Bidirectionality, Mediation, and Moderation of Metaphorical Effects: The Embodiment of Social Suspicion and Fishy Smells

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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), 7 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–3c), 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.

Keywords: trust and suspicion, smell, metaphor, embodiment and grounded cognition, priming

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) 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" (p. 112). 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) 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" (p. 1052). 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

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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, 2010; Zhong & Liljenquist, 2006). Similar bidirectional effects have been found between weight and importance (Jostmann, Lakens, & Schubert, 2009; Schneider, Rutjens, Jostmann, & Lakens, 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 et al. (2009, p. 1263) used the term *reverse directionality* in describing these two findings, both of which were abstract-to-concrete effects: 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). More abstract-to-concrete effects appeared in the review by Landau et al. (2010), who pointed out in a footnote, "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" (p. 1052). This point, however, was taken up by IJzerman and Koole (2011), 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" (p. 356).

The same point was made by Schneider et al. (2011). Finding that manipulating a book's perceived importance changed its estimated weight, they suggested

> 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. (p. 477)

With these challenges, Landau, Keefer, and Meier (2011) 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. (p. 364)

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 (1999) offered the most detailed version of conceptual metaphor theory in their 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 conflations 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).

Note that whereas the mechanism of concrete-to-abstract projection is unidirectional, experiential correlation and neural coactivation are bidirectional. But projection is probably the best known aspect of conceptual metaphor theory, as seen in various authors' renderings of it. 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, and 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 (1999) 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, Román, & Ouellet, 2011, p. 46). Our reading of Lakoff and Johnson (1999) is a little different, as elaborated in the next point.

3. Projection and coactivation. Although 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, 2012). 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), people's current goals and needs, feelings and action possibilities, stereotypes and cultural knowledge all systematically affect their supposedly "basic" perception (for reviews, see Balcetis & Lassiter, 2010; Gibson, 1979; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005; Norenzayan, Choi, & Peng, 2007; Proffitt, 2006; Witt, 2011; Zadra & Clore, 2011). 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 article was to test these predictions. In addition, we sought 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 (a) bidirectional, (b) mediated by accessibility, (c) moderated by applicability, and (d) 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. In Studies 1 and 2, we 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, in Studies 3a–3c, we tested whether socially induced suspicion enhances people's ability to correctly label fishy smells but not other smells. In Studies 4–6, we 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, in Study 7, we 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), oxytoxin 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, we used a trust game in Study 1 (modeled after Berg, Dickhaut, & McCabe, 1995), in which people are more likely to invest their own resources when they trust their partners to reciprocate. In Study 2, we used 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 women) 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 of money (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 that quadruples the potential payoff, 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 = *very bad*, 4 = *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 nonhazardous 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 (see Figure 1), 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.

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 women) 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.

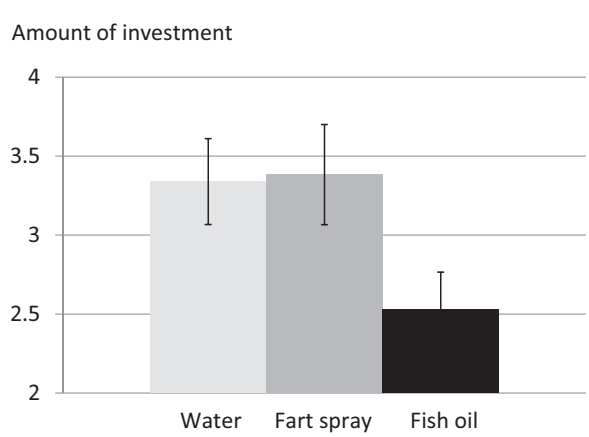

Figure 1. Amount of investment in a one-shot trust game as a function of incidental smell in Study 1. Error bars represent standard errors.

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 women) 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 nonsuspicion (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 the participants began the sniffing task right away (nonsuspicion 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 (see Table 1, top portion).

Several observations led us to conduct a couple of follow-up studies. First, we recognized that other than fish oil, the only aversive smell in Study 3a was onion, and even that might be aversive to some but not all participants. 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.

Table 1
Percentage of Participants Who Correctly Labeled the Smells as a Function of Suspicion Versus Nonsuspicion Condition in Studies 3a and 3b

	% of participants with correct labeling			
Smell in Study 3a	Nonsuspicion	Suspicion	$\chi^2(1, N = 80)$	p
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**
	% of participants with correct labeling			
Smell in Study 3b	Nonsuspicion	Suspicion	$\chi^2(1, N = 54)$	p
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

Note. Boldface highlights the smell of interest.

Study 3b Method

Participants and design. Fifty-four students (mean age = 18.7 years, 35 women) 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 nonsuspicion ($n = 30$).

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 (see Table 1 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 women) 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. nonsuspicion) × 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 5 s 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 (see Table 2, middle and lower portions). Again, suspicion induction had no significant effect on participants' likelihood of correctly labeling the other four smells, whether fragrant or foul (see Table 2).

