

FIGURE 3.8. Top left panel: Facial expressiveness as a function of the intensity of an emotional stimulus for two individuals, one whose somatic nervous system is characterized by low sensitivity and one whose somatic nervous system is characterized by high sensitivity. Top right panel: Sympathetic activation as a function of the intensity of an emotional stimulus for two individuals, one whose sympathetic nervous system is characterized by low sensitivity and one whose sympathetic nervous system is characterized by high sensitivity. Bottom panel: The relationship between facial expressiveness and sympathetic activation of a prototypical externalizer (Individual A) and a prototypical internalizer (Individual B) as a function of the intensity of an emotional stimulus. Predictions are predicated on individual differences in system sensitivities; predictions for generalizers are not depicted in this panel for purposes of clarity. The dark line in each panel depicts the theoretical relationship between expressiveness and sympathetic activation at three levels of stimulus intensity (S1–S3), and the ovals convey the variability typically found in psychophysiological functions. From “Relationship between Facial Expressiveness and Sympathetic Activation in Emotion: A Critical Review, with Emphasis on Modeling Underlying Mechanisms and Individual Differences” by J. T. Cacioppo, B. N. Uchino, S. L. Crites, M. A. Snyder-Smith, G. Smith, G. G. Berntson, and P. J. Lang. *Journal of Personality and Social Psychology*, 62, 110–128.

BIOLOGICAL SYSTEM

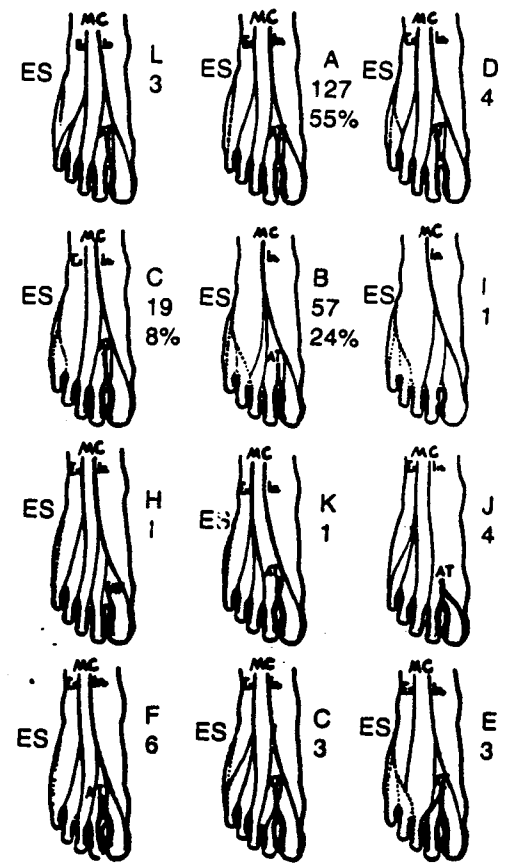
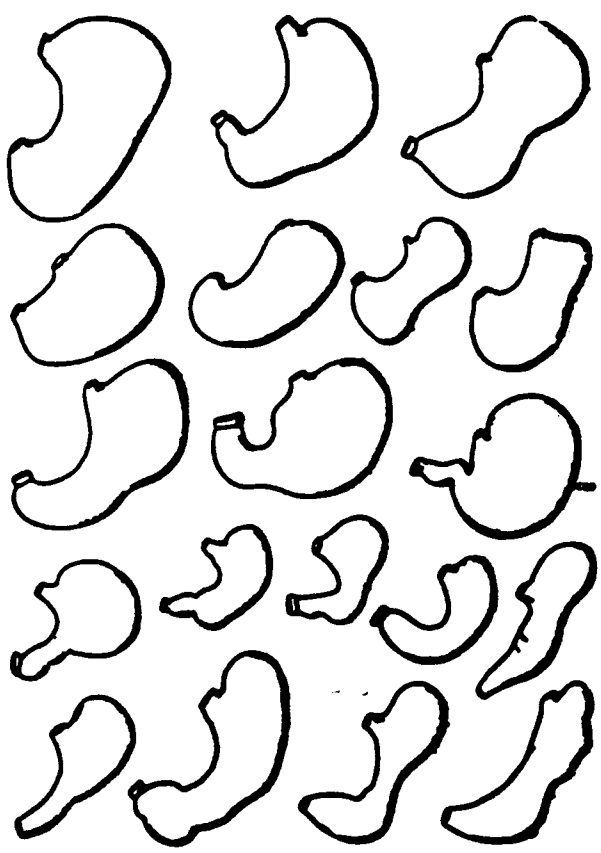
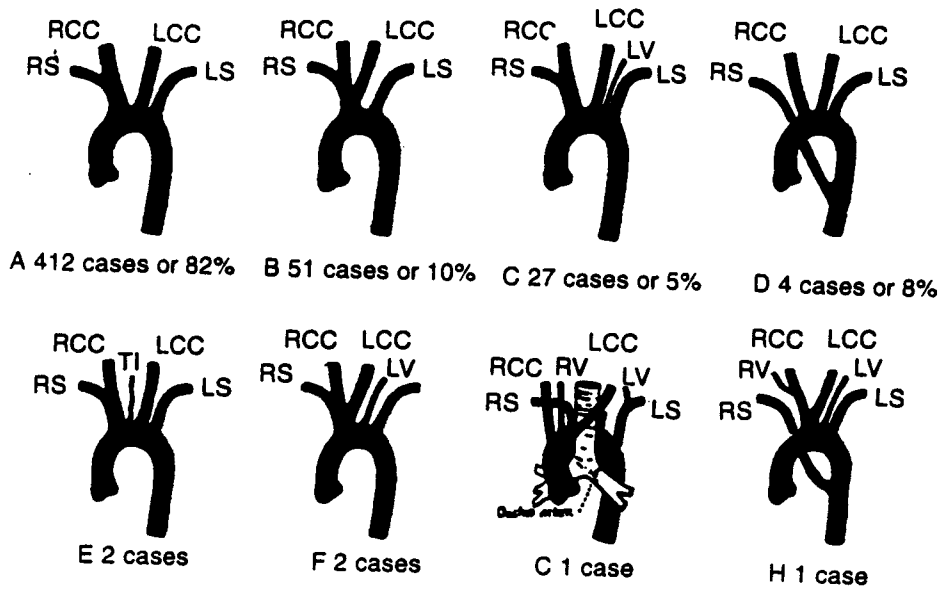


