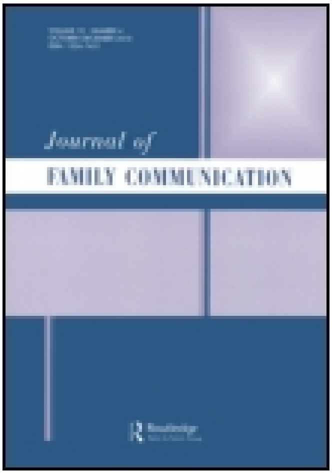

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An Introduction to the Uses and Potential Uses of Physiological Measurement in the Study of Family Communication

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Physiological measurement has not been widely used in family communication research, despite numerous associations that exist between physiological markers and communication processes and outcomes. This article discusses some of the most commonly measured physiological markers in the autonomic nervous system and the endocrine system and gives examples of studies that have linked these markers to various aspects of emotion, attachment, and relationship quality. Logistical issues surrounding the measurement and analysis of these markers are also addressed. Measurement of several important physiological processes can be incorporated into existing research paradigms in the field of family communication with relative ease, and such a move would be fruitful for those researchers wishing for a more complete understanding of how people experience various communicative events.

Recent years have seen a proliferation of research methods for studying and understanding family communication, as various volumes (e.g., Greenstein, 2001), including this issue of *Journal of Family Communication*, attest. This is certainly one mark of a continually maturing field of study. It bodes well for our abilities to predict and understand family communication behavior that we have so many established and validated methodological options from which to choose.

One method that has not been widely used in family communication research thus far, however, is the measurement of physiological processes, such as heart rate, blood pressure, skin temperature, and hormonal reactivity. Indeed, one might wonder what these types of processes have to do with communication in families.

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The answer is that they are theoretically and empirically implicated in a number of family communication phenomena, including (among others) conflict, affection, stress, emotion, and attachment. When spouses are engaged in marital conflict, for instance, it is not only their attributions, cultural norms, family rules, gender roles, or person perceptions that are influential. Conflict also activates sympathetic nervous system arousal, which is typically accompanied by increases in blood pressure, heart rate, and skin temperature, and it also activates the secretion of hormones, such as cortisol, by the endocrine system (see, e.g., Fehm-Wolfsdorf, Groth, Kaiser, & Hahlweg, 1999; Kiecolt-Glaser et al., 1996; Miller, Dopp, Myers, Stevens, & Fahey, 1999). The physiological processes listed earlier help to prepare the body to meet the demands of the situation and they are responsible for the fact that we do not experience conflict or other types of communicative events purely in cognitive or emotional ways—rather, we also experience them physiologically (see DeLoux, 1999).

Understanding how physiology is implicated in family communication processes is important because it helps researchers not only to understand those processes better but also to identify how such processes can affect people's physical health and well being in both the short and long terms. One important example is in the area of stress, which is problematic in numerous and substantial ways. For instance, several studies have demonstrated that stress inhibits immune system functioning (e.g., Jemmott, Wilson, & McClelland, 1983; Kiecolt-Glaser, Garner, et al., 1984; Kiecolt-Glaser et al., 1987; Kiecolt-Glaser, Speicher, Holliday, & Glaser, 1984; Manuck, Cohen, Rabin, Muldoon, & Bachen, 1991; Schleifer, Keller, Camerino, Thornton, & Stein, 1983). Excessive physiological reactions to stress are also implicated in coronary artery disease and hypertension (Blascovich, Schiffert, & Katkin, 1989; Hotz, 1995; Krantz & Manuck, 1984; Potempa, 1994), as well as elevated cholesterol and cardiovascular disease (Roy, Kirchbaum, & Steptoe, 2001). In fact, McEwen (1999) estimated that the annual economic cost of stress and stress-related disorders in the United States alone is nearly $200 billion. To the extent that family communication processes, such as marital or parent–child conflict, contribute to stress, then a more complete understanding of how these processes are linked to physiological outcomes can aid researchers in developing ways to circumvent these problems.

Why hasn't physiological measurement been used more frequently in family communication research? One important reason may be that family scholars are simply unaware of (a) what physical markers are relevant to their areas of study, and (b) how they would go about measuring and analyzing those markers. This is certainly understandable, given that most family communication researchers have little or no training in psychophysiology. A second, related reason is that few family communication theories (if any) offer guidance with respect to what physiological markers are relevant to family communication processes and why. Psychophysiological research should no more be conducted atheoretically than any other form of research—without researchers who are familiar with the methods and purposes of physiological measurement, such theories are unlikely ever to be developed. The implications of physiology to the field's understanding of family communication are numerous and substantial and they warrant our attention. Thankfully, family communication scholars need not become biologists to incorporate physiological measurements into their work. Although some forms of physiological measurement are best suited for use in a laboratory environment, others can be incorporated into more naturalistic research paradigms (including those involving interviews, diaries, or longitudinal self reports) with relative ease. Thus, the measurement of physiological processes and markers can be included in a number of existing data-collection methodologies. The purpose of this essay is to discuss aspects of physiology that might be of interest to family communication scholars and to describe the ways in which scholars can include measurements of such markers in their research programs.

