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*Emotion Review* 2010 2: 340

DOI: 10.1177/1754073910376423

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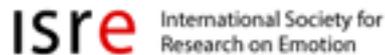
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# Body and Mind: Zajonc's (Re)introduction of the Motor System to Emotion and Cognition

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## Abstract

Zajonc and Markus published a chapter in 1984 that proposed solutions to the difficult problem of modeling interactions between cognition and emotion. The most radical of their proposals was the importance of the motor system in information processing. These initial preoccupations, when wedded with the vascular theory of emotional efference (VTEE), propelled theory and research about how the face works to control emotion and to control interpersonal interaction. We discuss the development of Bob's thinking about facial expression—facial efference is the term he preferred—as he moved toward predictions that sounded radical at the time, and which these days sound like precursors to advances in neuroscience and psychology subsumed under the term “embodied cognition.”

## Keywords

brain temperature, emotion, empathy, facial efference, facial feedback, mimicry

One of us, who knew and worked with Bob Zajonc in the mid 1980s (PMN), traveled to Poland in 1985. She still possesses a 68-page travel journal of her two-week sojourn. Thereafter, she flew to Paris, and visited with Bob and Hazel Markus, who were spending time in France. She shared with them stories of her trip. It seemed that Bob was pleased about something, but that something could not be characterized as a belief that she could now—as a consequence of a visit to his native country—better understand him. She suspected that what pleased him was a newly generated hope that, as a consequence of her visit to Poland, she had realized that she could never completely understand him at all.

How do people come to know other people, especially when they do not share the same cultural or linguistic tradition? This problem was at the heart of Bob's contributions to modern research on emotion. Bob was deeply interested in empathy, probably because he thought that what people *could* know about each other is their emotional reactions. He further conveyed the

belief that the processes by which people come to know others' emotions represents one of the most fundamental psychological processes known to humans. The fundamental process was the use of the motor system to encode and represent information. In 1984 Bob and Hazel Markus published the paper “Affect and Cognition: The Hard Interface” (Zajonc & Markus, 1984). The Hard Interface paper described an emerging intellectual preoccupation with the motor system. Its central theme was the frustration that,

The tendency today is to regard motor processes that occur in association with information as secondary and derivative. For example, in the controversy about whether cognitive representations are in the form of propositions (Pylyshyn, 1981) or images (Kosslyn, 1981), no mention was made at all of the possibility that they may have significant motor correlates. The analysis of hard components of cognition is virtually incompatible with the type of computer model of information processing prevalent in contemporary psychology. (Zajonc & Markus, 1984, pp. 81–82)

*Author note:* The authors thank Markus Brauer for his very helpful feedback on this paper. The work of the first two authors was supported by a grant (FaceExpress—Blanc CSD9 2006) from the Agence National de Recherche (ANR), France. The work of Paula M. Niedenthal was supported by a grant (FaceExpress - Blanc CSD9 2006) from the Agence National de Recherche (ANR), France.

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The ideas developed in the Hard Interface paper about the importance of motor processes in affect and cognition were subsequently linked to the vascular theory of emotional efference (VTEE). The VTEE could explain the relationship between facial efference (a better, more agnostic word than facial expression, Bob thought) and subjective feeling states. And together these ideas were used in the attempt to fully account for the way in which people know each other's emotions. What Bob wanted to argue was that if the motor system is representational in nature, then the most socially profound motor behavior is facial mimicry (second only to bodily mimicry). Facial mimicry could serve the purpose of reproducing in the self the emotion perceived on the face of the other. We might never understand each other, but we can represent the emotional state of others, and this can get us quite far. In what follows we summarize the ideas discussed in the Hard Interface chapter, and subsequent research findings relating to the production of emotion in the self through facial efference. We then describe research that was generated by the marriage of that thinking with the VTEE. Of greatest importance in this union, which was ironically totally ignored by scientific psychology at the time, was a series of studies on the phenomenon of couples growing to look alike over the course of their marriage. Finally, we conclude with a summary of where we are now.