FIGURE 3.9. Top: Variations in the mode of origin of the branches arising from the arch of the aorta ($N = 500$). From *Catalog of Human Variation* by R. A. Bergman, S. A. Thompson, and A. K. Afifi, 1984. Baltimore: Urban & Schwarzenberg. Reproduced with permission. Bottom left: Variations in the form of the stomach. From *Atlas of Human Anatomy* by B. J. Anson, 1951. Philadelphia, PA: W. B. Saunders, Co. Reproduced with permission. Bottom right: Variations in the distribution of the cutaneous nerves on the dorsum of the foot ($N = 299$). From *Catalog of Human Variation* by R. A. Bergman, S. A. Thompson, and A. K. Afifi, 1984. Baltimore: Urban & Schwarzenberg. Reproduced with permission.

are less intimately involved in the maintenance of life (e.g., see Anson, 1951; Bergman, Thompson, & Afifi, 1984). For instance, Figure 3.9 illustrates the variation that exists in the mode of origin of the arterial branches arising from the arch of the aorta (upper panel), the form of the stomach (lower left panel), and the distribution of cutaneous nerves in the foot (lower right panel). Studies of the facial muscles underlying expressivity have not only revealed structural variations in the location and form of the muscles but also individual differences in the very presence of these muscles. The *corrugator supercilii* and *risorius* muscles of mimicry, for instance, have been estimated to be absent in approximately 20% and 50% of the population, respectively (see Tassinari, Cacioppo, & Geen, 1989).

