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Incorporating Consciousness into an Understanding of Emotion and Nonverbal Behavior

David Matsumoto
Department of Psychology, San Francisco State University, USA; Humintell, USA

Matthew Wilson
Humintell, El Cerrito, USA

Abstract

We posit a model of emotion and nonverbal behavior (NVB) that incorporates a perspective of consciousness. We leverage an understanding of the neural pathways innervating NVB to describe the complexity of its neural architecture and the links between those pathways and mental states. We suggest that all NVB are activated by both cortical and subcortical structures, allowing for unconscious, coordinated movements across multiple channels as well as conscious, less coordinated movements; that mental states are associated with both cortical and subcortical structures; and thus that NVB will occur in multiple channels, both unconsciously and consciously, and differ across time. We discuss the implications of this model for future theory and research.

Keywords
emotion, nonverbal behavior, consciousness, voluntary versus involuntary

Decades of research on emotion and nonverbal behavior (NVB) have involved increasingly detailed specifications of and amassed a wealth of information about single NVB channels (e.g., face, voice). This has resulted in a somewhat fractured approach to understanding NVB that may have facilitated contradictions in findings and controversies in theory. For example, modern research on emotion has its roots in classic studies on the universality of facial expressions of emotion (Ekman et al., 1969; Ekman & Friesen, 1971; Ekman, 1972; Izard, 1971) and basic emotion theory (Ekman, 1992a, 1992b). These studies focused on a single NVB channel—face—and were rooted in studies examining judgments and production of facial expressions across cultures. This work spawned a generation of study (see reviews in Hwang & Matsumoto, 2016a; Matsumoto et al., 2008a) that has been controversial (Aviezer et al., 2008, 2012; Feldman Barrett, 2006; Fridlund, 1994, 1997; Jack et al., 2009, 2012; Russell, 1991, 1995); much of this controversy has focused on critiques of basic emotion theory and especially claims about the nature of facial expressions of emotion (debated elsewhere; see Crivelli & Fridlund, 2019; Keltner et al., 2019a, 2019b, for recent arguments).

Such contradictions in findings and debates about the association between emotion and expressive behavior may be a consequence of the field's having lost sight of the forest for the trees in its approach (ours included) to studying and understanding NVB in its focus on studies of single NVB in single slices of time, and a lack of incorporation of contemporary views of consciousness. In this paper, we posit a model of emotion and NVB that incorporates consciousness and suggest that doing so may clear up previous inconsistencies in the literature about their nature and provide new guidelines for conceptualizing their association and designing studies in the future. Our view is rooted in the neural complexity of the human brain and nervous system; the simultaneous existence of multiple mental states and their underlying neural connections to the NVB signaling system; and the neuroanatomy underlying NVB that tie mental states to that system. Our analysis will suggest that NVB are activated by both cortical and subcortical structures, allowing for unconscious, relatively more coordinated movements as

Corresponding author: David Matsumoto, Department of Psychology, San Francisco State University, 1600 Holloway Avenue, San Francisco CA 94132, USA.
Email: dm@sfsu.edu

well as conscious, learned, and relatively less coordinated movements; that mental states are associated with both cortical and subcortical structures; and thus that NVB, as physical embodiments of mental states, will occur in multiple modalities and both unconsciously and consciously across time.[1]

To be sure, many persuasive theories of consciousness currently exist, such as Global Workspace Theory (Baars, 2005; Baars & Franklin, 2007), Higher Order Thought Theory (Brown et al., 2019), viewpoint theory (Merker et al., 2021; Morsella et al., in press), and others (refer to review in Brown et al., 2019). The focus of these theories is on the explanation of consciousness itself. Other theories focus on emotional phenomena related to consciousness, almost exclusively subjective emotional experience (Barrett et al., 2007; Critchley, 2005; Damasio, 1999; Lambie & Marcel, 2002b; LeDoux & Brown, 2017; Seth et al., 2012; Thagard & Aubie, 2008; Tsuchiya & Adolphs, 2007; Winkelman et al., 2011).

Ours is not a theory of consciousness or the explanation of subjective experiences associated with emotion, but instead a theory of how emotion-produced, multi-channel nonverbal behavior differs across time according to unconscious and conscious processes. Below we provide a brief overview of the nervous system, focusing on recent work demonstrating its complex interconnectivity. We then discuss four NVB channels and their neural pathways based on neurophysiological insights from brain research, and then the existence of multiple mental states and their connections to NVB via this intricate neuroanatomy. We describe the implications of this analysis in a novel model of emotion, expression, and consciousness, and then discuss the theoretical and empirical implications of this model, hopefully allowing for an integration and synthesizing of previous fractures and explication of implications to understanding and studying NVB as a package of components of weak signals. Based on this framework, we propose that (a) NVB is part of a total bodily communication package and occurs across multiple channels; (b) NVB channels are activated by both cortical and subcortical structures, allowing for both unconscious, coherent behavior as well as learned, conscious, less coherent behavior across time; and (c) this complexity has implications for theory and research.

NVB Channels and Their Neural Pathways

Working Overview of Nervous System

Here we briefly describe the complexity and interconnectivity of the neurophysiology that links mental states and the body. This description does no justice to the breadth of knowledge that exists, and interested readers are referred elsewhere to much more comprehensive reviews (e.g., Cuevas, 2015; de Oliveira-Souza, 2012; Paxinos & Mai, 2004; Siegel & Sapru, 2019; ten Donkelaar et al., 2004).

The nervous system is typically characterized as divisions, which have been useful for teaching and research. One is the central and peripheral nervous systems (CNS and PNS). The CNS contains the brain and spinal column whereas the PNS contains nerves that transmit information to and from the CNS and the rest of the body. Within the brain, a common division has been the cortical and subcortical areas. The cortex is generally considered primarily related to higher-order cognitive functions such as thinking, reasoning, problem solving, and language; subcortical structures of the brain refer to its deeper structures (including the hypothalamus, pituitary and pineal glands, thalamus, and basal ganglia, commonly referred to as the limbic system; MacLean, 1990) and are typically associated with more automatic and unconscious functions related to survival and homeostasis such as feeding and sleep.

The PNS is further subdivided into the somatic nervous system (SNS), which activates muscle movements associated with NVB, and the autonomic nervous system (ANS), which activates the physiology and organs. Two well-known neural tracts that innervate the SNS are the pyramidal and extrapyramidal tracts (de Oliveira-Souza, 2012; ten Donkelaar et al., 2004). The pyramidal tracts are primarily associated with learned movements and originate in an area of the brain known as the cortical motor strip. The extrapyramidal tract is the motor system network typically responsible for unlearned action; it is mainly found in the subcortical areas and activates lower motor neurons in the spinal cord involved in reflexes, locomotion, complex body movements, and postural control.