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 4–6, 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).

Table 2
Percentage of Participants Who Correctly Labeled the Smells as a Function of Suspicion Versus Nonsuspicion Condition in Study 3c Overall (Top Portion), in the Low-Cognitive Load Condition Only (Middle Portion), and in the High-Cognitive Load Condition Only (Lower Portion)

	Overall % of participants with correct labeling			
Smell	Nonsuspicion (n = 48)	Suspicion (n = 43)	$\chi^2(1, N = 91)$	p
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	Nonsuspicion (n = 23)	Suspicion (n = 20)	$\chi^2(1, N = 43)$	p
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	Nonsuspicion (n = 25)	Suspicion (n = 23)	$\chi^2(1, N = 48)$	p
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

Note. Boldface highlights the smell of interest.

Study 4: Socially Induced Suspicion Activates Suspicion-Related Thoughts

Method

Participants and design. Forty-nine students (mean age = 19.7 years, 24 women) 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 nonsuspicion (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 women) 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 women) 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 (see Table 3).

In sum, when people are induced to feel suspicious, they become better at labeling fishy smells (Studies 3a–3c). 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 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 only at labeling fishy smells but also at detecting their presence. To test this possibility, we used a signal detection paradigm (Macmillan & Creelman, 2005) in Study 7: 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 women) 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 nonsuspicion (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 = *sure an odor was not presented*, 2 = *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 the participants, the experimenter showed no suspicious behavior; for the other half, suspicion was induced right before Set 2 (fish oil) by the 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 (i.e., 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*) (see Table 5; Mayer & Gaschke, 1988).

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] Confidence ratings for each odor flask served as the dependent variable in a multilevel 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. nonsuspicion) as a Level 2 categorical factor. Fixed effects included odor concentration (main effect), condition (main effect), and Odor Concentration × Condition (interaction effect). Random effect of participant as a Level 2 grouping variable was also estimated because intraclass 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 intraclass correlations would underestimate 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 4.

Table 3
Percentage of Participants Who Correctly Labeled the Smells as a Function of Fish-Related Versus Unrelated Concepts Prime in Study 6

Smell	% of participants with correct labeling: Unrelated concepts primed	Fish-related concepts primed	$\chi^2(1, N = 34)$	p
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

Note. Boldface highlights the smell of interest.

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 midway 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 midway 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 nonsuspicious participants, suspicious participants' confidence ratings increased more sharply with the concentration of fish oil (see Figure 2; Condition × Odor Concentration), $F(1, 1614) = 3.93$, $p = .05$, but not fart spray (Condition × 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 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 nonsuspicion conditions (ps $> .16$; see Table 5).

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. The specific 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 the 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 et al., 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

[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.

Table 4
Means (and Standard Deviations) of Confidence Ratings for Sets 1–3 as a Function of Suspicion Versus Nonsuspicion Condition and Odor Concentration Level in Study 7

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

Note. Boldface highlights the smell of interest.

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., Balcetis & Lassiter, 2010; Gibson, 1979; Niedenthal et al., 2005; Norenzayan et al., 2007; Proffitt, 2006; Witt, 2011; Zadra & Clore, 2011). 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.

Table 5
Means (and Standard Deviations) of Mood and Emotions as a Function of Suspicion Versus Nonsuspicion Condition in Study 7

	Condition			
Item	Nonsuspicion	Suspicion	$F(1, 52)$	p
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

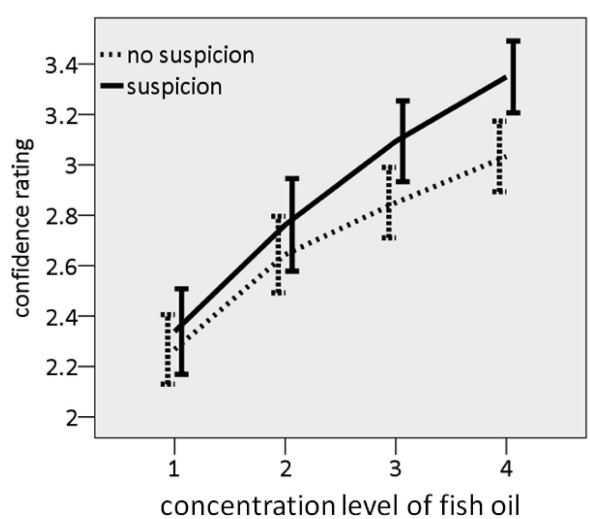

Figure 2. Confidence ratings for smell presence as a function of fish oil concentration in the suspicion and no-suspicion conditions in Study 7. Error bars represent 95% confidence intervals.

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; see 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 et al., 2010) 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. (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, & Jones, 1977; 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). 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 nonembodied 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? Although metaphors are generally assumed to result from higher order cognition's reuse of and grounding in sensorimotor processes (e.g., Landau et al., 2010; Williams et al., 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 or he 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 dislikable 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 genomewide 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"), whereas 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.

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