Importantly, reliable individual differences in physiological functioning—including somatic and sympathetic reactivity—have also been documented (e.g., Engel, 1960; Engel & Moos, 1967; Garwood, Engel, & Capriotti, 1982; Kasprovicz, Manuck, Malkoff, & Kranz, 1990; Lacey, Bateman, & Van Lehn, 1953; Lacey & Lacey, 1958; Malmö, 1975; Roessler & Engel, 1974; Sherwood, Dolan, & Light, 1990). *Individual response stereotypy* is a generic term which refers to variance in physiological (e.g., somatic, autonomic, brain) activity that is attributable to the person or to person-situation interactions (e.g., reactivity measures; distinctive physiological responses attributable to idiosyncratic appraisals or coping strategies; cf. Hare, 1973). Early observations by Lacey and his colleagues regarding dispositional contributions to physiological functioning are illustrated in Figure 3.10. Briefly, each panel in Figure 3.10 reflects the systolic and diastolic blood pressure, skin conductance, heart rate, heart rate variability, and pulse pressure responses of a single subject. Each line in a panel reflects physiological activity during rest or during one of four different tasks (anticipation of cold pressor, cold pressor test, mental arithmetic, word fluency). Physiological activity is depicted in terms of the subject's rank order among 42 subjects on each physiological measure when performing each of the tasks. Even a quick perusal of Figure 3.10 reveals two points: (1) striking consistency can be found within individuals in terms of their pattern of physiological responding across tests (depicted within each panel by the nearly overlapping lines), and (2) clear differences can be found within individuals in terms of which physiological systems show relatively high reactivity and which show relatively little reactivity across tests (depicted within each panel by the variations in rank across the physiological measures).

The concept of individual response stereotypy has been further differentiated since its introduction by Malmö and Shagass (1949) and Lacey et al. (1953). *Individual response hierarchy* refers to individual differences in the response (or responses) showing maximal, second most maximal, . . . least maximal activation across stressors. Malmö and Shagass (1949), for instance, found that psychiatric patients who chronically complained of headaches showed relatively high reactivity to stressors in muscle tension in the forehead region, whereas psychiatric patients who chronically issued heart complaints (e.g., heart palpitations) showed relatively high reactivity in heart rate and heart rate variability. One of the implications of

individual response hierarchies is that one should expect low between-subject correlations among physiological indices of activational responses to stressors.

Individual response uniqueness refers to differences across groups of individuals (e.g., hypertensives, normotensives) in response hierarchies. Hypertensives and offspring of hypertensives, for instance, are more likely to exhibit high cardiovascular reactivity than are normotensives and offspring of normotensives (e.g., Fredrikson et al., 1985).

Finally, *individual response consistency* refers to the reliability of these physiological response profiles across stressors and time. Inspection of Figure 3.10 reveals that the ordering of each individual's physiological responses is stable across several different stressors. Indeed, the response hierarchies depicted in Figure 3.10 represent remarkably high individual response consistency. There is variability across effector systems in terms of the stability of physiological responses across time. Heart rate and heart rate reactivity measures are generally stable across time and psychological stressors, systolic blood pressure and systolic blood pressure reactivity are typically somewhat less stable than heart rate and heart rate reactivity measures, and diastolic blood pressure and diastolic blood pressure reactivity measures are generally unstable across tasks and time (Cacioppo, Uchino, & Berntson, 1994; Fahrenberg, Foerster, Schneider, Muller, & Myrtek, 1986; Llabre, Spitzer, Saab, Ironson, & Schneiderman, 1991; Manuck, Kasprovicz, Monroe, Larkin, & Kaplan, 1989). There is individual variability in individual response consistency, as well, with some individuals showing little response consistency and others showing rigid response hierarchies. In a pioneering study on this topic, Lacey and Lacey (1958) reported vast individual differences in response consistency in their longitudinal study of children's response to stressors (see, also, Myrtek, 1984).

The ontogeny of individual differences in physiological functioning may flow from as simple a source as natural variation in a heterogeneous gene pool. Indeed, such variation should yield individual differences in the operating characteristics of physiological systems at multiple levels of organization. Moreover, the forces of natural selection make possible a wide range of population distributions for these physiologically-based individual differences.

Social and situational forces can play an important role in shaping individual differences in physiological functioning and in translating these physiologically-based individual differences into personality and social behavior (Cacioppo, 1994). In addition, powerful situational determinants of physiological response have been identified (i.e., *situational response stereotypes* such as the orienting response, defense response, startle response, & cardiac-somatic coupling), and these situational contributions have been found to co-exist with, and be capable of overwhelming, individual response stereotypes (e.g., Engel, 1972; Fahrenberg et al., 1986; Foerster, 1985; Myrtek, 1984). Thus, just as can be the case when studying dispositional contributions to behavior, analyses of the dispositional contributions to somatovisceral response require that situational influences and situational-dispositional interactions also be considered. Recent reviews, for