Although numerous aspects of human physiology no doubt affect, and are affected by, communicative behavior, I focus my discussion on the measurement of markers from two major physiological systems, the autonomic nervous system and the endocrine system. Both are implicated in multiple aspects of arousal, activation, and relaxation, and are responsive to shifts in mood and emotion. As such, the markers of each system are of potential interest to researchers working to understand a range of family communicative behaviors.

The autonomic nervous system and the endocrine system are described in separate sections later. In each section, I begin by describing the basic physiology of the system and reviewing research that has linked various markers within that system to communicative behaviors of interest to family scholars. Let me offer two caveats about these reviews. First, they are illustrative, not exhaustive; my purpose is not to review all of the research done on each marker but to give examples of ways in which it has been studied in social scientific work. Second, many of the examples come from research done outside the field of family communication. When few, or no, studies have yet been conducted, I offer predictions about how family communicative processes might correlate with a particular physiological marker; these hypotheses will await empirical verification by family communication researchers. Finally, I end each section by addressing potential applications of the various markers within that system and by describing the logistics of measuring those markers, noting the ease with which family scholars can incorporate measurement of many such markers into their existing research paradigms.

AUTONOMIC NERVOUS SYSTEM

The body's nervous system consists of two parts: the central nervous system and the peripheral nervous system. The central nervous system is comprised of the brain and the spinal cord and has primary responsibility for all functioning in the body. In tandem, the peripheral nervous system governs behavior and reactivity that are peripheral to the central nervous system's activities but are still essential for health and survival, such as digestion, blood flow, and the regulation of a consistent body temperature. The peripheral nervous system can be divided into two main parts: the somatic nervous system, which controls skeletal muscle movement, and the autonomic nervous system (ANS), which maintains regulatory functions in the body. The ANS is responsible, for instance, for regulating blood flow, heart rate, skin temperature, and perspiration, and other functions that are necessary to keep the body running efficiently. For further reference on the structure and function of the nervous system, see Marieb (2003).

My discussion here focuses on the ANS, which can be further divided into two units: the sympathetic and the parasympathetic nervous systems. The sympathetic nervous system governs excitation and arousal; the parasympathetic nervous system governs relaxation and rest. The two systems work in tandem to increase bodily energy when it is needed and to conserve it when it is not.

The sympathetic nervous system generates arousal partly through the release of two chemical agents called catecholamines: *epinephrine* (also known as adrenaline) and *norepinephrine* (also known as noradrenaline). Both are secreted into the bloodstream by the adrenal gland. Epinephrine is responsible for the increased heart rate that accompanies arousal, producing what is referred to in layman's terms as an "adrenaline rush." Norepinephrine increases blood pressure during sympathetic nervous system activation through vasoconstriction (constriction of the blood vessels). These catecholamines are released into the bloodstream fairly quickly following exposure to a stimulus and prepare the body for increased energy demands; for example, epinephrine and norepinephrine are secreted during periods of stress to provide excess energy to be expended dealing with the stressor (Sapolsky, 2002).

Autonomic nervous system arousal affects several physiological markers; among these are heart rate, blood pressure, skin temperature, skin conductance, and pupil size (Andreassi, 2000). Each of these has been studied in relation to various communicative processes and relationship outcomes; further research on each of these markers has the potential to illuminate multiple aspects of family communication. I discuss each later.

Heart Rate

When the human body secretes epinephrine, it results in an increase in heart rate (HR). In healthy adults, resting heart rates are around 70 beats per minute for men and around 80 beats per minute for women. However, HR fluctuates rather constantly in response to a number of stimuli, including metabolic demand, breathing rate, relaxation or excitation, drug use, and ambient temperature. Importantly, it is also reactive to shifts in emotional experiences, particularly those associated with stress and conflict (Tortora, Grabowski, & Prezbindowski, 2002).

Much of Gottman's work with spouses has demonstrated two important patterns with respect to HR. First, HR reactivity during communicative events is associated with marital quality, and second, this pattern is different for women than for men. In their early longitudinal research with marital partners, for instance, Levenson and Gottman (1985) reported that HR during a conflict episode and an events-of-the-day conversation in the laboratory was strongly correlated with declines in marital satisfaction 3 years after the laboratory sessions, but only for husbands. Correlations between husbands' HRs and declines in marital satisfaction 3 years later were .80 for the events-of-the-day conversation and .92 for the conflict episode; for wives, the same correlations were .08 and –.11, respectively.

In other research, Gottman (1994) has found that husbands' HRs during conflict episodes and events-of-the-day discussions significantly discriminated between those whose wives were seriously considering divorce 3 years later and those whose wives were not seriously considering divorce (those in the latter group had higher HR during both types of conversations). In fact, HRs for the husbands in the two groups differed from each other by an average of 20.11 beats per minute (across four measurements); Gottman commented on the large size of this effect, given that laboratory effects have tended to average less than five beats per minute.

Blood Pressure

Blood pressure (BP) involves two different types of pressure: systolic and diastolic. Systolic BP is an index of the level of force exerted against the walls of the arteries when the heart is contracting or working ; diastolic BP is the level of force exerted against the arterial walls when the heart is resting or between contractions. Normal systolic BP for a healthy adult ranges from approximately 95 to 140 mm Hg, with an average of 120; normal diastolic BP ranges from approximately 60 to 89 mm Hg, with an average of 80 (Cromwell et al., 1976). Moreover, resting BP is higher in men than in women, from puberty through adulthood (Eichorn, 1970).