Although these neural divisions are well accepted, in reality most areas of the nervous system, especially within the brain, share high degrees of structural and functional interdependence (Paxinos & Mai, 2004). This occurs because of large degrees of complex interconnections among and across different regions and systems. For example, areas of the brain typically considered to exist in the subcortical areas (e.g., the limbic and extrapyramidal systems) also include large areas of the neocortex and are not solely subcortical (Blessing, 1997). The 12 cranial nerves—pairs of nerves that reside in the brainstem (Monkhouse, 2006)—relay information between the brain and parts of the body, primarily to and from the head and neck, and are important pathways of SNS activation of NVB. Although they are typically considered components of the PNS, several of the cranial nerves are more accurately depicted as residing in the CNS.

Functional interconnectivity is also supported by considering the speed of neuronal transmission (Horowitz et al., 2015; Swadlow & Waxman, 2012). Depending on the type and placement of nerve fibers, neural transmission can occur from a slow speed of 1 m/s to as fast as 120 m/s (Siegel & Sapru, 2019). These speeds indicate that even if one part of the brain is primarily associated with a mental state initially, many other brain regions are also activated almost simultaneously, even if sequentially.

This highly complex neural system activates the various muscles of the body typically considered NVB channels—the face, voice, hands, and whole body. As discussed below, NVB channels are connected to both cortical and subcortical structures of the brain and to both pyramidal and extrapyramidal tracts, allowing for conscious and unconscious, automatic and deliberate movements.

Face

The face includes over 20 anatomically independent muscles that move skin and change feature shapes, producing morphological appearance changes known as expressions (as opposed to facial physiognomy, which refers to the physical landmarks and structure of the face; see Gray & Goss, 1966). Although individual differences exist, cadaver studies have demonstrated that there is a uniform occurrence in the muscles required to produce emotional expressions not only in humans but also in nonhuman primates (Vick et al., 2007). Newborn infants have the same facial musculature at birth (Ekman & Oster, 1979). Facial muscles are innervated by a single cranial nerve (also known as the facial nerve or VII cranial nerve). Scholars vary on describing the pathways from the facial nerve to the facial muscles (Myckatyn & Mackinnon, 2004); generally speaking, the nerve divides into several main branches (temporal, zygomatic, buccal, marginal mandibular, and cervical branches), and then further subdivides to activate specific muscles and parts of muscles, as can be seen in Figure 1.

The facial nerve receives impulses from both the pyramidal and extrapyramidal tracts of the nervous system (Matsumoto & Lee, 1993; Rinn, 1984). The pyramidal tract drives learned facial actions and originate in the motor strip. The hands receive the largest degree of innervation from this area and thus are under the greatest degree of learned control (more below). Faces receive the next largest degree of activation from this area, and within the face, the lower face is more highly represented (Rinn, 1984, 1991), facilitating the use of muscles for eating, speech articulation, and controlling emotions and words. The extrapyramidal tract initiates unconscious emotional expressions. Neural connections to the facial nerve are discussed in more detail elsewhere (Kuypers, 1987; LeDoux & Phelps, 2008; Rinn, 1984, 1991), and interested readers are referred to these sources.

Facial behavior and expressions, therefore, are under dual neural control, with connections from both cortical and subcortical areas of the brain. Given the existence of many facial muscles, this neuroanatomy renders the face as one of the most anatomically complex muscle systems available for communication (Gray & Goss, 1966; Hwang & Matsumoto, 2016b). Faces allow for a multiplicity of uses and functions beyond emotional expression (see review in Hwang & Matsumoto, 2016a), which is one reason underlying complicated and sometimes contradictory findings in studies of it.

Voice

The voice is also a complex signal system, communicating speech as well as non-speech (often emotion-related) vocalizations. Sounds are produced with the coordination of over 100 muscles (laryngeal, orofacial, and respiratory; refer to Simonyan & Horwitz, 2011) that move the face, jaw, tongue, lips, vocal cords, larynx, and diaphragm (Frank et al., 2013). Sounds also occur because of physiological changes resulting from the activation of both ANS and SNS that alter blood flow, blood pressure, muscle tension, mucus secretion, and respiration. These affect the length, shape, and smoothness of movements of body parts responsible for sounds, which in turn affect tone, energy, loudness, and other audible vocal elements (Scherer, 1989).

A complex neural system of control activates this sound-producing package, with seven cranial nerves involved (Monkhouse, 2006; Webb, 2017).[2] Motor pathways for control of this sound package reside at multiple levels of the nervous system and consist of both pyramidal and extrapyramidal systems (Fujii et al., 2016; Jürgens, 2002; Liebenthal et al., 2016; Simonyan & Horwitz, 2011).

Speech begins with verbal representations that are signaled from an area of the brain known as Broca's area (in the neocortex), activating the motor strip and various cranial nerves, and then out to the musculature of the speech mechanism and other portions of the head, neck, shoulders, and abdominal and thoracic viscera (Frank et al., 2013). These impulses go through the motor strip, which controls learned actions, as infants and young children need to learn to move various muscles to produce speech.

Non-speech emotional vocalizations begin in the subcortical areas of the brain (Frank et al., 2013) and involve indirect activation pathways through the extrapyramidal tracts, regulating reflexes and maintaining posture and tone. Those brain areas send signals that engage the ANS and SNS, which produce the physiological changes mentioned above responsible for tone, energy, and loudness (Scherer, 1989). This multi-level neural control allows for vocal cues to convey both cognitive and emotional states (Sauter et al., 2010; Scott & McGettigan, 2016).

Thus, the voice is also under a complex system of dual neural control, with direct connections from both cortical and subcortical areas. Adding to this complexity is the fact that speech and non-speech vocalizations are linked to each other because speech will be infused with emotion-related vocalizations via indirect pathways. Both systems can send signals simultaneously to the sound-producing package in the throat structures.