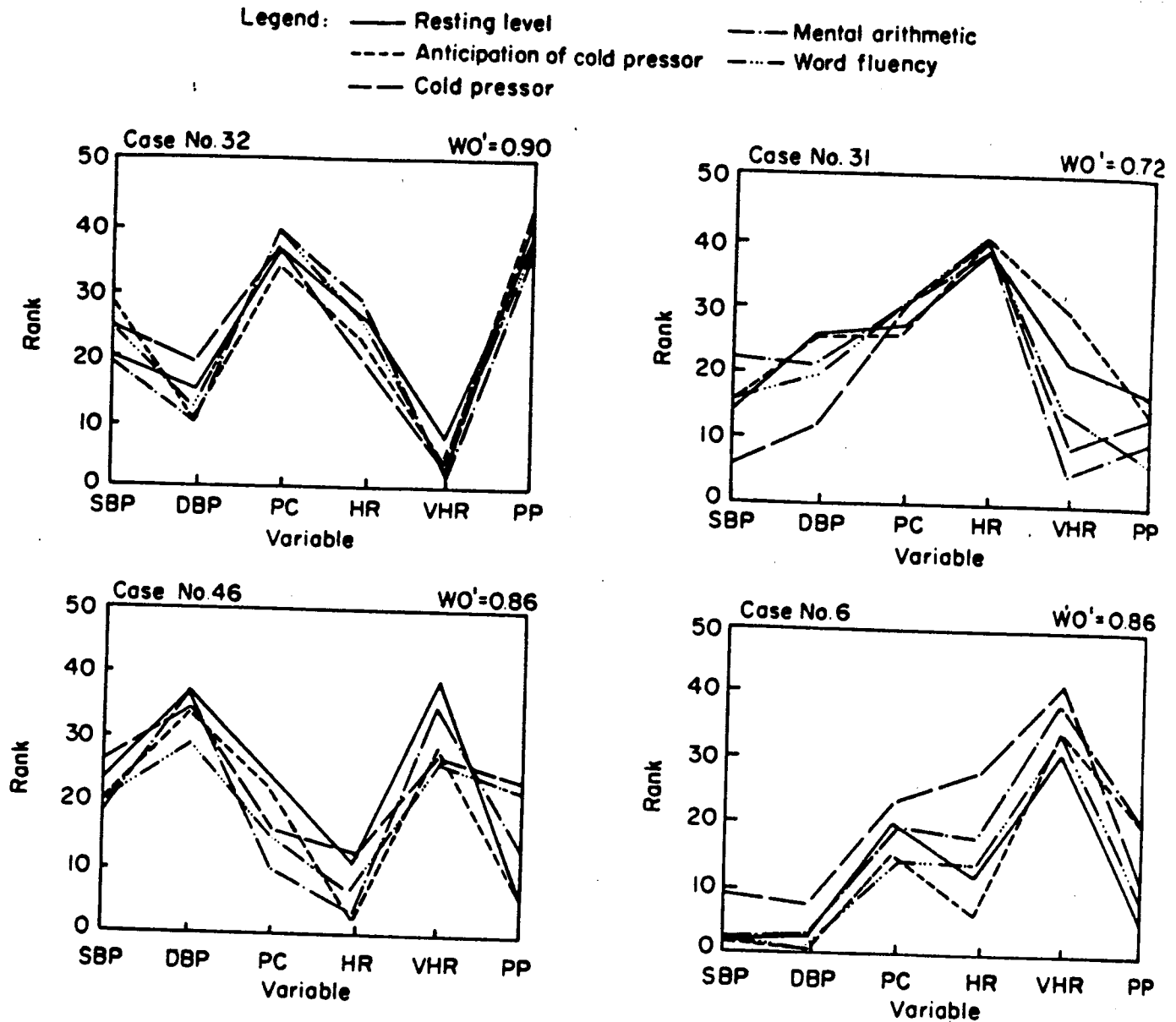


FIGURE 3.10. Four examples of individual response stereotype. The five conditions of measurement are shown at the top of the figure. On the abscissa are shown the six variables measured: SBP = systolic; DBP = diastolic blood pressure; PC = skin conductance; HR = heart rate; VHR = heart rate variability; and PP = pulse pressure. The ordinates represent ranks, showing the relative positions of the subjects in the total group of 42. From "Psychophysiological Approaches to the Evaluation of Psychotherapeutic Process and Outcome" by J. I. Lacey, 1959. In E. A. Rubinstein and M. B. Parloff (Eds.), *Psychophysiological Approaches to the Evaluation of Psychotherapeutic Process and Outcomes in Research and Psychotherapy*. Washington, DC: American Psychological Association.

instance, indicate that individual response consistency is higher when comparisons are made within rather than across stressors (Foerster, 1985; Myrtek, 1984; Stern & Sison, 1990). This is consistent with the notion that there are substantial situational (and situation \times disposition) as well as dispositional determinants of physiological response.