Several studies have investigated BP reactivity during interactions between spouses. For instance, Brown and Smith (1992) studied persuasion attempts in a sample of 45 married couples and found that husbands demonstrated high systolic BP reactivity (measured as the change from baseline values) immediately before and during their attempts to persuade their wives. Wives, by contrast, did not show elevated BP levels (see also Smith & Brown, 1991). Similarly, Denton, Burleson, Hobbs, Von Stein, and Rodriguez (2001) measured BP reactivity in 60 married couples classified as either initiators or avoiders of relationship problem discussions. Participants took part in stress-inducing procedures, including a mental math test and a cold pressor test (in which a participant is asked to put his or her forearm into a bucket of ice water and hold it there as long as possible). They also watched a marital argument on video and took part in a conjoint interview. Denton et al. (2001) found a number of differences with respect to BP. First, as they had predicted, avoiders (whether male or female) had greater systolic BP reactivity during the interview than did initiators. Moreover, husbands who had avoider wives showed greater systolic and diastolic BP reactivity than did husbands who had initiator wives. BP reactivity was especially high for initiator husbands who were married to avoider wives. No significant effects of sex or initiate–avoid status were found to influence BP during the mental math, cold pressor, and video conflict activities.

Perhaps the most intriguing finding in the Denton et al. (2001) study was that husbands had significantly lower levels of systolic and diastolic BP reactivity than did women. This is interesting because it contradicts previous research indicating that reactivity is greater in men than in women for both systolic BP (Lawler, Wilcox, & Anderson, 1995) and diastolic BP (Murphy, Stoney, Alpert, & Walker, 1995). In line with Eichorn (1970), however, Denton and colleagues found that baseline systolic and diastolic BP were both higher for men than for women.

Researchers sometimes combine systolic and diastolic BP measures into an index called *mean arterial pressure* (Papillo & Shapiro, 1990). Mean arterial pressure serves as a measure of the average pressure during the cardiac cycle and is computed using the following formula:

$$\text{Mean arterial pressure} = 1/3\ (\text{systolic BP} - \text{diastolic BP}) + \text{diastolic BP}.$$

Using this formula, an average BP of 120/80 yields a mean arterial pressure of 93.33. Although the selection of an appropriate index should be driven by theoretic principles, researchers may elect to use mean arterial pressure as a singular index of BP instead of using systolic and diastolic indexes separately, particularly in the absence of different hypotheses for systolic and diastolic BP, to reduce alpha error.

Skin Temperature

Skin temperature (ST) is an indirect measure of the amount of blood flow in skin tissue (Sargent, Green, & Walters, 1972). Because it is related to blood flow (and thus to vasodilation and vasoconstriction), ST is under the control of the sympathetic nervous system.

ST is affected by emotion in a fairly direct way. When people experience emotional arousal (e.g., when they get angry or stressed), ST increases because the sympathetic nervous system directs blood flow away from bodily functions that are nonessential at the time (such as digestion) and toward the skin tissue as a way of preparing the body for a fight-or-flight response. Contrariwise, when people are relaxed, or experiencing arousal-inhibiting states such as fear, sadness, or depression, ST decreases because the body does not need to be geared up for immediate behavioral activation. Parenthetically, this difference explains why getting angry is often referred to as being "hot under the collar," whereas being fearful is referred to as having "cold feet."

The link between emotion and ST is exemplified in Ekman's facial feedback hypothesis, which posits that, by merely forming a facial expression (e.g., smiling) associated with an emotion (e.g., happiness), one will begin to experience the physiological markers associated with that emotion. In his research (see Ekman, Levenson, & Friesen, 1983; Levenson, Ekman, & Friesen, 1990), Ekman had participants (who were professional actors) form facial expressions associated with various emotions, although he measured their physiological processes and compared them to instances when the participants were actually experiencing those same emotions. Ekman found, among other things, that making an "angry face" caused participants' STs to rise, and that making a "sad face" caused their STs to fall. By contrast, making a "happy face" did not elicit a change in ST.

ST has also been studied in interactive research paradigms. For instance, Le Poire and Burgoon (1996) measured ST reactivity in two studies using participants who interacted with confederates trained to manipulate their levels of nonverbal involvement. After a baseline segment of each conversation, confederates began to display very high, high, low, or very low involvement, and maintained this manipulation for the remainder of the interaction. Using repeated-measures analyses, Le Poire and Burgoon found that participants' STs increased in response to all four levels of the involvement manipulation. In other words, participants' ST increased in response to noticeable changes in the confederates' communicative behaviors, perhaps as a function of participants having become psychologically aroused by the shifts in conversational style.

Galvanic Skin Response

Galvanic skin response (GSR) is an index of changes in electrodermal activity, or skin conductance, which is associated with one's level of perspiration. Humans have between 2 and 5 million eccrine sweat glands, which are distributed over almost every part of the body surface (Fowles, 1986). They appear in the greatest density on the palms of the hands and the soles of the feet; in fact, Jacob and Francone (1970) estimated that one square inch of skin on the palm contains 3,000 sweat glands. Activity in the sweat glands is influenced by both the sympathetic and parasympathetic nervous systems, but primarily by the sympathetic nervous system.