Hands

Here, we refer to hands as including arms, hands, and fingers. The hands are generally activated through the motor strip, which makes sense because we learn to use our hands in very

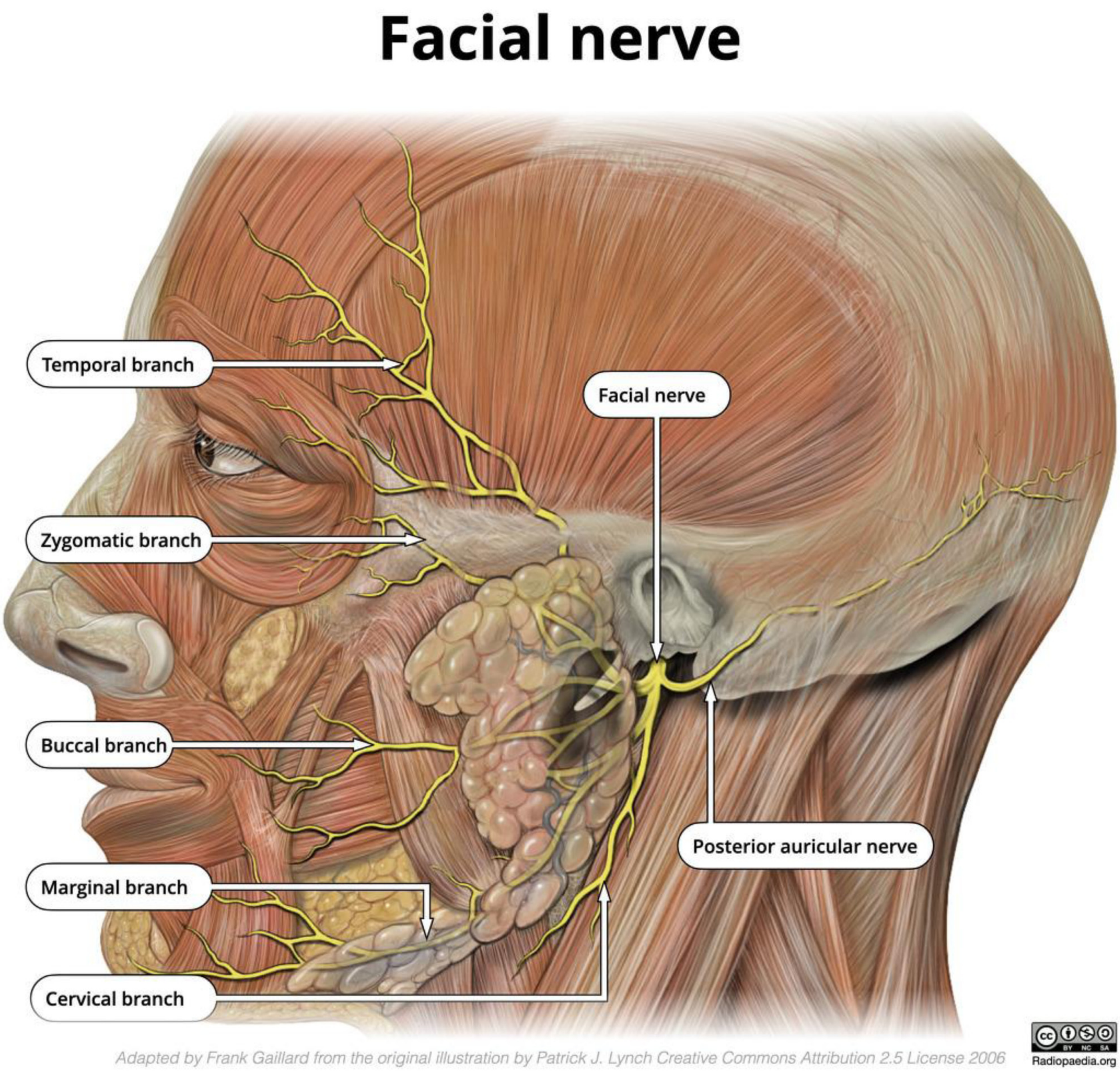

Figure 1. Facial nerve branches. *Note*. Case courtesy of Assoc Prof Frank Gaillard, Radiopaedia.org, rID: 35842. Retrieved from https://radiopaedia.org/cases/facial-nerve-branches-illustration.

intricate, precise ways (Perez, 2015; Ullén et al., 2003), and these body parts have the largest representation on the motor strip (Gray & Goss, 1966). Interestingly, the neural pathways associated with the vocalization of verbal representations of thoughts into words pass through the motor strip (Frank et al., 2013), enabling hand movements to embody cognition through speech illustrators and emblematic gestures (Cartmill & Goldin-Meadow, 2016; Matsumoto & Hwang, 2013). Of course, speech can also occur without hand movements.

Important for this discussion, recent studies have indicated that hand movements are also activated by subcortical structures (Almairac et al., 2014; Perez, 2015; Raghavan et al., 2006; Verleger et al., 2003), implicating unconscious activation of these body parts. Neuroscientists are also discovering new, unconscious neural pathways that demonstrate the influence of brain regions associated with sensory input and perceptions of extrapersonal space (Gardner, 2017; Rathelot et al., 2017), suggested decades earlier (Mountcastle et al., 1975).

Whole Body

Here, we refer to the body as including the trunk, hips, and lower limbs. The muscles in these areas are primarily used for gross motor movements such as walking, running, leaning, twisting, or maintaining balance (Marieb et al., 2020; Saladin, 2017). These muscles are activated from the motor strip and the pyramidal tract, allowing for conscious, learned movements (Cacioppo et al., 1990). This makes sense because we learn to use these muscles to perform large motor movements such as when infants learn to roll, sit, stand, walk, and run. Because their neural representation on the motor strip is considerably smaller than the hands or lower face and head (Rinn, 1984), learning to move these body areas precisely takes considerable learning, practice, and repetition.

Whole body movements are also affected by subcortical (and likely extrapyramidal tract and unconscious) influences, the evidence for which comes from at least two sources. One includes the psychophysiological literature on emotion, which demonstrates activation of ANS activity that primes the whole body for motor behavior and action (see Levenson, 2003a, 2014 for reviews), producing action readiness (Frijda, 2010; Frijda et al., 1989). This is why the same motor structure can be used to perform impulsive actions as well as fight vs. flight reactions. Indirect activation pathways also regulate reflexes and maintain posture and muscle tone, also emanating from unconscious, extrapyramidal tract activation.

A second source of evidence for subcortical, extrapyramidal tract influences on whole body movements comes from studies examining plaques, scarring, or other types of lesions in the subcortical areas of the brain. These are often associated with multiple sclerosis and other types of movement disorders in the upper and lower body (Benabid et al., 1998; Hofman et al., 1989; Young et al., 1981). Thus, as with the other NVB channels, the whole body is activated by neural tracts involving both learned, conscious movements in the cortical areas of the brain as well as those involving unlearned, automatic, unconscious movements in the subcortical areas.

Summary

Although we separated the NVB channels into their typical silos, they are connected to both cortical and subcortical structures of the brain, and to both pyramidal and extrapyramidal tracts, allowing for conscious and unconscious, learned and unlearned, and automatic and deliberate movements. NVB channels are also likely connected to each other via their links with the brain, which is the central command center of a complex, interconnected system via connections between the CNS and PNS and because of the extremely high speeds of neuronal transmission connecting different parts of the nervous system with each other. Central command, in turn, is associated with mental states, to which we now turn.