## The Hard Interface: Reintroducing the Motor System

The manifest goal of the Hard Interface chapter was to point out that the at-the-time current models of information processing could not compellingly account for interactions between affect and cognition. As the above quote indicates, Zajonc and Markus (1984) held that semantic, we would now also say “disembodied,” theories of the conceptual system—the dominant model—were unsatisfactory for this purpose. And they were also unsatisfactory on many other counts. Most generally, Zajonc and Markus argued that such theories fail to address the connection between abstract representation and behavior. Thus, there was the problem of how cognitions about emotion, such as occur during the act of listening to a sad story, could produce bodily components of sadness, including tears and relevant changes in posture. And there was the complementary problem of how feeling a particular emotion or mood state might bring to mind ideas related to that emotional state that have nothing else whatsoever to do with the declarative context. In the disembodied semantic theories, the solution was to state that these were cases of influences of one associative structure on another. The bodily component of emotion might be translated into propositional form in some (not yet specified) way and all interaction would take place through associative processes there. But Zajonc and Markus further charged that a number of informal observations highlighting the embodied nature of cognition could not be accounted for by semantic theories. Bob's favorite examples involved chess and music:

Why does chess-playing require such an enormous *physical* effort? . . . The violinist, Itzhak Perlman, in trying to play a difficult note, raises

his eyebrows (if it is a high note) and keeps them raised until the note has been played. His face and body perform a rich program of varied movements. Why, again? (Zajonc & Markus, 1984, p. 84, emphasis in original)

Zajonc and Markus' solution to the failings of disembodied semantic theories of the conceptual system was the proposal that muscular and somatic states constitute “hard representations” that can be used in higher level cognition. The word “representation” for them was understood as “internal states standing for external events.” For example, in this account, when a dog hears a bell and withdraws a leg in order to avoid a shock, the leg flexion can be said to “represent” the dog's knowledge of the bell-shock relation. Furthermore, according to this view, the motor behavior can serve a representational role by *itself*, and does not need first to be translated into a “soft” propositional representation. The hard representations can also interact with one another, as when, for example, a movement representing positivity decreases the likelihood of a movement representing negativity. Unsurprisingly, the demonstration by Fritz Strack and colleagues in 1988 (Strack, Martin, & Stepper, 1988) that the manipulation of a smile by the use of a pen held between the lips or the teeth affects the extent to which humor is found pleasing, produced considerable excitement around the Research Center for Group Dynamics.

The experimental research that was generated by the claim of the representational capacity of the motor system focused on the idea that,

If the motor system is involved in learning a piece of music, it might also be implicated in learning a poem, in proving a theorem, in encoding a street scene, or in trying to recall a face of an old acquaintance. (Zajonc & Markus, 1984, p. 85)

Research reported in Zajonc, Pietromonaco, and Bargh (1982) tested the last of these specific predictions, namely the role of the motor system in recognition of face identity. In one representative experiment from that series, participants studied a set of photographs of faces. During the study period some participants were directed to try to reproduce in themselves the gaze, configuration of the mouth and eyes, and postural features of the head and shoulders of each face; essentially to mimic the faces. Another group of participants viewed the faces while chewing bubble gum, which was intended to interfere with any mimicry, and a final group of participants chewed bubble gum while making judgments about the same features of the faces that the first group was led to mimic. A measure of recognition memory was later completed in which the “old” faces and “new” distractor faces were presented. The important result was that the participants who simply mimicked the faces showed the best recognition memory for the faces (73% correct), while the bubble gum chewers who did not make judgments about the facial features showed the worst performance (59% correct).

So, it seemed that interfering with the motor system's representational capacity had deleterious effects on recognition memory. Years later, in his book *Blink*, Malcolm Gladwell observed that art experts could sometimes do a better job than certain carbon dating analyses in distinguishing authentic

versus fake antiquities and statuary. The “bubble gum” study seems relevant to that observation. Bob would account for this observation by appealing to the fact that the experts had covertly mimicked the postures of so many authentic statues that the muscular encoding of phony ones would produce a sensation (and then judgment) that something was very much wrong. Art experts, he would claim, can distinguish the authentic from the fake through motor processes induced by covert mimicry of posture.