To measure GSR, researchers attach electrodes to a participant's skin, pass a low-voltage electrical current between them, and examine changes in the skin's ability to conduct that current. Because electricity is conducted more efficiently on a wet surface than on a dry one, GSR serves as an indirect measure of a participant's level of perspiration. GSR, which is sometimes quantified in conductance units called μmhos, is typically measured in a laboratory setting in which participants are introduced to visual, auditory, or emotion-provoking stimuli.

Like ST, GSR is a marker of sympathetic arousal and it shows a number of connections with emotion. In two studies, for instance, Kring and Gordon (1998) showed participants film clips designed to highlight and elicit different types of emotions while their GSR was being measured. Kring and Gordon compared the responses of male and female participants and found that men had greater GSR reactivity than women to films eliciting anger and fear. Women, by contrast, had greater reactivity than men to films eliciting sadness and disgust. Other studies have demonstrated the effects of emotion on GSR (see, e.g., Geen & Rakosky, 1973).

Other work has linked GSR to family communication more directly. In one study, Wiesenfeld, Malatesta, Whitman, Granrose, and Uili (1985) investigated the correlates of mother–infant attachment by comparing the physiological responses of breast-feeding and bottle-feeding mothers to their infants' emotional signals. Mothers in both experimental conditions watched videotapes of their own infants' emotional expressions (crying, smiling, and emotionally neutral displays) while their GSR was monitored. Breast-feeding mothers, who reported greater satisfaction during feeding and a greater desire to pick up their infants than did bottle-feeding mothers, also exhibited lower GSR and lower HR. Andreassi (2000) speculated that the hormones associated with lactation might act to lower general ANS arousal and increase relaxation during feeding, and that these may help to facilitate mother–infant attachment.

In their longitudinal work with 30 married couples, Levenson and Gottman (1983, 1985) also found that both husbands' and wives' skin conductance during laboratory conflict episodes and conversations about daily events in 1980 were significantly associated with declines in their marital satisfaction 3 years later. Average correlations between skin conductance and longitudinal declines in marital satisfaction were .48 for husbands and .62 for wives.

Pupillometry

Finally, the ANS regulates dilation and contraction of the pupils. The pupil can dilate to around 8 to 9 mm, can contract to approximately 1.5 mm, and can react to stimuli in .2 sec (Guyton, 1977). Pupil dilation and contraction are affected by a number of factors, including ambient light, use of stimulants or depressants, and the distance of one's object of focus. Perhaps more interestingly for communication researchers, the sympathetic nervous system activity also causes pupil dilation in response to an attractive other (Aboyoun & Dabbs, 1998). Specifically, pupil dilation is implicated in interpersonal attraction and pair bonding, in two interrelated ways. First, our pupils dilate when we look at someone we find attractive

(Andersen, Todd-Mancillas, & DiClemente, 1980). For instance, Aboyoun and Dabbs (1998) presented participants with images of clothed and nude adults and found that participants' pupils dilated more in response to nude images, regardless of the sex of the participants or the sex of the target. Second, controlling for other attracting factors, having dilated pupils makes us more physically attractive to other people (Hess, 1975). There is evidence that pupil dilation is also associated with auditory stimuli. Dabbs (1997) found that sexually charged sounds caused pupil dilation and that this effect was enhanced for people who were high in testosterone. Pupil dilation is difficult for untrained observers to appreciate consciously without the aid of instrumentation. This limitation is discussed later. However, humans appear to be able to detect pupil size changes at a subconscious level, which is adaptive for mating because it is reliably associated with attraction.

Applications

Given that they are all associated with ANS arousal, changes in HR, BP, ST, skin conductance, and pupil size may well be related to a number of family communicative processes, some of which have been studied and many of which have not. For instance, the level and type of physiological arousal that engaged or newlywed couples experience when talking about their relationship could well be predictive of their long-term happiness and marital satisfaction. In fact, Kiecolt-Glaser, Bane, Glaser, and Malarkey (2003) found that endocrine activity (involving epinephrine, norepinephrine, cortisol, and adrenocorticotropic hormone) in couples during their first year of marriage was predictive of marital satisfaction and dissolution 10 years later. Physiological reactivity during parent–child conflict may show associations not only with the quality of the parent–child relationship but also with the parent's health or the child's success in later romantic relationships. Skin conductance reactivity during conversations between adolescent siblings could be related to their likelihood of staying in constant contact with each other during adulthood. These applications are all speculations based on existing knowledge about these physiological markers, but they illustrate some of the many ways in which family communication scholars can apply that existing knowledge to the relationships and communicative processes of interest to them.

Logistical Issues

A researcher could easily spend $50,000 or more equipping a laboratory for sophisticated physiological measurement. Such laboratories use computerized systems that employ a different electronic module for each type of physiological signal being measured. Examples include the LabLinc V system from Coulbourn Instruments (www. coulbourninst.com) and the MP150 system from BioPac (www.biopac.com). Researchers can begin conducting physiological measurement with less expensive equipment, however, provided that the manufacturer can provide validity and reliability data for the instruments and that they serve the aims of the research program for which they are purchased.