The constraints placed on the manifestation of individual differences in physiological response by situational factors was illustrated graphically in a recent study of

the effects of orthostatic (sitting vs standing) and psychological (mental arithmetic, reaction time, and speech stressors) stressors on cardiac chronotropy (Berntson et al., 1994; Cacioppo et al., 1994). The cardiac effector surface for normal levels of autonomic innervation of the sinoatrial node has been worked out by Berntson et al. (1993) and is depicted in Figure 3.11. The effects of standing on basal cardiac states is depicted by the open circle and arrow in the left panel of Figure 3.11, whereas the autonomic determinants of the cardiac response to the

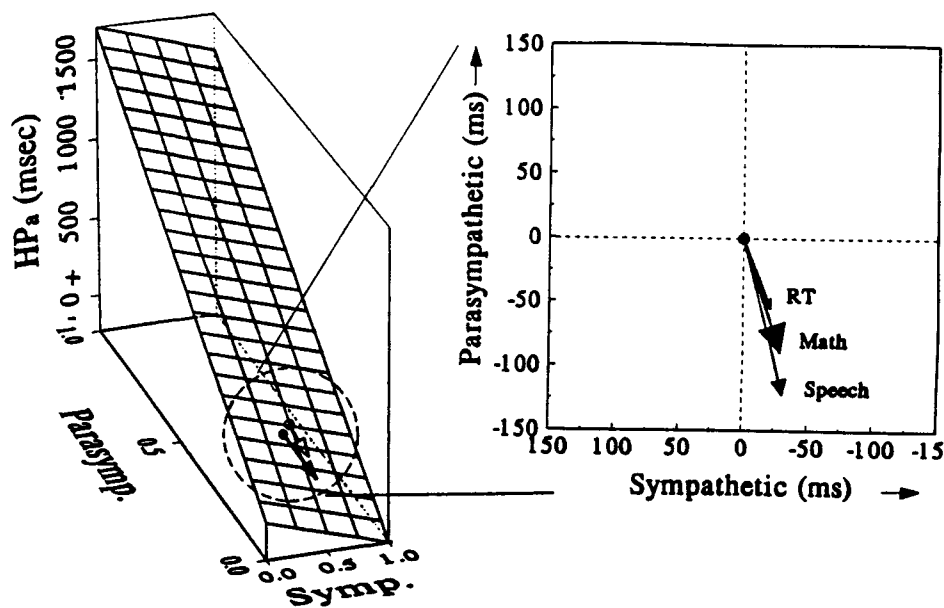


FIGURE 3.11. Cardiac responses to stress as depicted in autonomic space. Left panel: Autonomic space and its associated cardiac effector surface for the human. The sympathetic and parasympathetic axes are expressed in proportional units of activation. The length of the axes are scaled relative to the dynamic ranges of the autonomic divisions (see Berntson et al., 1993) such that a given displacement along either of the axes represents an equivalent msec change in heart period. The z-axis represents the autonomic contribution to cardiac chronotropy as a change from the intrinsic period in the absence of autonomic control (double blockade). The cardiac effector surface overlying the autonomic axes represents the chronotropic state of the heart for all loci within autonomic space (see Berntson et al., 1993). The open arrow indicates the response vector for these subjects to a change in posture from sitting to standing. The solid arrow on the effector surface depicts the mean response vector to the psychological stressors. The baseline preceding the psychological stressors is indicated by the solid dot, and the maximal response is indicated by the solid arrowhead. Right panel: The relevant segment of the cardiac effector surface. The axes units are expressed in msec change in heart period. The expanded inserts depict the cardiac response as movements along the two autonomic axes, expressed in msec of heart period as defined by equations outlined in Berntson et al. (1994). The large dot at the center of the right panel is the basal starting point, and the arrow vectors extending from this basal point depict the overall autonomic responses to the reaction time, mental arithmetic, and speech stressors. The width of the arrowheads illustrate the size of the bias estimate (e_{blk}), corresponding to the confidence range of the autonomic blockade analyses. From "Autonomic Cardiac Control: III. Psychological Stress and Cardiac Response in Autonomic Space as Revealed by Pharmacological Blockades" by G. G. Berntson, J. T. Cacioppo, P. F. Binkley, B. N. Uchino, K. S. Quigley, and A. Fieldstone. *Psychophysiology*, 31.