## Linking the Motor to the Subjective in the VTEE

Mimicry was clearly important, but first Bob had to link the body causally to subjective feelings. Facial feedback theories of the time were making this claim, but Bob felt that a compelling account of the mechanism for the phenomenon was not yet available (e.g., Adelman & Zajonc, 1989). The Hard Interface chapter derived productivity in this regard from Bob’s reading of the little-known book by Israel Waynbaum, *La Physiologie Humaine: Son Mécanisme et son Rôle Social* (1907). Waynbaum noted that: (a) the blood supply of face and brain come from one source, namely the common carotid artery; (b) the supply of cerebral blood should be stable; (c) there are many facial muscles, especially around arteries. Waynbaum proposed that all emotional states produce circulatory perturbations. Since the facial and cerebral carotid have the same origin, equilibrium in cerebral blood flow (CBF) can be maintained by directing blood to the face or to the brain. This then was the primary function of facial efference: facial muscles push arteries and veins against the bony structure of the skull, and thereby regulate CBF.

The great novelty of Waynbaum’s theory was the idea that subjective experience of emotion could *follow* the facial expression, and that the latter had hedonic effects. Increased blood flow to the brain, he held, should be associated with positive feelings, whereas its opposite, temporary brain ischemia, should provoke negative affect and depressive mood. Specifically, the contraction of the major zygomatic muscle—involved in smiling—retains cerebral blood and causes momentary intracerebral hyperemia, which in turn should lead to the sensation of a positive effect. Consequently, laughing and smiling must be healthy—as is taking an oxygen bath. In sum, Waynbaum conveyed the belief that all facial efference has a precise biological function—for example, frowning our forehead when we concentrate would act like a tourniquet on the external carotid and on facial veins, and thus send more blood to the brain, stimulating its work. In this way, he provided the possibility to explain many facial phenomena that could otherwise seem arbitrary.

Of course, Waynbaum’s work, despite its coherence and parsimony, was dismissed by the authority figures of the early 20th century, such as Henri Piéron and Georges Dumas—and in consequence forgotten for many years. Bob admitted that we know that many assumptions of Waynbaum’s theory are false: the cerebral blood supply is much more complex than Waynbaum supposed, and it can be kept constant in a variety of ways. In consequence, modification of CBF by muscular action on arterial

flow is highly improbable. Still, for Bob, Waynbaum was also right in many ways. Bob focused on the link between emotion and brain temperature—this latter was important because temperature likely influences the release and synthesis of different neurotransmitters and thereby produces different subjectively felt states. These temperature changes may be obtained not by peripheral changes in facial blood supply, as Waynbaum suggested, but rather by central processes. More precisely, modifications of CBF may be provoked by the activation of motor cortex areas corresponding to specific facial muscles.

In explaining the nature and function of emotional expression, Bob examined another problem: if facial gestures can modify internal subjective states, what causes the gestures? There are many possible causes. Some of the facial expressions are produced at will, and thus every motivation to perform them can be an antecedent. Other expressions—such as fear reactions to strangers—may be fixed and involuntary action patterns. Facial gestures can be elicited as conditioned responses acquired in the past, may be cases of mimicry, and function as responses established by reinforcement. For example, if a child smiles in reaction to his father’s smile, and then receives affection, his likelihood of returning smiles is heightened. Other antecedents for emotional facial expressions could be related to organism’s orienting reactions. Bob discussed this class in the light of theories of two 19th century scientists: Theodor Piderit and Pierre Gratiolet. Both of them linked emotion to sensation. Theodor Piderit—whose work had been politely rejected by Darwin—assumed that emotional expressions are provoked by sensory and peripheral activity and by hedonic reactions, all elicited by emotional stimuli. Some sensory events are in themselves agreeable—and *so are their representations*. In consequence, pleasurable events and representations evoke approaching reactions and disagreeable representations evoke rejecting gestures. This is why we make a grimace when we imagine biting into a lemon. The sweet look of the smile (and correspondingly, many *sweet* linguistic metaphors, like *sweetie* or *sugar*) would derive from imaginary pleasurable taste, and from the motivation to increase the sensory experience. On the other hand, closed eyelids observed in pain or contempt expression may indicate the motivation to diminish the empirical experience related to the representation.

Another similar theory of emotional expression—neglected by Darwin and rediscovered by Bob—was that of Pierre Gratiolet. This work also focused on the motor responses accompanying sensory events. One of the important postulates of Gratiolet’s theory (which contained an entire classification of muscular movements) was that facial efference can be elicited by images, memories, and mental representations, as well as by external stimuli. According to the VTEE, all above cited antecedents of facial efference have one thing in common: they affect the cerebral blood flow and the affective tonus. This modification of subjective state might occur immediately before facial efference. Another possibility is that facial expression is executed automatically, without any prior conscious experience. In other words, the emotional process would be triggered by an internal sensory or cognitive event that leads to peripheral action—facial efference—that in turn modifies the subjective feeling.