When selecting a HR monitor, for instance, the researcher should ask at least three questions. First, from where on the body is the heartbeat signal captured? Commercial HR monitors often use one of three devices for capturing the signal—a chest band, a wrist band, or an ear clip—each of which has its advantages and disadvantages. The chest band is often the most sensitive and accurate means of capturing the signal; it is also the most invasive, as participants must wear the band around their chests and against their skin. Wrist bands are less invasive but are often less accurate and participants may find them bulky to wear. Good examples of both types of monitors are produced by Polar (www.polarusa.com). The third device is a small clip that attaches to a participant's ear lobe like a clip-on earring. This is probably the least invasive of the three means of capturing HR, although it may restrict participants' movement more than the other two. Obviously, researchers will want to consider which type of apparatus will fit best into their research protocols.

Second, if the monitor averages beats-per-minute within time frames, what time frames are available? The selection of an appropriate measurement window (for all physiological signals, not just HR) is extremely important and should be guided both by the theoretic perspective the researchers are employing and by knowledge about the physiological process being studied. Wheeler and Reis (1991) described three different approaches to data collection, which they developed in the context of diary self-reports but which can be applied to physiological assessment as well. The first is *interval-contingent recording,* wherein data are collected at regular intervals that are predetermined by the researcher. For some physiological signals, these intervals, or "windows," might be very small (e.g., half a second); for others, they might be longer (e.g., 5 min), depending on the reactivity of the signal being measured. Measurement windows that are too narrow may result in oversampling, whereas windows that are too wide can mask important variation in the signal being measured, producing a "flattening" of important arousal dynamics (see Burgoon & Le Poire, 1992, for a discussion). Indeed, Le Poire and Burgoon (1996) indicated that 5-sec measurement windows for HR, pulse volume, and ST in their study may have been too large to ascertain immediate arousal change, and so they replicated their procedures with half-sec windows to achieve greater sensitivity.

A second approach is *signal-contingent recording,* wherein measures are taken at moments when participants are signaled by the researchers. An example is the Experience Sampling Method developed by Csikszentmihalyi and Larson (Csikszentmihalyi & Larson, 1987; Larson & Csikszentmihalyi, 1983). In that research, participants wore electronic beepers that were used by researchers to signal the participants as to when they should provide some type of measure. Such an approach could easily be used, for instance, with research on hormone fluctuation;

that is, participants could be signaled by the researchers to provide saliva samples at the times they are signaled. Finally, a third approach is *event-contingent recording,* wherein measures are taken following predetermined relevant events. For instance, participants could be instructed to take saliva samples immediately following any argument they have in a given period of time. In the laboratory, event-contingent recording could be used to take measures of ANS arousal following specific experimental stimuli, such as watching a film or engaging in a stress-induction activity. Researchers may use this method to examine the reactivity of any number of physiological markers to a range of stimuli.

Sophisticated monitors measure HR by examining the interbeat interval, or the length of time between beats. Less expensive monitors measure HR as a function of the average number of beats within a given time frame. Some monitors will report the average beats-per-minute every sec, every 5 sec, or every 10; others will report averages every 30 or 60 sec. Researchers should select monitors that offer the time frame options they require, a decision which should be grounded in the theoretic principles guiding the research and also in knowledge about the natural variation in the signal being measured.

A third issue of importance in selecting a HR monitor is how long a monitor can record HR at one time. During a laboratory procedure, researchers may wish to record participants' HRs over a period of time (for example, 20 min) to be able to ascertain increases and decreases over time. Therefore, they will want a monitor that, once it is activated, will store average HR figures over at least that length of time. Commercially available monitors vary widely in their lengths of recording time, so researchers should be aware of this feature when selecting a monitor. Often, the choice of a monitor to buy requires the researcher to find the best compromise between what he or she desires in the signal collection method, time frame option, and recording length.

Measuring systolic and diastolic BP also does not require the use of expensive equipment, but it does require instruments for which reliability and validity data are available. Many BP monitors use the familiar cuff that wraps around a participant's arm and inflates while the measurement is being taken. Electronic devices inflate and deflate the cuff automatically and display (or print out) the BP data for the researcher. Other BP monitors are worn around the wrist like a watch and take the measurement from the wrist, or capture the signal from the tip of the finger. Examples of such types of monitors are those produced by Lumiscope (www.lumiscope.com) and those produced as part of larger physiological recording systems by BioPac (www.biopac.com) or the James Long Company (www.jameslong.net).

Regardless of the device used, the researcher must designate the intervals at which the BP measurements are to be taken (e.g., every 2 min, every 10 min, every time the conversation topic changes, etc.). As with HR measurement windows, this decision should be driven by the researcher's theoretical perspective. Often, BP measurements will correspond with meaningful aspects of the laboratory protocol. If the protocol involves a couple being induced into an argument, for instance, the researcher may decide to take BP measures at equally timed intervals through the process, so as to ascertain patterns in the rise and fall of participants' BPs during their argument. Some BP monitors can be programmed to take and store measurements at predefined intervals. Those that cannot be programmed must be manually activated by the researcher.

Devices to measure ST and galvanic skin response are not as widely available as HR and BP monitors. ST measurement involves the use of thermistor probes, which are attached to a participant's skin and which send temperature data to a computer for processing. GSR measurement involves electrodes that are placed on a participant's skin (typically on the hand) and that conduct a low-voltage current between them. The instrument then assesses the ability of the skin to conduct that current, which is an indirect measure of the skin's moisture level. For a detailed discussion of these measurement procedures, consult Andreassi (2000), Boucsein (1992), and Cacioppo, Tassinary, and Berntson (2000).