psychological stressors are depicted by the black circle and arrow in the left panel. Note that (a) the loci lie generally within the lower one third of the vagal dynamic range and within the middle two thirds of the sympathetic range; and (b) as would be expected, vagal control is lower and sympathetic control is higher during standing than sitting and during the stressor than baseline periods. The noninvasive analyses suggest that the cardiac effects of the orthostatic stressor as well as the effects of the acute psychological stressors are implemented primarily by reciprocal activation of the sympathetic and parasympathetic branches of the autonomic nervous system.

Based on the known physiology, the postural effect depicted in the left panel of Figure 3.11 is largely attributable to reciprocal autonomic control by the baroreflex. Indeed, the correlation between our quantitative estimates (Berntson, Cacioppo, & Quigley, 1994) of sympa-

thetic and parasympathetic contributions to the cardiac response to orthostatic stressor was large and significant ($r = -.70$), confirming reciprocal cardiac activation at the idiographic level. The autonomic control of the cardiac effects of each of the psychological stressors, on the other hand, are thought to be modulated by more rostral brain systems and, therefore, were expected to reveal more inter-individual variation in the mode of cardiac control.

This is precisely what was found. The autonomic determinants of the cardiac responses to each of the psychological stressors is depicted in the right panel of Figure 3.11 (Berntson, Cacioppo et al., 1994). The large dot at the center is the basal starting point, the arrow vectors extending from this basal point depict the overall autonomic responses to the reaction time, mental arithmetic, and speech stressors, and the width of the arrowheads illustrate the size of the bias estimate (Berntson, Cacioppo et al., 1994).

This nomothetic depiction suggests that the HR reactivity evoked by each of the psychological stressors differed slightly in magnitude but were uniformly consistent with reciprocal autonomic activation. This contrasts, however, with the large individual differences we observed in the mode of autonomic response. Indeed, unlike what we found for posture, the correlation between our quantitative estimates of sympathetic and parasympathetic contributions to the cardiac response to psychological stressors was nonsignificant and opposite in sign ($r = +.09$).

This nonsignificant correlation was attributable to notable and reliable individual differences in the sympathetic and parasympathetic determinants of the cardiac response to the psychological stressors, as observed above (Berntson, Cacioppo et al., 1994). These individual differences are depicted in autonomic space in Figure 3.12. Each arrow represents the mean cardiac response of a given subject across all three tasks, and the horizontal and vertical error bars at each arrowhead depict the standard errors of the sympathetic and parasympathetic responses, respectively, across the three tasks for a given subject. Note that: (1) subjects can be ordered in terms of their HR reactivity, their sympathetic cardiac reactivity, or their