Mental States and Their Connection to NVB via Neuroanatomy

Although cognitions and emotions have primarily been considered as cortical and subcortical events, respectively, recent research has provided evidence that both are intricately connected to the motor system via pyramidal and extrapyramidal tracts and to cortical and subcortical areas of the brain. For example, as described above, representations of words expressed in speech are signaled from the neocortex (Broca's area), activating the motor strip and various cranial nerves, which are then are projected to the musculature of the speech mechanism and other portions of the head, neck, shoulders, and abdominal and thoracic viscera (Frank et al., 2013). Non-speech vocalizations begin in subcortical areas of the brain (Frank et al., 2013) and activate pathways through the extrapyramidal tracts, sending signals that engage the ANS and SNS; these same signals result in physiological changes that are responsible for tone, energy, loudness, and other audible vocal elements (Scherer, 1989).

Emotions and affective states are also connected to the motor system via a complex web involving pyramidal and extrapyramidal tracts. Many authors have provided excellent reviews of this area (Izard, 1993; LeDoux, 2000; MacLean, 1990; Panksepp, 1998; Papez, 1937), all suggesting multiple systems of neural pathways associated with different affective and emotional states.[3] Recently, Koelsch and colleagues (Koelsch et al., 2015) proposed four categories of emotions that originate from four neuroanatomically distinct brain systems (the brainstem-, diencephalon-, hippocampus-, and orbitofrontal-centered systems). These systems were increasingly differentiated in our evolutionary history and associated with the emergence of different types of affects and emotions (i.e., ascending activation, pain/pleasure, attachment-related affects, and moral affects, each involving more specific, differentiated emotions) that corresponded to the evolution of human complex cognitive abilities and circuitry.

Importantly, the affect/emotion systems interact with each other and with language, and with other cortical and subcortical structures that are not necessarily related to a particular class of affect or emotion (Koelsch et al., 2015). These connections may serve to integrate information from other systems, explaining how all classes of emotion and affect are connected to expressive motor systems. The four emotion systems have projections to the amygdala, which is associated with autonomic and endocrine activity, orienting responses, flight, attack and defensive behavior, fear, fear conditioning, pleasantness, and facial expressions of emotion (LeDoux & Phelps, 2008). The amygdala activates or inhibits neural activity in affect-generating brain structures (i.e., hippocampus, diencephalon, brainstem, and orbitofrontal cortex), rather than generating all affects itself.

In addition to crosstalk and direct and indirect neural pathways linking different brain areas and mental states, considering the speed of neural conduction in the brain and motor system is relevant here. As mentioned earlier, speeds vary depending on the type of nerve fiber but regardless are fast, sometimes greater than 100 m/s (Horowitz et al., 2015; Swadlow & Waxman, 2012), providing further evidence for neural, mental, and consequently motor, interconnectivity.

Another overlooked aspect of the mind is that it is replete with multiple thoughts and feelings that often co-exist, either simultaneously or in rapid sequence with each other, particularly when interacting with others. Spoken words reflect only part of the contents of one's mind, leaving other cognitions and emotions unspoken, some consciously accessible but much not. People are often in a cognitive-emotional fugue (Lewis et al., 1985), a concept that was introduced decades ago but lost in mainstream studies. Some thoughts and feelings are complementary to each other, some not; and they may be directly, indirectly, or unrelated to each other. People direct their limited cognitive resources to verbalizing certain, specific, selected thoughts (intentional communication) and to managing their appearance or impressions of others about themselves (for extended discussions, see Baumeister & Masicampo, 2010; Lambie & Marcel, 2002a; Murphy & Zajonc, 1993). While separating cognition and emotion into a dichotomy is necessary and convenient for theory, research, and teaching, they are highly intertwined with each other, both in terms of mental states and neural processes (as are the neuropsychological dichotomies discussed previously).

The existence of multiple cognitions and emotions in the mind and high degrees of neural interconnectivity within the brain and with the body suggest that multiple and different NVB may be associated with these multiple cognitions and emotions. Unspoken, diverse, complex, and at least partially unconscious mental contents may be expressed nonverbally through multiple channels (Matsumoto et al., 2013) and may embody cognitions or signal emotions; may be complementary, supplemental, qualifying, contradicting, or even irrelevant to the content of spoken words; and may occur in or outside of conscious awareness. Thus, NVB can, and should be, complex because the cognitive and emotional contents of the mind are varied, and humans are neurologically wired to express those complex contents.

The underlying neuropsychological reality in the above analysis also implies that outputs from multiple NVB channels can be expected at any time, being readouts of both cognitive and emotional mental states and products of both conscious, learned processes as well as unconscious, automatic processes. In other words, we are wired to transmit thoughts and feelings to various parts of our body consciously and unconsciously. A total communication package, therefore, includes not only the content of words but also readouts that occur in the NVB channels, with and without words. This should be especially true when people interact with others in cognitively and emotionally demanding situations.

A Model of Emotion, Nonverbal Behavior, and Consciousness

In this section, we describe how emotions involve both unconscious and conscious processes, with their implications for multi-channel NVB output. Figure 2 adapts an information processing model of emotion elicitation we have previously used to describe how emotions are triggered (Matsumoto et al., 2013; Matsumoto & Juang, 2023). The model begins with individuals scanning for meaningful events that are relevant to their welfare. These events may be external (e.g., observing the actions of others) or internal (e.g., thoughts and memories) to the individual. Percepts are formed from sensory input of those events and appraised (evaluated) according to their action relevance to the individual according to an emotion schema database. This database contains event templates against which percepts are appraised and for which individuals may be required to produce immediate action. Many of these templates are likely originally related to survival in nature as vestiges of our evolutionary history, and many are learned (Tooby & Cosmides, 2008). If events are appraised as requiring potential immediate action, then emotions are elicited; if not, events are dismissed, and individuals continue scanning. If and when an emotion-eliciting event occurs, a coordinated and organized set of action priming reactions are produced that include cognitive gating (the modulation of sensory, perceptual, and other cognitive processes), physiological reactions in the CNS and ANS (Davidson et al., 1994; Levenson, 1994, 1999, 2003b), and multi-channel NVB elicitation along the pathways described earlier, all in service of the actions being primed. The term emotion is a metaphor for this coordinated package of reactions that prepares individuals to act in order to adapt to the perceived event trigger (Frijda, 2010; Frijda et al., 1989; Frijda & Tcherkassof, 1997).[4]