Of all of the markers of ANS arousal I have addressed here, pupil dilation requires the most sophisticated instrumentation to measure. Reliable instrumentation for the measurement of pupil size has been available only in the last 30 years or so. The most commonly used device is a video-based pupillometer, which observes the eye through a closed-circuit television system and uses a signal processor to display and measure pupil dilation and contraction (Andreassi, 2000). Such a procedure produces either direct numerical readouts of pupil dilation or continuous charts showing changes in dilation. Often, researchers measuring pupil size use a technique called task-evoked pupillary response to measure how pupil dilation changes in response to a specific stimulus (for discussions, see Beatty, 1982, 1986; Stern & Dunham, 1990).

When measuring any ANS signal, researchers must be conscientious of aspects of the laboratory environment and the experimental task that could introduce error variance into the measurement. Ambient light and drug use, for instance, both affect pupil dilation, and extraneous movement can influence HR and BP measurements, as can posture (for an extended discussion on HR, BP, and pupil dilation measurement, see Andreassi, 2000; Pickering & Blank, 1989). The presence or absence of others at the time of measurement, and social interaction with them, can also affect the efficacy of various measurements (see, e.g., Long, Lynch, Machiran, Thoas, & Malinow, 1982; Lynch, Long, Thomas, Malinow, & Katcher, 1981). A detailed discussion of these extraneous influences is beyond the scope of this article; family communication researchers should consult with researchers in psychobiology or psychophysiology regarding the appropriate design of their studies to reduce these sources of error variance.

Clearly an alternative to building an elaborate and expensive laboratory and purchasing equipment to conduct these physiological measurements would be to develop collaborative research programs between communication researchers and physiologists, kinesiologists, and medical professionals. Multidisciplinary collaborations have the potential to enrich research programs and bring together scientists with differing, but complementary, expertise and resources.

ENDOCRINE SYSTEM

The endocrine system integrates and regulates the body's metabolic activities and is, among other things, responsible for the production of hormones. Hormones are chemical substances that are secreted by various endocrine glands in response to particular stimuli (Nelson, 2000). The major glands of the endocrine system include, among others, the thyroid gland, the pituitary gland, the adrenal gland, the pancreas, the hypothalamus, and the gonads (testes or ovaries). Each gland produces and secretes specific hormones in response to particular stimuli (Becker & Breedlove, 2002).

Two issues, in particular, have intrigued social scientists with respect to the effects or correlates of hormones. The first is the relation between a person's basal level of a given hormone and various characteristics of that person. The basal level is the person's average level of the specified hormone and it is often calculated as the aggregate of several measures taken of the hormone over a period of time, because the levels of many hormones fluctuate systematically through the day and night (Gorman & Lee, 2002; Richardson & Martin, 1988). In their study of testosterone levels in married and unmarried men, for example, Gray, Kahlenberg, Barrett, Lipson, and Ellison (2002) took four saliva samples from each participant, two in the morning and two in the evening, and correlated the aggregates of each with scores on measures of spousal investment and male parenting effort; they found that basal testosterone was significantly higher in unmarried than in married men (see also Ellison, Lipson, & Meredith, 1989).

The second issue of interest is the level of a person's hormonal reactivity and its relation to various characteristics of that person. Hormonal reactivity is typically defined as the magnitude and direction of the change in a person's hormone level as a result of being exposed to some stimulus. For instance, Turner, Altemus, Enos, Cooper, and McGuinness (1999) measured levels of the neurohormone oxytocin in a group of adult women before, during, and after mental imagery tasks and massage interventions. By calculating change (Δ) scores between the measures taken before and during a stimulus, and again between the measures taken during and after a stimulus, the researchers were able to ascertain the effects of each stimulus on hormone secretion. Their investigation found that oxytocin levels increased in response to massage, decreased in response to sad emotions, and showed no reaction to interventions designed to elicit positive emotions.

The endocrine system produces a number of hormones, only a handful of which have been studied in relation to psychological or communication processes. These include cortisol, testosterone, and oxytocin. I discuss each of these later.

Cortisol

Cortisol is a steroid hormone that is produced and secreted by the adrenal cortex in response to the release of corticotropic releasing hormone (CRH) by the hypothalamus. Cortisol is sometimes referred to as the "stress hormone" because it is released in response to physical, mental, or emotional stress. The secretion of cortisol causes a breakdown of muscle protein, which leads to the release of amino acids into the bloodstream. These amino acids are used by the liver to synthesize glucose for energy. Cortisol also depresses systems of the body that are not essential during stressful situations, such as the digestive and reproductive systems. It plays a dual role with the immune system: it stimulates immune organs in case the body must deal with injury, yet it also suppresses the immune system to prevent it from overreacting to injury and needlessly damaging tissues. In these ways, cortisol equips the body (much like ANS arousal) to deal with stress in the short term (McEwan, 1999; Nelson, 2000; Sapolsky, 2002). Chronically high levels of cortisol are very damaging to the body in the long term, however, because cortisol suppresses the immune system and inhibits bone formation (see Porterfield, 2001).