Initial research on the VTEE, conducted with Pamela Adelman, relied on infrared thermographic recordings of participants' faces as they imagined situations in which they might feel sad, happy, disgusted, afraid, surprised, angry, and neutral emotion. Findings suggested that at least surface facial temperature varied in systematic ways as predicted by the VTEE. Then, a paper reporting research with Sheila Murphy and Marita Inglehart and published in *Psychological Review* (Zajonc, Murphy, & Inglehart, 1989) took the demonstrations further. This research started from the observation that different forms of spoken language rely on the use of facial efference that corresponds in some ways to that of active facial expression. Perhaps, Bob thought, a consequence of the facial efference generated during some language use would produce changes in emotional state. In the first test of this hypothesis, German native speakers were invited to read two short stories in German. One story contained the vowel *ü* (U-umlaut) repeated throughout while the other contained no words with the vowel *ü* at all. The choice of *ü* stories was ingenious for two reasons. First, the production of *ü* implicated the action of corrugator muscles that participate in the expression of negative emotions, while the actual content of the stories was emotionally neutral. Thus, German native speakers that participated in the study could not make inferences about the subjective feelings that they "should be" experiencing under such experimental manipulations. Second, and more relevant to predictions of the VTEE, the manipulation also involved nostril constriction that reduced airflow cooling veins draining into the cavernous sinus. As a result, the uttering of *ü* was assumed to cause an elevation of brain temperature. While participants read, forehead temperature was measured, and later they also rated the pleasantness and likeability of the two stories.

As predicted, forehead temperature raised significantly from the relevant base-line while reading the story containing the words "Jürgen," "füchse," and "hühner," whereas there was no significant forehead temperature change while reading the story of "Peter," "hunde," and "katzen" (i.e., the control story). Also, the latter story was liked better and considered as more pleasant than the *ü*-story, whereas no differences were observed in measures of other emotion-unrelated features such as interest value or formal aspects of written German. There were no condition differences in content recall. Still, Bob speculated that there was a possibility that other unmeasured properties of the stories were responsible for the obtained differences in physiological and subjective states. For example, he worried that through some form of interoceptive conditioning, the *ü* words could be semantically associated with generally negative affect. Although there were good theoretical objections to such a possibility,<sup>1</sup> Bob and his collaborators recruited German and American participants to come to the lab and made them listen to the same stories as used in Study 1. In the selection of specific American participants, they made sure that participants had virtually never been exposed to the sound *ü* as a conditioned stimulus, nor had they ever learned to produce it.

Although there were no differences between German and American participants on the majority of subjective measures

used in Study 1, they did observe that Americans found the *ü* stories slightly more interesting than the no-*ü* stories, whereas the contrary was observed in Germans. Of course, such findings could have been attributed to the novelty of the sound for Americans and/or to the actual understanding of the stories in Germans, but such ad hoc explanations would not be parsimonious enough for Bob. More critically, in the absence of significant changes in the facial temperature (recall that participants were only listening to the stories), such findings still pointed to the possibility that subjective changes can be produced by something else other than muscular movements. A remaining possibility was that this something else was the semantic and potentially affective content of the stories.

To eliminate this possibility, the next step was to make both German and American participants simply repeat the vowel *ü* (and a control vowel *o*). This study showed in both Germans and Americans the critical rise in facial temperature during the repetition of *ü*, whereas no temperature increase was observed during repetition of the vowel *o*. Also, both groups of participants liked the *o* sound better and found it more pleasant than the sound *ü*. These effects were independent of perceived pleasantness and difficulty of utterance. For Germans, both *ü* and *o* sounds were perceived as equally pleasant and difficult to pronounce, whereas for Americans the *o* sound was judged as more pleasant and less difficult to pronounce. Indeed, regression analyses showed that the subjective feeling associated with uttering phonemes was directly related to temperature change, even when other factors such as liking, pronunciation difficulty, and so forth, were held constant.