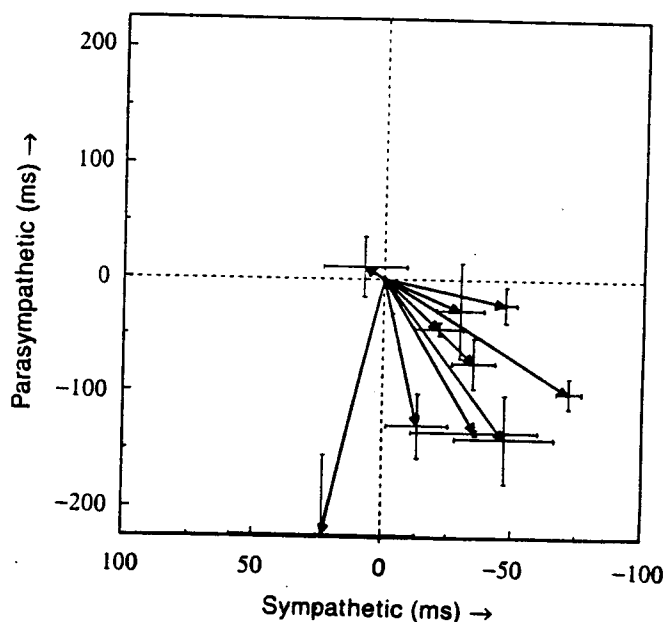


FIGURE 3.12. Interindividual variations in cardiac responses to psychological stressors as depicted in autonomic space. The arrows represent individual autonomic responses (from baseline) along the sympathetic and parasympathetic axes, expressed in msec of heart period as derived from the equations in Berntson et al. (1994). Each arrow vector represents the mean response of a given subject across all three psychological stressors. The horizontal and vertical error bars at each arrowhead depict the standard errors of the sympathetic and parasympathetic responses, respectively, across the three tasks for that subject. From "Autonomic Cardiac Control: III. Psychological Stress and Cardiac Response in Autonomic Space as Revealed by Pharmacological Blockades" by G. G. Berntson, J. T. Cacioppo, P. F. Binkley, B. N. Uchino, K. S. Quigley, and A. Fieldstone. *Psychophysiology*, 31.

parasympathetic cardiac reactivity to the stressors; and (2) as suggested by the nonsignificant correlation between sympathetic and parasympathetic contributions to the cardiac response to psychological stress, these rank-orderings are not simply redundant representations of interindividual variation. In subsequent research, we have found that interindividual variation in cardiac sympathetic reactivity (but not cardiac vagal reactivity) to psychological stressors predicts neuroendocrine and cellular immune responses (Cacioppo et al., 1995).

Finally, it is important to note that the existence of physiological dispositions to respond in characteristic ways does *not* imply that there are necessarily simple relationships between physiological and psychological variables or "traits" (see Myrtek, 1984). Infants who are relatively expressive or sympathetically reactive at birth may also tend toward being relatively expressive or sympathetically reactive as children and as adults, but it is the interaction of these physiological dispositions with environmental and social events that shapes both physiological and psychological dispositions at maturity. Thus, two infants who are similarly expressive at birth may differ dramatically in their expressiveness as adults if one is rewarded and the other is punished for being expressive.

CONCLUSION: MAPPING THE PSYCHOLOGICAL SIGNIFICANCE OF PHYSIOLOGICAL EVENTS

Models of physiological organization and control now recognize the specificity, modularity, and complex response patterning (e.g., stimulus response stereotypy) that can be evoked in behavioral contexts (e.g., Berntson, Cacioppo et al., 1991; Cacioppo et al., 1992; Gazzaniga, 1989). The orienting response, which historically was thought to reflect an arousal response, exemplifies the differential patterns of response of the two autonomic divisions across organ systems in that it is frequently associated with cardiac deceleration (parasympathetic activation or coactivation), pupillary dilation (parasympathetic withdrawal, sympathetic activation) and electrodermal responses (sympathetic activation) (Berntson, Boysen, & Cacioppo, 1991).

These complexities call for a reconsideration of the manner in which social psychologists think about physiological events. Consider, for instance, the mappings in Figure 3.13 of the relationships between the relaxation, orienting, defense, and startle response as elements within Ψ (i.e., psychological domain) and changes in skin conductance and heart rate as elements within Φ (i.e., physiological domain) (Cacioppo & Tassinari, 1990a). Even though we have simplified the elements to include only four behavioral processes within Set Ψ and to include only two physiological responses within Set Φ , heart rate or skin conductance by itself provides ambiguous information about the associated psychological event. A phasic physiological response, such as a change in heart rate or skin conductance, has been used in social psychology as evidence of arousal. As illustrated in Figure 3.13, however, a phasic physiological response can result from very different psychological processes. The use of single measures to index arousal may