A number of studies have demonstrated that cortisol levels rise when people are faced with stress-evoking stimuli. In a typical example, Kiecolt-Glaser et al. (1996) took baseline measurements of cortisol from a group of married adults and then induced participants to engage in a 30-min marital conflict. They found that wives showed greater increases in cortisol secretion during the conflict when their husbands disengaged from the conflict than when they did not. Husbands' hormone levels, by contrast, were not affected by the conflict episode.

There is also reason to believe that spouses' levels of cortisol reactivity may be related to the quality of their relationship or its communication style. After videotaping 80 couples engaging in conflict and classifying the couples as having either predominantly positive communication behaviors, predominantly negative communication behaviors, or asymmetric behaviors (one spouse is predominantly positive; the other, predominantly negative), Fehm-Wolfsdorf et al. (1999) reported that couples with predominantly positive communication behaviors showed significantly greater increases in cortisol during the conflict episode than did the couples with predominantly negative communication behaviors. This suggests, perhaps, that cortisol reactivity to marital conflict is associated with the quality of the relationship, with spouses in higher-quality relationships showing greater stress reactivity to conflict than those in relationships of lesser quality (see also, e.g., Kiecolt-Glaser et al., 1993). This is one of many interesting points with respect to conflict in marriages (or other family subsystems) that awaits attention from family communication scholars.

Testosterone

Testosterone, which is sometimes referred to as the “male sex hormone” although it is present in both sexes, is an androgen steroid hormone secreted by the testes (in men) and the adrenal cortex (Nelson, 2000). It stimulates muscle development, hair growth, and the production of sperm in men, and has also been linked to male competition and aggression in both humans and animals (for a review, see Archer, 1994).

Several studies have linked men’s testosterone levels to changes in marital and parental status. Booth and Dabbs (1993), in a study of over 4,000 servicemen, reported that participants’ basal testosterone levels were inversely associated with their likelihood of marrying, and, for those participants who did marry, testosterone levels were directly associated with their likelihood of engaging in extramarital sex. Gray et al. (2002) found that testosterone levels were significantly higher in unmarried men than in married men, even after controlling for the effects of age, and Mazur and Michalek (1998) found that men’s testosterone levels were highest 4 to 8 years prior to marriage and began to decline shortly after marriage.

Testosterone levels appear to drop in men not only when they marry but again when they become fathers. Storey, Walsh, Quinton, and Wynne-Edwards (2000) compared the testosterone levels of men whose wives had given birth within the previous 3 weeks to those of men whose wives were due to give birth in 3 weeks or less, and found that men in the former group had 33% lower testosterone levels than did those in the latter group. Similarly, Berg and Wynne-Edwards (2001) found lower testosterone levels in men expecting the birth of their first child than controls.

These researchers have speculated that such changes in men’s basal testosterone levels at the points of marriage and fatherhood facilitate decreases in aggressive, competitive tendencies that may have been more adaptive before these turning points than afterward. When seeking a mate, for instance, men are in competition with other men, and testosterone may facilitate their ability to compete (see Mazur & Booth, 1998). After finding a mate, however, the need for such competition (and thus for a high level of testosterone) is reduced, theoretically. Likewise, from an evolutionary perspective, testosterone may contribute to a level of vigilance (and, if necessary, aggression) in men that is required to mitigate the likelihood that other men will copulate with their mates and to increase men’s likelihood of producing offspring of their own. After men produce children, however, their tendencies toward aggression may become maladaptive, and their further decreases in testosterone may facilitate more nurturant behaviors.

Oxytocin

Oxytocin is a peptide hormone that is produced in the hypothalamus and released into the circulatory system via the pituitary gland. It is perhaps best known for the two important functions that it serves with respect to childbirth. It initiates the delivery process by stimulating uterine contractions, and is responsible for the let-down reflex, stimulating milk ejection in lactating women. This reaction has been linked with parent–child attachment (Becker & Breedlove, 2002).

Oxytocin is also secreted during sexual interaction, including flirting behavior (Carter, 1992) and the "afterglow" effect that couples experience following lovemaking (Arletti, Benelli, & Bertolini, 1992), which encourages the maintenance of pair bonds (Carmichael et al., 1987). Several investigations have indicated that oxytocin is released into the circulatory systems of both men and women at sexual orgasm (Carmichael et al., 1987; Murphy, Seckl, Burton, Checkley, & Lightman, 1990; Richard, Moos, & Freund-Mercier, 1991).

Oxytocin may be an important part of the brain's reward system, the neurological function that promotes behaviors that are important to survival and reproduction by making people feel good when they engage in those behaviors. Panksepp has written extensively on the connections between oxytocin and human attachment (see, e.g., Nelson & Panksepp, 1998; Panksepp, 1998). He suggested the following: "A straightforward emotional prediction is that brain oxytocin may evoke warm positive feelings of social strength and comfort when aroused by peripheral stimuli" (Panksepp, 1992, p. 243; see also Insel, 1997). Similarly, Porges's polyvagal theory (1995, 1996, 1997, 1998) offers that oxytocin release can facilitate a conditioning process that can help explain why friendship and parent–child bonding are so important and why people grieve to the extent that they do when they experience the loss of loved ones (for additional examples, see Taylor, 2002; Uvnäs-Moberg, 1998).