Many of us would be satisfied with these successful empirical demonstrations, but not Bob. Thus, Study 4 was designed to generalize the findings to vowels capable of producing positive affect. To this end, the whole range of vowels *i*, *e*, *o*, *a*, *ü*, *ah* and *u* were examined, although vowels *ü* and *e* were of the focal interest. Consistent with the VTEE, it was indeed found that some vowel phonemes are capable of decreasing temperature and eliciting positive subjective affect. Because the order of focal vowels was thoroughly counterbalanced, the differences in subjective affect can be reasonably attributed to pronouncing these phonemes. Moreover, the additional regression analyses were consistent with such reasoning. Thus, unlike previous studies using physiological measures such as blood pressure and galvanic skin response (GSR), the present findings were able to discriminate between both hedonic intensities and between positive and negative affect.

Although the results of these four studies were compelling, Bob was not happy with their very indirect way of assessing the role of cooling versus warming of the cavernous sinus in observed changes in affective states. Thus he decided to uncover this role with a more direct manipulation. Thanks to his enthusiastic reading of the animal literature, as Rajecki (2010) and Berridge (2010) have discussed in greater detail, Bob learned that when air at 25°C is blown over the nasal mucosa of sheep, there is a precipitous temperature drop in the cavernous sinus, in the cerebral arteries and in the brain of the sheep (Baker & Hayward, 1968). No hasty conclusions about similarities

between sheep and freshman psychology undergraduates should be drawn—yet Bob and his collaborators recruited the latter to participate in a study on the perception of smell. The study was composed of three trials with only one actually containing an odorant substance (called the “oregano” trial; the others were “warm air” and “cool air” trials). Similarly to the sheep study, a heating and cooling unit resembling a hair dryer, which remained invisible to participants, generated the air used in the three trials. On the warm-air trial, the air was heated to 32.2°C. On the cool-air trial, the air was heated to only 18.9°C. On the oregano trial, air of 22.2°C was slightly scented by a sachet of oregano. Participants rated the pleasantness of and their liking for whatever they smelled on each trial.

The differences in air temperature elicited predicted changes in facial temperature and also influenced rated liking and pleasantness of manipulated “odors.” Indeed, cool air was rated the most likeable and the most pleasant, whereas the warm air was liked the least and considered as least pleasant (with oregano scented air falling in-between). Thus, even in the total absence of facial movement, the direct physical manipulation of the temperature reaching the cavernous sinus resulted in affective changes. Perhaps the proposed role of facial muscles in acting as blood flow regulators was correct.

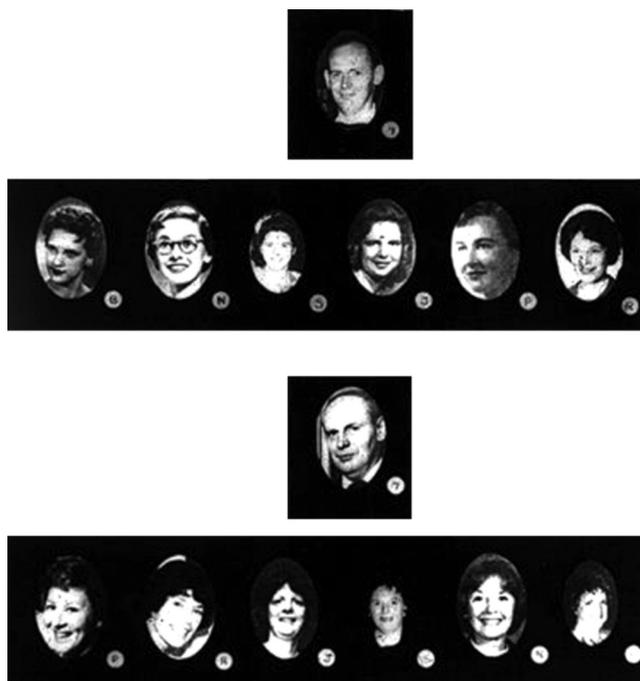
## Mimicry and Empathy

Now Bob could explain how mimicking someone else’s facial expression could facilitate empathy, and he convened three graduate students in his office for a research meeting. If facial efferece affected emotional state, as the VTEE predicted, then

the mimicry of another person’s facial expression (because it produces corresponding use of facial musculature) should be a fundamental mechanism by which we know another person’s emotion, the very basis of empathic understanding. That sounded reasonable. Then Bob generated a specific hypothesis, typical of Bob in its wide-reaching implications: If this is so, one consequence is that members of couples who are married for a long time should grow to resemble each other. Why this is true should be obvious, he claimed. People who are married are trying to understand each other all the time. If they have to mimic each other in order to really understand, then they should use their many facial muscles in the same way over decades. Just as with any muscle, this would lead to a distinct development of the facial muscles that participate in facial expression, and because these two people shared this specific development, they should show increased resemblance from before the time of their wedding.