We overlay the model in Figure 2 with a proposal of what processes are unconscious, what enter consciousness (i.e., the conscious field), and what are encapsulated (Firestone & Scholl, 2016; Merker et al., 2021; Morsella et al., in press). Here, the term encapsulation refers to mental content that is independent of other content and not affected by higher order knowledge or other cognitive or motivational content; that is, encapsulation refers to the idea that a particular conscious content (e.g., an urge, a memory) is protected and insulated from the influence of other conscious contents (e.g., higher-level knowledge or voluntary processing). For example, illusions such as the Mueller-Lyer illusion or the McGurk effect are said to be encapsulated because knowledge about the true nature of the stimuli does not turn off or otherwise modify the illusory percept; such encapsulation has been argued to be advantageous over the course of development (refer to extended discussions in Firestone & Scholl, 2016; Morsella, 2005; Morsella et al., 2016). Or consider very young children, in whom feelings and emotions just happen; these emotional states are encapsulated. Given this understanding, we propose that the process of (a) forming percepts from sensory input, (b) appraising percepts for their action relevance, and (c) initiation of the action priming reactions called emotion, which includes NVB, are

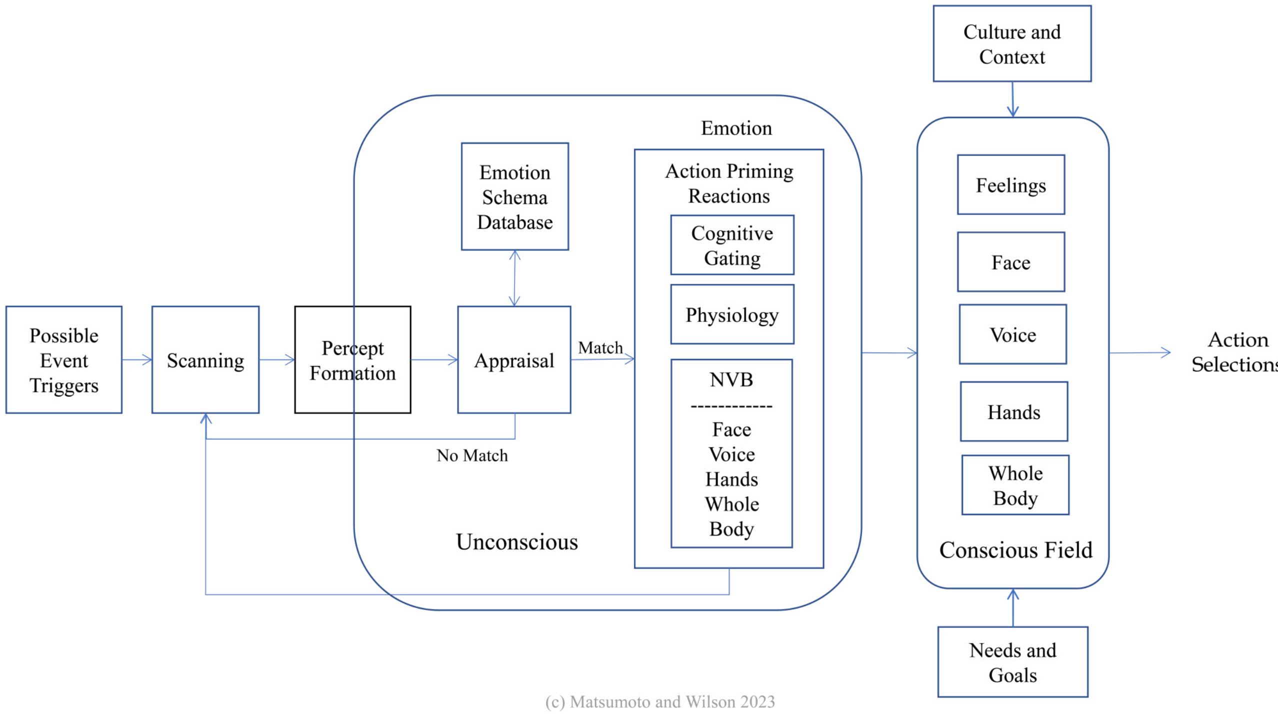

Figure 2. Proposed model of emotion, NVB, and consciousness. *Note*. Content in square boxes is encapsulated. When emotions are elicited, NVB, including face, voice, hands, and whole body movements, are first unconscious and part of a coordinated, organized, and coherent set of reactions (in the middle square box under Emotion). This package of NVB then transitions to the conscious field, where NVB divides into each channel and becomes encapsulated, and where expressive behavior becomes more conscious and less coordinated and organized.

encapsulated components outside of conscious awareness, that is, unconscious.

Support for this position comes from several sources, one of which is studies examining startle reactions (Ekman et al., 1985, 1997). In these studies, the behavioral reactions of individuals were recorded and analyzed when an extremely loud and unexpected audible stimulus was suddenly presented during an interview. The average time from the introduction of the eliciting stimulus to the onset of an observable behavioral reaction was 54 ms. This extremely quick time from event trigger to initial NVB production suggests that the process of percept formation, evaluation, and reaction initiation in Figure 2 is unconscious. Further evidence for this position comes from studies demonstrating support for the neural architecture of emotion elicitation and fear conditioning (Izard, 2007; LaBar & LeDoux, 2003; LeDoux & Phelps, 2008; Panksepp, 2007, 2008), as well as studies examining immediate emotional reactions of very young children and infants (Campos et al., 2003, 2004; Camras et al., 1992, 1998).

Unconsciously primed action readiness, comprising the initial package of cognitive gating, physiological reactions, and NVB then transitions into the conscious field, where each NVB channel becomes encapsulated. (This transition may correspond to a two-system view of emotion processing as posited by LeDoux & Pine, 2016.) The conscious field represents the boundaries within which conscious contents exist at any one time (Searle, 2000). Within the conscious field, specific mental states and behavior modalities are encapsulated, as their nature or occurrence cannot be influenced directly by higher-level knowledge, individual will or desires, or each other (Morsella et al., 2016; Morsella et al., in press). The NVB package divides into each channel of NVB (face, voice, hands, whole body), which becomes encapsulated components of the conscious field and somewhat independent of each other. Feelings, which refer to subjective experience, qualia, and action-related urges are also encapsulated components in the conscious field and represent an integration of unconscious processes and components in the conscious field.

The conscious field serves the role of integrating neural activities and information processing structures for the purpose of activating the skeletomotor system, that is, action selection (Morsella et al., 2016). Therefore, although actions may be unconsciously primed and serve as a basis for motivations underlying behavior (corresponding to the notion that emotion affords action with minimal conscious thinking; refer to Tomkins, 1962, 1963; Tooby & Cosmides, 2008), humans have the ability of selecting action that may or may not correspond with the unconsciously primed action readiness state. The conscious field facilitates this action selection process.