The connections between oxytocin and psychological and communication processes have not been widely studied. On the basis of theory and existing research in other disciplines, the presence of oxytocin, as well as other neurotransmitters (dopamine) and endogenous opioid peptides, may be correlated with perceptions that a relationship is rewarding (see Damsma, Day, & Fibiger, 1989; Sapolsky, 2002).

Applications

What do all these hormones have to do with family communication? They may be implicated in a number of important family processes. Cortisol appears to be secreted in response to family conflict (Fehm-Wolfsdorf et al., 1999; Kiecolt-Glaser et al., 1996; Miller et al., 1999) and may, therefore, also be secreted in response to other family stressors, such as family transitions (such as divorce, remarriage, death of a family member), or financial strains, such as the loss of a principal wage-earner's job. Testosterone is associated with male competition and aggression (Archer, 1994) and may, therefore, play a role not only in family violence (including spousal abuse) but also in men's nurturant behaviors with their children. Oxytocin, dopamine, and endogenous opioids are all part of the brain's reward system and are thus implicated in numerous aspects of relational attachment and bonding, including the formation and maintenance of romantic pair bonds and the attachment between parents and their children (see, e.g., Nelson & Panksepp, 1998; Panksepp, 1998) . Many possibilities to discover links between family communication processes and endocrine system activity await researchers in our field.

Logistical Issues

Two pertinent logistical issues that face researchers wishing to study basal hormone levels and hormonal reactivity are sample collection and analysis. Sample collection is not complicated but it does require the use of specific collection receptacles, a working knowledge of the naturally and artificially occurring influences on the hormone being measured, and the enforcement of certain safety measures (see Grunberg & Singer, 1990). First, the researcher will want to know how the hormone of interest can be measured. Some, like cortisol, can be consistently measured (Kirschbaum & Hellhammer, 1989, 1994) using blood, urine, or saliva (Baum & Grunberg, 1995). Of these, salivary measurements are the least invasive and are the simplest because they do not require significant training for the researcher. Saliva samples for the measurement of cortisol, for instance, are usually taken using a receptacle called a salivette, manufactured by Sarstedt (www.sarstedt.com). The salivette involves the use of a cylindrical piece of cotton that the participant is asked to chew on for approximately 1 min. The cotton piece is then deposited in a small plastic container, which is sealed and placed in a centrifuge. Centrifugation draws the saliva out of the cotton, through a small hole in the plastic container, and into a test tube for analysis.

Saliva samples for testosterone analysis are usually taken using polystyrene tubes. Researchers typically have participants expectorate through a straw, into a tube, for analysis. Research indicates that testosterone levels measured in saliva reliably approximate those measured in blood (Navarro, Juan, & Bonnin, 1986). After taking the saliva samples, the researcher will typically store them in a refrigerator or freezer prior to analysis (Baum & Grunberg, 1995).

Studying hormones that can be measured in saliva also allows the researcher the advantage of being able to collect the samples in nonlaboratory settings. Because the collection receptacles for saliva samples are small and easy to use, the researcher can use them in field experiments and observational studies, and can even train participants to take their own saliva samples over a period of time, allowing for in-home longitudinal data collection.

Other hormones, like oxytocin and dopamine, are usually measured with blood samples. Obviously, this necessitates greater attention to safety and usually requires contracting with a laboratory or medical facility for sample collection and analysis.

Before taking saliva or blood samples to study a particular hormone, researchers should familiarize themselves with what internal and external variables influence participants' levels of the hormone of interest. Time of day, exercise, food consumption, and the use of caffeine, alcohol, or tobacco are all variables that influence hormone levels (see Denton et al., 2001; Nelson, 2000). To compensate for this predictable ebb and flow, researchers often schedule all of their data-collection sessions during the same block of time within the day; alternatively, they could make note of the time of day each saliva or blood sample was taken and statistically control for time of day in their analyses. Some hormones are also affected by the use of prescription pharmaceuticals, including birth control pills. Endocrinologists often use screening questionnaires to exclude potential participants who have used such drugs within a specified time frame, and it would be worth the effort of family communication researchers to obtain and use such screening questionnaires in their own studies.

Again, multidisciplinary collaboration with researchers from the biological, anatomical, and neuropsychological sciences is a more logistically reasonable and cost effective approach to the conduct of research into the physiological components of communication behavior.

CONCLUSION

This essay has attempted to make a case for why family communication scholars might wish to incorporate the measurement of various physiological markers into their research on family processes and outcomes. Because it is such a dynamic communicative context, the family is an ideal venue for studying how communication behaviors affect, and are affected by, physiological processes. Importantly, many physiological markers are fairly simple to measure with minimal intrusiveness, meaning that family communication scholars can incorporate physiological measurement into many existing research paradigms with relative ease.

Because few, if any, graduate programs in human communication currently train students in physiological measurement, multidisciplinary collaboration with biological, anatomical, and neuropsychological scientists makes this type of research feasible. Through collaboration, a link between physiological measurement in family communication research and biological, anatomical, and neuropsychological sciences could be made that enriches understanding of family communication processes. This collaborative approach will enrich all participating disciplines. Physiological processes are not social constructions; they are manifestations of a physical reality that affects all of us, including the families we seek to understand. Incorporating measurements of these processes into our study of family communication will only aid us in understanding families more fully.

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