social suspicion and smelling something fishy); and (4) mediated by the accessibility and applicability of metaphorically associated knowledge. Throughout the dissertation, I have discussed the theoretical implications of each property, such as how the modality-sensitive nature of embodiment can predict more nuanced priming effects, how social knowledge can be activated through cross-modal priming, and how metaphorical effects may have culturally variable and universal origins.

Jointly considering all properties makes another important point. As shown in Table 7, all properties cannot be fully predicted by any one of the major theoretical perspectives, including conceptual metaphor theory (Lakoff & Johnson, 1980, 1999), embodied cognition (e.g., Barsalou, 1999, 2008), and basic principles of social cognition (e.g., Higgins, 1996). They call for a big-picture integration of insights from these perspectives and the development of a unified framework.

Table 7. What the major theoretical perspectives have to say about the existence and empirical properties of metaphorical effects.

	Conceptual metaphor theory (Lakoff & Johnson, 1980, 1999)	Embodied cognition (e.g., Barsalou, 1999, 2008)	Basic principles of knowledge activation (e.g., Higgins, 1996)
Existence of metaphorical effects	predicts it	is mute	are mute
Property of metaphorical effects			
Conceptually generalizable from one abstract domain to another	is mute	is mute	predict it
Sensitive to modality of experiences in abstract and concrete domains	is mute	predicts it	are mute
Bidirectional between abstract and concrete domains	is incompatible with it	predicts it	predict it
Mediated by accessibility & applicability of metaphorically associated knowledge	is compatible with it but describes it in a different way	is compatible with it but describes it in a different way	predict it

Towards A Unified Framework

One step towards developing a unified framework is to tie the metaphorical and embodied nature of thinking with the known principles in social cognition. Specifically, metaphorical knowledge may produce metaphorical effects in accordance with the principles of knowledge activation and use (e.g., Higgins, 1996)—with a couple of revisions to the basic process.

- Basic process: A prime activates associated, stored knowledge. If the activated

knowledge is applicable to a target, it is used; if inapplicable, ignored.

- Revision 1 (metaphorical thinking): Knowledge association can be metaphorical and not just literal. For example, *clean* and *warm* can activate the metaphorically associated meanings of *moral* and *affectionate*.
- Revision 2 (embodied thinking): Knowledge can be stored in embodied forms rather than as amodal symbols. This allows bodily experiences such as cleansing and warmth to activate literally or metaphorically associated knowledge.

The revised process predicts the existence of metaphorical effects and all their properties as listed in Table 7. First, metaphorical knowledge association allows metaphorical knowledge activation and use, hence the existence of metaphorical effects. Second, stored knowledge, including metaphorical knowledge, is not set in stone, but gets revised upon learning and can be generalized and applied to novel, related domains (Mandler & McDonough, 1996, 1998, 2000), hence the conceptual generalizability of metaphorical effects. Third, if knowledge is stored in embodied forms, then metaphorical knowledge can be activated by bodily experiences and the activation is sensitive to the body's sensorimotor modalities (Barsalou, 2008; Pecher, Zeelenberg, & Barsalou, 2004), hence the modality-sensitivity of metaphorical effects. Fourth, activation of associated knowledge can go both ways, hence the bidirectionality of metaphorical effects. Fifth, knowledge can be activated and used only if it is accessible and applicable to the target (Higgins, 1996), so metaphorical effects are mediated by the accessibility and applicability of metaphorically associated knowledge.

In addition to predicting metaphorical effects and their properties, a unified framework addresses important theoretical questions and opens up promising directions for empirical investigation. I conclude my dissertation with several of these examples

below, which I plan to address in the next few years.

Are Metaphorical Effects “Just Priming Effects”?

As metaphorical effects become increasingly recognized as the rule rather than the exception, a frequent complaint I have heard informally at conferences (but yet to see in published papers) goes like this: sure, it is cute to show that holding a warm cup of coffee elicits affectionate perception and behavior (Williams & Bargh, 2008a), but all these effects work just like priming effects anyway. What is the big deal?

The big deal is that just a few years ago we would not have *predicted* them. Predictive power is a key criterion for evaluating theoretical frameworks. The field of social cognition began with the information processing approach in cognitive psychology. By and large, social cognitive models treated social thought as amodal symbolic information. Another traditional assumption in cognitive sciences, that metaphor played no central role in ordinary thinking, led social cognitive models to take little note of the fact that much of social thought is metaphorical (Asch, 1955, 1958). Without recognizing the (a) embodied and (b) metaphorical nature of thinking, traditional models in social cognition would not predict a priori (a) whether and (b) which bodily experiences influence which social psychological outcomes.