The conscious field does this by incorporating and interacting with learned cultural influences that are represented in multiple ways, including the form of learned action patterns, associated higher-level cognitive products (attitudes, beliefs, values, norms, worldviews), and memories of culturally learned display rules (Ekman & Friesen, 1969; Matsumoto et al., 2008b) that produce proscriptions for action. Cultural influences can also contain memories of rules of etiquette or appropriateness, such as how to respond when angry at the boss at work, and culturally determined display and instrumental behavior rules that govern what expressive (e.g., smile or not) and instrumental behavior (e.g., run or not) are appropriate in any given context (Matsumoto & Wilson, 2008).

Cultural influences also include learned cultural meanings afforded to context—the meanings of who, what, when, where, why, how, and history—that produce proscriptions for behavior (Matsumoto, 2007; Matsumoto & Juang, 2023). These proscriptions are based on culturally determined meanings of context, as the main function of culture is to assign meaning to context to facilitate social coordination, and learning contextual meaning is an important aspect of enculturation (Matsumoto & Juang, 2023). The conscious field also incorporates and interacts with situational needs and goals that produce proscriptions for behavior.

Culturally modifiable expressions (e.g., social smiles) and instrumental behaviors (e.g., running, hitting, approaching) are, therefore, action selections that occur because of the collective contents of the conscious field. That is, these behaviors represent action that are selected based on the components in the conscious field at a given time and context. Therefore, depending on contextual meaning, feelings and urges, needs and goals, and culturally learned display and instrumental rules, anger can result in rage, hitting, clenching one's mouth, yelling obscenities, smiling, or doing nothing, depending on the contents in the conscious field, the salience of needs and urges, and culturally learned meanings and information in the context.

The model suggests that NVB can be both unconscious and conscious. When emotions are triggered, the speed of initiation of behavioral reactions (e.g., startle described above) is extremely rapid and indicates that the entire NVB package consisting of various NVB channels is unconsciously innervated as a coherent, multi-channel package that allows for action readiness and immediate signaling to others. Research providing evidence for response coherence among emotion components provides support for this notion (Bonanno & Keltner, 2004; Ekman, 1992b; Hwang & Matsumoto, 2016a; Levenson, 2014; Rosenberg & Ekman, 1994). Thus, some expressive behavior may occur extremely quickly and be outside of conscious awareness (e.g., piloerection, skin coloration, breathing changes, extremely rapid facial expressions). The NVB package quickly transitions, however, to the conscious field, in which separate NVB channels become encapsulated and are represented along with other contents in the field. As mentioned previously, the conscious field allows for action selection by integrating information in the conscious field. Thus, individuals may consciously regulate their hands but not face, or voice and body but not hands, or words but not body, etc., because these NVB channels are encapsulated. Larger, instrumental behavior choices are also encapsulated (freeze, flee, fight, etc.). Therefore, although multi-channel NVB are unconsciously integrated as a whole and coherent at emotion initiation, they may appear less so once they participate in the conscious field wherein other kinds of contents can influence action selection. Action selection is thus context sensitive, resulting from the combined influence of all conscious contents at a given moment.

Further support for this position comes from studies examining the immediate NVB reactions of Olympic athletes upon winning or losing a medal. Immediate facial expressions and whole body reactions of both sighted and blind individuals were similar across cultures as a function of winning or losing (Hwang & Matsumoto, 2014b; Matsumoto & Hwang, 2012b; Matsumoto & Willingham, 2006, 2009), indicating a universal, coherent basis for their emotional expressions. Examining their expressive behavior in temporal sequence later, however, demonstrated cultural differences in their expressions, which occurred on average less than one second after their immediate, universal reactions (Hwang & Matsumoto, 2014a; Matsumoto et al., 2009). Moreover, there was variation in the secondary reactions, with some athletes displaying anger, some fear, some sadness, some contempt, and some nothing. There was also considerable variation in expressions at the medal ceremonies, which is a much more consciously mediated event. That is, once the emotion package including multi-channel NVB transitioned into the conscious field, their outputs were more susceptible to learned cultural contents and thus varied.

Different workspace models of consciousness posit that contents in the conscious field are broadcast to processes that can, in turn, directly influence contents in the field (Baars, 2005; Baars & Franklin, 2007; Dehaene et al., 1998; Dehaene & Naccache, 2001). Our view, which considers the encapsulation of emotion-related conscious contents, is more consistent with a model in which the conscious field is used to integrate the various information represented by the contents in the conscious field to modulate the skeletomotor output system (Morsella et al., 2016; Morsella et al., in press). Such a model is more appropriate for a model of emotion and NVB based on the description of the neural architecture of NVB described earlier, the nature of consciousness and encapsulation, and literature that demonstrates that different NVB outputs are associated with different messages and specific skeletal muscles.

Theoretical Issues

The model posited above can address some debates in the literature, for example, how emotional expressions can be both universal and culture-specific (Ekman, 1992a; Feldman Barrett, 2006; Izard, 2007; Keltner et al., 2019a; Magai et al., 2006; Panksepp, 2007), or why a multi-channel approach to understanding total communication packages is advantageous over single channel approaches in cognitively and emotionally demanding situations (e.g., deception; refer to Burzo et al., 2017; Matsumoto & Hwang, 2018a, 2020). For instance, some controversies in the emotion expression production literature may be addressed by delineating whether the expressions examined were immediate reactions produced from unconscious processes or subsequent responses produced from action selection in the conscious field. Some controversies may be related to what aspect or domain of emotion was studied, for example, immediate expressive reactions versus self-reported feelings. Some controversies may be related to whether studies relied on emotional language (e.g., attitudes, values, or beliefs about emotion, or labeling of emotional expressions) or not (refer also to Matsumoto & Hwang, 2019; Matsumoto & Hwang, 2012a, for extended discussions of these issues).

But the model also presents some theoretical and empirical issues that are at odds with the literature. One of these has to do with the nature of emotion appraisal. Research for decades has explicated the nature of the antecedents and appraisals of discrete emotions across cultures (Matsumoto et al., 1988; Scherer, 1997a, 1997b; Scherer & Wallbott, 1994). In these studies, respondents were typically asked to recall a time when they experienced a certain emotion, describe the eliciting event, and then rate the eliciting event along several theoretically derived dimensions. Findings from these studies have been instrumental in the creation of appraisal theories of emotion that are well accepted today (Ellsworth & Scherer, 2003; Scherer, 2001; Scherer et al., 2001). In general, these theories posit that the appraisal process involves a complex evaluation of the eliciting event along any number of dimensions related to self-relevance (presumably in the emotion schema database in Figure 2).