One of us (PMN) found the 12 or so couples who agreed to contribute photographs of themselves to this scientific enterprise. The partners were all around 55 years old, and they had been married since their early or mid 20s. They were asked to provide separate photographs of each of their faces from the time of their marriage and, 25 years later. They also completed questionnaires about the quality of their relationships in order to test the refined hypothesis that good empathizers should grow to look more like each over time than poor empathizers.

In the main study, participants saw target individuals (either young or old) of one sex presented with six faces of the other sex at the same age (Figure 1). Of the six options, one of course was the real spouse. In one condition, participants rank-ordered



**Figure 1.** A low-tech stimulus display from Zajonc, Adelman, Murphy, & Niedenthal (1987).

the options according to the likelihood that they corresponded to the actual spouse. In another, the participants rated the facial similarity between the target and each of the six options. In follow-up studies the faces of all the target individuals were covered with white masks. New participants performed the same tasks as those performed by the participants in the main study. This was done in order to be able to test the hypothesis that any increased resemblance in the couples was due to greater similarity in hair style, or to the fact that the lighting or photographic paper was actually more similar in the later photos compared to the earlier ones.

Results of the studies were clear and striking. Compared to randomly created pairs, individuals who were married to each other grew to look more alike over the 25 years of their marriage. In addition, this relation was stronger for those couples that reported having a good marriage. And finally, the possibility that this result was due to an influence of other features of the photos, such as the subjects' hair or the photographic paper, was ruled out by the follow-up study. Such results were exciting, and Bob, great writer that he was, had lots of fun writing them up in such a clever and scientific way. The paper was submitted initially to the *Journal of Personality and Social Psychology*. And, in an act of efficiency that almost took our collective breath away, the paper was rejected without being sent out for review. It might even have been returned the next day. There is no need to describe the smoke that came out of Bob's office when he received the rejection letter. He stormed up and down the halls of the Research Center for Group Dynamics. It must be an important paper, the co-authors thought then. Ultimately the paper was published in a smaller, specialized journal, and no one ever mentioned it again (Zajonc et al., 1987).

Except the media. The findings were splashed over the front page of the *New York Times* Science section on 11 August, 1987: "Long-Married Couples *DO* Look Alike, Study Finds" (Goleman, 1987). And as the months went by, Bob began to receive the most mind-boggling letters from all over the world. In one, from Australia, a man enthused that the findings supported the idea that Eve was made from Adam's rib. A creepier letter proposed that this increased similarity was not caused by facial mimicry but rather by the fact that women absorb the semen introduced into their bodies during sexual intercourse. The letters came from everywhere and demonstrated that people were touched in many ways by these findings. A bonus from this media blitz was that it contained further informal evidence in favor of the theory. One supportive media story in particular comes to mind: Bob arrived at his office to find a copy of the *National Enquirer*, an American celebrity gossip newspaper, which had been placed on his desk by his ex-wife. On the first page of it she had written, "Turn to page 12." On that page was a story whose headline read "Child Falls into Garden and is Devoured by Venus Fly Trap." There, Bob further read "Turn to page 5." Page 5 reported that, "My Baby was Born with Three Heads." From there Bob was instructed to turn to page 17, where he found that "Couples Grow to Look Alike, University of Michigan Study Finds." Impressively, in their article, the

*Enquirer* provided us with photographs of well-known celebrity couples, including Paul Newman and Joanne Woodward, and Pat and Shirley Boone, who had been married for a very long time and who resembled each other (facially) enormously.

But the scientific impact was nil, *nic, rien du tout*. And that was it. Then, in 2005, at a small conference in Paris concerned with how the brain processes mimicry and what function mimicry serves, called "From Social Resonance to Agency: Multidisciplinary Perspectives," one of us gave a talk entitled "Who mimics whom? Constraints on imitation of emotional gesture" (Niedenthal, 2005). Along with other recent findings, she reported the original couples-growing-to-look-alike data. Amazingly, important and influential scientists were excited by those findings. Only months later, a well-known neurophysiologist who is part of the team in Parma, Italy, that discovered the mirror neuron, said earnestly during a presentation of his work, "I heard about a very interesting study conducted in Social Psychology. In it, the researchers looked at the increases of facial resemblance of couples over the course of their marriage." Later, that same neurophysiologist described the findings on National Public Radio in the United States. It took all those years of embarrassment, discouragement, and sometimes hilarity, but the findings were finally appreciated as theoretically and scientifically meaningful in the way Bob had intended them.