In fact, given the aforementioned framework, many of the metaphorical effects demonstrated in recent research *are* priming effects—but it does not make them uninteresting. For *priming* simply “refers to procedures that stimulate or activate some stored knowledge” (Higgins, 1996, p. 134). It makes no claim about the nature of the stored knowledge or the activation process. By finding that incidental warmth can elicit interpersonal affection, we are gaining insights into how knowledge can be stored (in

embodied forms rather than as amodal symbols only) and activated (through metaphorical association rather than literal association only). These findings add substance to our theoretical understanding of the priming process.

Meanwhile, some metaphorical effects do go beyond the typical notion of priming effects. To illustrate, consider that actual cleansing (Zhong & Liljenquist, 2006) or visualizing oneself as cleansed (Zhong, Strejcek, & Sivanathan, 2011) has been shown to attenuate one's guilt and make one feel morally pure and righteous, whereas simply being primed with purity concepts without cleansing does not produce the same effects (Lee & Schwarz, 2011). Apparently, for some metaphorical effects, merely making the concepts accessible may be insufficient; the action requirements need to be fulfilled. In fact, merely making the concepts accessible may even backfire because thinking about purity without a chance to cleanse may increase one's sense of impurity, a possibility that awaits testing. Contrast this with the fishy findings (Lee & Schwarz, in press-a), where the presence of fishy smells is sufficient to produce metaphorical effects on social suspicion, much as the accessibility of trait concepts is sufficient to affect the encoding of person descriptions (e.g., Higgins, Rholes, & Jones, 1976; Srull & Wyer, 1979). The critical factor to explore may be what sensation or motor action is implied by the metaphor of interest. To be clean, one typically needs to cleanse. To smell something fishy, one simply needs to smell. An exploration of such bodily nuances will advance our understanding of both knowledge accessibility and metaphorical effects.

Do Metaphorical Effects Depend On Subjective Construal of Bodily Experiences?

As a truism in social cognition, “the individual actively construes social situations. We do not respond to environments as they are but as we interpret them to be” (Taylor,

1998, p. 58; see also Griffin & Ross, 1991). Complex social environments require interpretation of course. But does subjective construal matter even for something as concrete and basic as bodily experiences with the physical environment?

Strack (2012) found that using a sanitizing wipe after recalling immoral acts decreases guilt (“wiping it off”), but if the experimenter calls it a *moisturizing* wipe, now the same bodily experience *increases* guilt (“rubbing it in”). Subjective construal matters. In some cases it may even be the primary basis of metaphorical effects. For example, the Ganges is a sacred river for Hindus, who consider its water to be so purifying as to remove one’s sins of a lifetime (Eck, 1982). *Purifying* is surely in its symbolic sense though because the Ganges is among the dirtiest rivers in the world (Salemme, 2007); the Ganga Action Plan “was the largest single attempt to clean up a polluted river anywhere in the world and has not achieved any success in terms of prevention pollution load and improvement in water quality” (Singh & Singh, 2007, p. 421). Apparently, through cultural construction, subjective construal can turn dirty water into moral cleanser.

The role of subjective construal in metaphorical effects remains largely unexplored. Based on preliminary experimental and anecdotal evidence, it appears to play a significant role. This would imply that metaphorical effects should be highly malleable and susceptible to influences from social goals, self-awareness, pragmatic inferences, and many other contextual factors. Metaphorical effects may also be turned on and off and in different directions through well-established mechanisms of meaning making, as illustrated below.

Are Metaphorical Effects Always Assimilative?

So far, metaphor research has mostly demonstrated assimilation effects. For

example, when incidental disgust bears on some moral transgressions under judgment, the transgressions are judged as more severe and wrong, presumably because they feel more disgusting (Schnall, Haidt, Clore, & Jordan, 2008). This is an assimilation effect because the manipulated cause and the measured effect go in the same direction (more disgusting).

A prime does not always produce an assimilation effect though. When the knowledge activated by a prime is used to inform a judgment target, it produces an assimilation effect; when used to inform a judgment standard, it produces a contrast effect (Bless & Schwarz, 2010). This logic may apply to metaphorical effects and predict that a bodily experience can produce metaphorical assimilation or contrast, depending on whether it informs the judgment target or judgment standard. For example, if the feeling of disgust bears on a dishonest politician, people may judge him as more immoral (assimilation). But if the feeling of disgust bears on a child molester, people may judge a dishonest politician as less immoral (contrast from the standard of a disgusting molester). Systematic investigation into the existence and determinants of assimilative versus contrastive metaphorical effects is a promising future direction.

Do Multiple Processes Exist and Can They Interact with Each Other?