Our model raises questions about such approaches. That is, if the appraisal of eliciting events is unconscious and clocked times from event occurrence to behavioral reaction are as fast as 54 ms, which is outside of conscious awareness, individuals may not have access to the contents of that appraisal process. This would suggest that responses to questionnaires recalling past emotion-eliciting episodes from memories could be post hoc rationalizing of such memories (referred to by Goldie, 2000 as post-rationalizing), and that data obtained from such recollections reflect folk theories of the elicitors for emotions but not necessarily what actually happens during the appraisal process. To be sure, cross-cultural consensus on folk theories of emotion elicitors is interesting and important to discover, but that may be much different than what actually occurs in the mind to trigger emotions. The methodology to measure what occurs in the mind during such rapid processes may not yet be developed, and our model would suggest that we really do not know yet the contents of the appraisal process.

Another theoretical issue raised by the model in Figure 2 concerns parsing a difference between voluntary or deliberate NVB and involuntary, spontaneous NVB.[5] While pyramidal and extrapyramidal tracts are primarily concerned with voluntary and involuntary movements, respectively, high degrees of interconnectivity within and between regions and rapid neural conduction speeds suggest that most motor output is not solely the province of either tract. Even if emotion-eliciting events are primarily evaluated and emotions activated in subcortical areas, triggering unconscious motor impulses for coordinated, multi-channel expressive behavior, the cortex, including contextual information, learned rules, norms, and goals will also effectively be immediately activated, triggering learned modulation of the expressive behavior through the conscious field. Parsing this distinction is important but challenging given the methods available today.

Ambiguity in distinctions between spontaneous and learned makes the issue more complex. As argued many years ago (Matsumoto & Lee, 1993), even spontaneously produced expressions are those that have been learned and practiced so well and so often during socialization and enculturation that they are naturally produced but still outside volitional awareness. Individuals generally have little awareness of the expressions they produce (Barr & Kleck, 1995) and can display culturally regulated (i.e., learned) behavior spontaneously and outside of conscious awareness. Labeling such behavior as voluntary or involuntary is difficult.

Researchers may attempt to parse the voluntary versus involuntary distinction based on behavior onset speed. Extremely quick behavior such as startles or facial expressions of extremely short durations (Ekman et al., 1985; Matsumoto & Hwang, 2018b) is likely produced unconsciously, probably because the neuropsychological wiring and processes would make an influence by conscious, volitional thoughts temporally later. But using reaction speeds as cutoff points for knowing exactly when behavior is voluntary or involuntary is difficult and arbitrary at best, at least now, and to our knowledge, only one study has explored this issue to date (Matsumoto et al., 2009).

Finally, the model in Figure 2 suggests that NVB and messages extracted from them are weak signals, especially if they result from action selection involving the conscious field. Because of the complexity of the neurophysiological system described earlier (which is limited to methods of studying it and likely only approximates its actual complexity), messages signaled by NVB may be diffuse, rapid, weak, and malleable to ever-changing contexts and mental states. Moreover, in many cases, the same anatomical structures are used for multiple functions. Facial movements, for instance, can signal emotions, emblems, speech illustration, eating, talking, breathing, physical effort, and idiosyncrasies (Hwang & Matsumoto, 2016a). Thus, NVB can be ambiguous, producing weak signals that can hinder theoretical development and signature discovery (and may have contributed to contradictory findings in the past).

In the future, we suggest some degree of specification among channels and subchannels in terms of the messages signaled. This specification may be rooted somewhat in the neuropsychology underlying the various channels that provide guidelines to conceptualize and hypothesize about NVB clusters heretofore not considered. Prior research provides roadmaps to some predictions: discrete emotions may be more likely portrayed in face or voice (Hwang & Matsumoto, 2016a), general affective states in body or voice (Matsumoto et al., 2016; Scott & McGettigan, 2016), and cognitive processes and specific verbal words or phrases in gestures (Cartmill & Goldin-Meadow, 2016). Some studies have provided evidence for the relative contributions of different NVB to signaling mental states; Hartwig and Bond's (2014) meta-analysis on NVB associated with veracity and deception showed that within a cluster of NVB that differentiated truths from lies, some cues were relatively more important than others. Such findings suggest that the influence of various brain regions and neural pathways likely differ depending on the salience of different mental states and context.

But hypothesizing what specific combination of emotions, affective states, cognitive processes, or words or phrases will be produced nonverbally in any specific situation is daunting, especially given that many mental states are transient, fleeting, and malleable, and given changes in context or interactive discourse content and style. Regardless, positing combinations of mental states to be discerned in a context that may be displayed across channels, instead of relying on one or a few mental states displayed within a single channel, may be a step in a healthy direction.

Empirical Issues

The model in Figure 2 also has empirical implications, the main one being that future studies examining associations between NVB and mental states should consider what aspect and channel of NVB is being studied—immediately innervated NVB that may still be part of an unconscious process or NVB that is occurring in the conscious field. NVB innervated by a central command structure in the brain as part of an immediate reaction pattern will be more coordinated, organized, cross-culturally similar, and stronger signals of mental states across channels as they will be part of an innate expressive system allowing for unconscious action priming that has intrapersonal, interpersonal, and sociocultural functions (Hwang & Matsumoto, 2016a, 2018; Keltner & Haidt, 1999; Levenson, 1999). NVB produced from the conscious field, including studies requiring language (e.g., judgments of facial expressions or self-report) will be less coordinated and organized, more cross-culturally variable, and weaker signals of mental states.

Another empirical implication of the above analysis is that future studies consider examining NVB across multiple channels, rather than in single channels, and across time. To a large extent, studies of emotion and NVB have already incorporated a multi-channel approach. Over two decades ago, studies combining behavior across NVB channels such as face, head movements, and gaze demonstrated communication of emotions such as shame and embarrassment (Keltner, 1995; Keltner & Buswell, 1997). Research has also provided evidence for the communication of emotions such as love, gratitude, and sympathy via touch (Hertenstein et al., 2009), along with face (Oveis et al., 2009). Studies examining face along with head, arm, and whole body movements have documented an expression of pride (Tracy & Matsumoto, 2008; Tracy & Robins, 2008). This line of multi-channel research was preceded by more classic work decades ago (Ekman et al., 1976, 1980, 1991).