Indeed, in light of recent simulationist and embodied cognition theories of how emotions are processed, and especially how empathy works, the data were interpretable and exciting. Embodied simulation is now seen as an important process underlying the recognition and access to meaning of facial expressions (e.g., Atkinson, 2007; Decety & Chaminade, 2005; Gallese, 2003; Goldman & Sripada, 2005; Keysers & Gazzola, 2007; Niedenthal, 2007; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005; Winkielman, McIntosh, & Oberman, 2009). Just as Bob anticipated, when researchers use the term "embodied simulation" they mean that a facial expression has triggered a simulation of a state in the motor, somatosensory, affective and reward systems that represents the meaning of the expression to the perceiver. In contemporary embodied simulation account, the perception of a facial expression is accompanied by the bodily and neural states associated with the expression and its correspondent emotion. This simulation is then used as the representation of meaning on which an interpretation or judgment is based.

It should be noted that Bob's pioneering ideas did not elicit straightforward acceptance and enthusiasm at the time. Why? In another largely overlooked paper about style of explanations in social psychology (Zajonc, 1989), which came out at the same time, Bob actually generated a potential answer to this question. He suggested that levels of explanations that are offered, and consequently tested, in social psychological science are fundamentally shaped by beliefs and assumptions that researchers hold at that moment about "human nature" or "the mind." We can say that, given the dominant computer metaphor of the mind, psychology was not ready for Bob's motor and neurochemical (he called this "wet") emphasis. Bob concluded his paper on styles of explanation by saying,

In the long run we shall know better how useful the various perspectives and approaches fared. They should all continue therefore. No approach can be completely wrong, even those that seem to recruit hysterical outbursts of critique. Even a wrong explanation is useful because it has a chance of highlighting the path to the right one.

Although this paper was not explicitly linked to his VTEE and the relevant empirical research, one can sense that he was in many ways writing about both Waynbaum's and his own writings. Yet, unlike Waynbaum's, all research ideas, intuitions, and intentions related to the role of the motor system in the affect-cognition interface that Bob put forward, in both formal and informal settings, did nourish the research of his students.

For instance, Piotr Winkielman and Paula Niedenthal have spent some time researching emotion simulation and the processing of emotional concepts (e.g., Halberstadt, Winkielman, Niedenthal, & Dalle, 2009; Niedenthal, Winkielman, Mondillon, & Vermeulen, 2009). Winkielman and Daniel McIntosh, another former student of Bob's, have examined the failure of some populations, such as autistic children, to use embodied facial expressions and mimicry in the understanding of emotional meaning (e.g., Clark, Winkielman, & McIntosh, 2008; McIntosh, Reichmann-Decker, Winkielman, & Wilbarger, 2006; Winkielman et al., 2009). And Niedenthal and colleagues recently published a model of the use of embodied simulation in the interpretation of the smile, called the Simulation of Smiles Model (SIMS; Niedenthal, Mermillod, Maringer, & Hess, in press).

This last work follows from Bob's thinking quite transparently. Indeed, in preparing this paper for this special issue on contributions to modern emotion research, we came across a passage that Bob read in his talk, "Social Psychology and the Emotions," which he presented at the Maison des Sciences de l'Homme (Paris) in 1987. He said,

If smiling has subjectively-felt pleasurable aftereffects, then the reproduction of another person's smile is in itself pleasurable and, therefore, reinforcing. This fact might explain why smiling is a powerful communicative signal. There are few greater pleasures, according to Waynbaum (1907, p. 190), than witnessing one's baby's first social smile—a gesture that eventually becomes one of the most potent instruments of social influence.

Both Waynbaum and Zajonc were waiting for neuroscience to support these claims. And in recent times, it has (Minagawa-Kawai et al., 2009; Nitsche, et al., 2004).

## Note

- 1 Because in their diminutive form many very pleasant German words contain a ü, through the same mechanism of interoceptive conditioning, they might be assumed to actually be associated with positive affect.

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