As the field is going beyond mere demonstration and beginning to unpack the underlying processes, we will most likely learn that multiple processes contribute to metaphorical effects (Lee & Schwarz, in press-b). First, incidental bodily experiences can activate metaphorically associated thoughts, goals, and feelings to affect how people construe the situation at hand. Most of the demonstrated effects in the literature can be conceptualized as reflecting differences in the mental construal of various aspects of the

situation, as when physical disgust intensifies the feeling that moral transgressions are “disgusting” and wrong. In addition to this *content* route, a second possibility is that incidental bodily experiences may activate metaphorically associated mental *procedures* that initiate, terminate, or change the judgmental, decisional, or behavioral process itself. For example, physical cleansing allows people to metaphorically wipe the slate clean and frees them from residual concerns about their recent decisions, thereby eliminating postdecisional dissonance (Lee & Schwarz, 2010a). To date, experimental support for this type of effects is very limited, but we find it promising. It allows researchers to leverage numerous well-understood paradigms in behavioral decision making to explore the potentially broad impact of embodied metaphors. Third, metaphorical effects of incidental bodily experiences are likely to be eliminated when people become aware of their incidental nature, consistent with feelings-as-information theory (Schwarz, 2012) and models of mental correction (Strack & Hannover, 1996; Wilson & Brekke, 1994). This would mean that bodily experiences are most influential when they are subtle and escape direct attention.

In some situations, the above processes may be pitted against each other. For example, would physical cleansing eliminate postdecisional dissonance in a choice between guilty pleasure and virtuous restraint? If cleansing simply wipes the slate clean (process #2), it should matter little what the content is and postdecisional dissonance should be eliminated. But if cleansing activates moral meanings (process #1), it should affect how moral one feels about the choice alternatives or oneself, and the downstream consequences may be more complicated. Which of these processes occur may depend on whether people are aware or not (process #3) of the metaphorical effects of physical cleansing on thoughts, feelings, goals and procedures. Divergent outcomes of these

processes are promising avenues for future research.

How to Solve the Multiple Mappings Problem in Metaphorical Effects?

The same bodily experience can metaphorically structure multiple abstract meanings. For example, *up* carries such diverse metaphorical meanings as *happy* or *good* (Meier, Robinson, & Clore, 2004; Crawford, Margolies, Drake, & Murphy, 2006; Weger, Meier, Robinson, & Inhoff, 2007), *divine* (Meier, Hauser, Robinson, Friesen, & Schjeldahl, 2007), *powerful* (Schubert, 2005; Giessner & Schubert, 2007), and *moral* (Sanna, Chang, Miceli, & Lundberg, 2011). Conversely, the same abstract domain can be metaphorically structured by multiple bodily experiences. For example, the righteous stand on moral *high* grounds (Sanna et al., 2011), live in the *light* (Zhong, Bohns, & Gino, 2010), and have a *clean* spirit (Zhong & Liljenquist, 2006; Schnall, Benton, & Harvey, 2008; Liljenquist, Zhong, & Galinsky, 2010; Zhong, Strejcek, & Sivanathan, 2010). When researchers test a hypothesized metaphorical effect, what factors or mechanisms determine which of the many-to-many mappings is at work?

To the best of my knowledge, no empirical attempt has been made to open this black box. The unified theoretical framework may shed some light on it. For a stimulus to produce any priming effect (Higgins, 1996), people have to attend to some of its features (step 1); the attended features activate some stored knowledge (step 2), which gets used (step 3). Attention may thus be the first gatekeeper that determines which bodily experience is going to play a causal role. In basic social cognition, some variables known to determine which features of the presented stimulus receive attention are the features' salience, the perceiver's needs and goals and expectancies, and alternative stimuli in the situation. The same variables may matter for metaphorical effects. A simple question-

order manipulation, for instance, may be sufficient to influence what aspects of bodily experience receive attention and determine the downstream metaphorical effects.

In the second step, stored knowledge is activated, but only if it is available in mind and accessible in context. The same principles may apply to metaphorical effects such that individual and cultural differences in metaphorical knowledge (hence its availability) and situational differences in metaphorical knowledge accessibility constrain which metaphorical mappings get activated and to what extent.

In the final step, activated knowledge is used, but only if it seems relevant to the task and appropriate to use. How it is used further depends on metacognitive experiences and lay theories about their meanings (Schwarz & Clore, 1996, 2007). Therefore, even if multiple metaphorical mappings are activated, which one and how it is used are going to be determined by relevance, appropriateness, metacognitive feeling, and inferred meaning.

The existence of multiple mappings between bodily experiences and metaphorical meanings confers complexity and richness to metaphorical thought and language (Lakoff & Johnson, 1980, 1999). At the same time, it presents a problem for psychologists interested in discovering the exact mechanisms through which metaphorical effects occur. Systematically testing for the mechanisms and determinants in the above examples may help solve this problem. It also highlights the theoretical mileage to be gained by integrating the basic principles of social cognition with the new insights into the embodied and metaphorical nature of human thinking.

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