Recent multi-channel NVB research has also documented an expression of the emotion of triumph. Matsumoto and Hwang (2012b) presented images of initial, whole body reactions of winners of the final judo matches in the 2004 Athens Olympic Games to U.S. American and South Korean observers. Some reactions were identified as triumph in both cultures. Subsequent studies documented the production of those whole body expressions across cultures (Hwang & Matsumoto, 2014a, 2014b). In these studies, the first behavioral reactions of judo athletes immediately after winning or losing a match for an Olympic medal were coded. Analyses indicated that the triumph expression's primary components were expansion, aggression, and attention, and involved multiple NVB channels including face, hands and arms, and whole body. These findings corresponded with other studies examining the same reaction (although they may not have called the expression triumph; see Bellocchi & Ritchie, 2015; Friedman & Miller-Herringer, 1991; Henrich & Gil-White, 2001; Mazur, 1985), including research involving nonhuman primates (De Waal, 1998).

To date, only a few studies, however, have examined multi-channel NVB across time (e.g., Matsumoto & Hwang, 2018a; many studies sample multi-channel NVB across time but aggregate data). Future studies doing so while incorporating considerations of consciousness offer a potential for different insights about age-old questions concerning the nature of emotion and expression. This approach converges with classic, multi-channel descriptions of emotion (Darwin, 1872; De Waal, 2003; Ekman, 1973, 2003) as well as contemporary emotion theories involving concepts such as response coherence (Bonanno & Keltner, 2004; Ekman, 1992b; Hwang & Matsumoto, 2016a; Levenson, 2014; Rosenberg & Ekman, 1994), as mentioned earlier.

But there are pitfalls as well; for example, developing clear theories and hypotheses about which specific NVB in which specific channels will be produced in which types of contexts and across time is difficult, for reasons described earlier. There are also multiple methodological issues, one of which concerns increased Type I error when considering multiple predictors of mental states. This problem is compounded when sample sizes do not have sufficient power and findings based on many multivariate procedures are optimized for individual data sets, and leads to concerns about replicability and generalizability. Some multi-channel studies have recomputed analyses using randomized data to compare findings obtained with observed data (Matsumoto & Hwang, 2018a, 2020). Such procedures are akin to parallel analysis, which uses randomized raw data or intercorrelation matrices to determine the number of factors or components to extract (Franklin et al., 1995; Hayton et al., 2004; Lim & Jahng, 2019; Wood et al., 2015). Although such procedures mitigate Type I error concerns, however, they do not eliminate them.

Distinguishing between multiple NVB across versus within channels is also important because the term multiple NVB can refer to multiple NVB assessed within a single channel. Assessments of the face, for instance, can produce data on different emotions (e.g., anger, disgust, fear, etc.); assessments of voice can produce data on different paralinguistic qualities (e.g., tone, intensity, duration, pauses, etc.). Although assessments of multiple NVB within channels are undoubtedly important, a multi-channel approach suggests assessments of NVB across different channels or modalities, for example, face and voice, face and gesture, voice and whole body movements, etc. We suggest that a multi-channel approach is optimal because different types of messages are primarily expressed through different channels, and their assessment is consistent with a view of the multiplicity and complexity of mental states, their association with NVB, and consciousness. Also, we suspect that people commonly and deliberately attempt to manage and control single NVB channels (for example, see the findings reported in Anolli & Ciceri, 1997; Appling et al., 2015; Strömwall et al., 2006); in such situations, signals from different channels may be produced, depending on where attention is placed.

Another issue concerns difficulties in interpreting findings across studies, especially because there is no accepted standard of which NVB channels should be assessed across multiple channels and how they should be measured. Even if the same investigators assess the same NVB in different studies, differences in research contexts, experimental design, and procedures constrain the nature of the mental states associated with those contexts, and thus the NVB produced. Differences in findings across studies may occur because of differences in context or because findings are not replicable. While future reviews can consider analyzing studies that examined multi-channel NVB to identify patterns of consistent NVB that emerge, unfortunately such a volume of research may not yet exist. Doing so may require some consistency in the selection and measurement of NVB across studies and investigators, which rarely occurs, rendering integrative and synthetic reviews difficult. Researchers may need to consider which NVB to include in a more comprehensive and systematic assessment in the future.

Conclusion

The purpose of this article was not to argue that there still are not meaningful research questions involving single NVB channels in single slices of time that should be addressed in the future, nor that the concept of a multi-channel NVB approach is new to the literature. Without doubt, there are situations in which a single NVB approach is necessary and sufficient, depending on the literature and specific research question. Equally without doubt are the contributions previous multi-channel NVB studies have made. For these reasons, much of the efforts and findings based on the previous literature are pricelessly crucial in the field of emotion and NVB.

Yet, certain situations may require a different approach; this approach may be a multi-channel one across time that incorporates a perspective of consciousness. For sure, such an approach is not without challenges, as described above; but those challenges are also opportunities to understand the complexity of NVB and the human mind better than before. Revisiting how each NVB channel can function uniquely and interconnectedly, consciously and unconsciously, coherently and not, bridging boundaries of unconsciousness to consciousness, all the while emphasizing the potential importance of a multi-channel approach might improve our understanding of the complicated nature of NVB. Cross- as well as within-channel examination of NVB in the future may produce further insights into the nature of the total bodily communication packages associated with the human mind that are commensurate with mental complexity, the neurophysiological system, consciousness, and the totality of the world of NVB.

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ORCID iD

David Matsumoto https://orcid.org/0000-0002-3186-1503

Notes

1. We do not take a position on whether consciousness is only associated with cortical structures, and recognize that controversies exist regarding this issue (interested readers are referred to Merker, 2007 and Morsella et al., 2016 for extended discussions). Our position is that NVB are connected to both cortical and subcortical structures, allowing for both unconscious and conscious influences.
2. These include the V^{th}, VII^{th}, and XII^{th} (associated with speech articulation and prosody), the $VIII^{th}$ (associated with loudness and voice modulation), the IX^{th} (associated with phonation and resonance), the X^{th}

(associated with phonation, resonance, and articulation prosody), and the XI[th] (associated with respiration, phonation, and resonance).

3. We delineate between emotion and affect and consider the latter to be readouts of bodily processes that are ongoing across time. We consider emotions to be specific reactions that activate a package of components (discussed more fully in text).
4. Although the model of emotion elicitation in Figure 2 is one way, we do not intend to suggest that conscious knowledge cannot influence unconscious processes. Contents of the conscious field can feed back to the unconscious emotion elicitation process as possible event triggers, thereby eliciting emotions. Also, elements of the emotion schema database must be flexible, as cultural learning allows for individuals to learn what to become emotional about, above and beyond any innate emotional triggers individuals come to the world with. For simplicity's sake, we describe in this paper a single elicitation event and its associations with consciousness.
5. Readers may notice we have avoided the use of the terms voluntary and involuntary to describe processes until now.

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