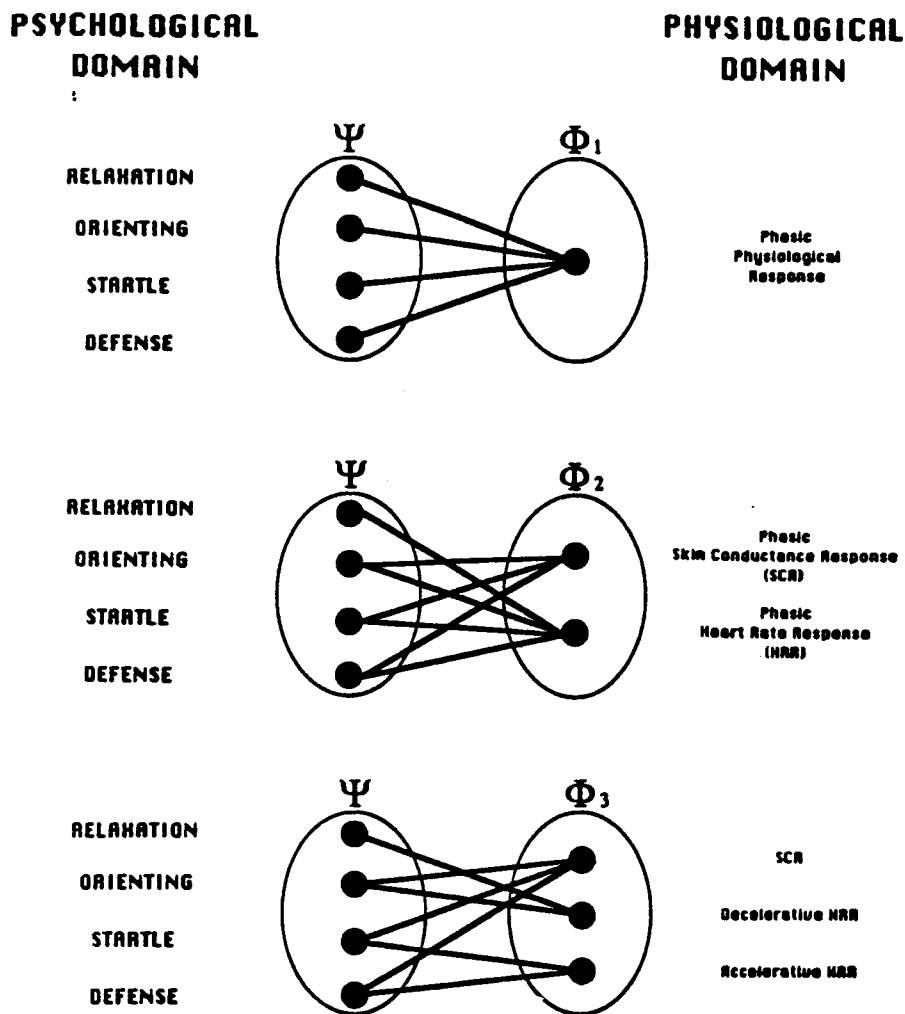


FIGURE 3.13. Depiction of relations between the psychological constructs of relaxation, orienting, startle, and defense and the physiological measures of heart rate (HR) and skin conductance response (SCR). Top panel: Links between the psychological elements and a change in physiological activity. Middle panel: Links between the psychological elements and absolute change in heart rate and skin conductance. Bottom left panel: Links between the psychological elements and individual physiological responses. From "Psychophysiological Approaches to the Evaluation of Psychotherapeutic Processes and Outcomes, 1991: Contributions from Social Psychophysiology" by J. T. Cacioppo, G. G. Berntson, and B. L. Andersen. *Psychological Assessment: A Journal of Consulting and Clinical Psychology*, 3, 321-336.

be of limited use in many investigations of complex social or psychological processes.

Set Φ can be redefined such that any subset of physiological elements reliably associated with at least one psychological element is replaced by a single, unique element in Set Φ' —an element that represents the pattern or syndrome of activation (see Figure 3.14, middle panel). This reconceptualization of what constitutes an element in the physiological domain results in a one-to-one relation between the relaxation response and physiological events, and between the orienting response and physiological events. It also yields a many-to-one relation between the concepts of startle and defense reactions and physiological events, a mapping which does not allow Ψ to be specified as a function of Φ . Of course, there are no limits on how one can reconceptualize elements in the psychological

domain (e.g., individual differences, developmental stages, psychopathology) or elements in the physiological domain. Set Φ' can be redefined, for instance, to consider yet another feature—the form of the physiological events as they unfold across time. The result is Set Φ . As depicted in the bottom panel of Figure 3.14, both defense and startle are associated with increased heart rate and skin conductance response, but the heart rate acceleration peaks and returns to near normal levels within approximately two seconds in the case of a startle and does not begin to rise for several seconds and peaks much later following the stimulus in the case of a defense response (Berntson, Boysen, & Cacioppo, 1991). Thus, contrary to the single-measure approach spawned by arousal theories, multiple measures (or multiple features of physiological functions) and low intercorrelations among measures make

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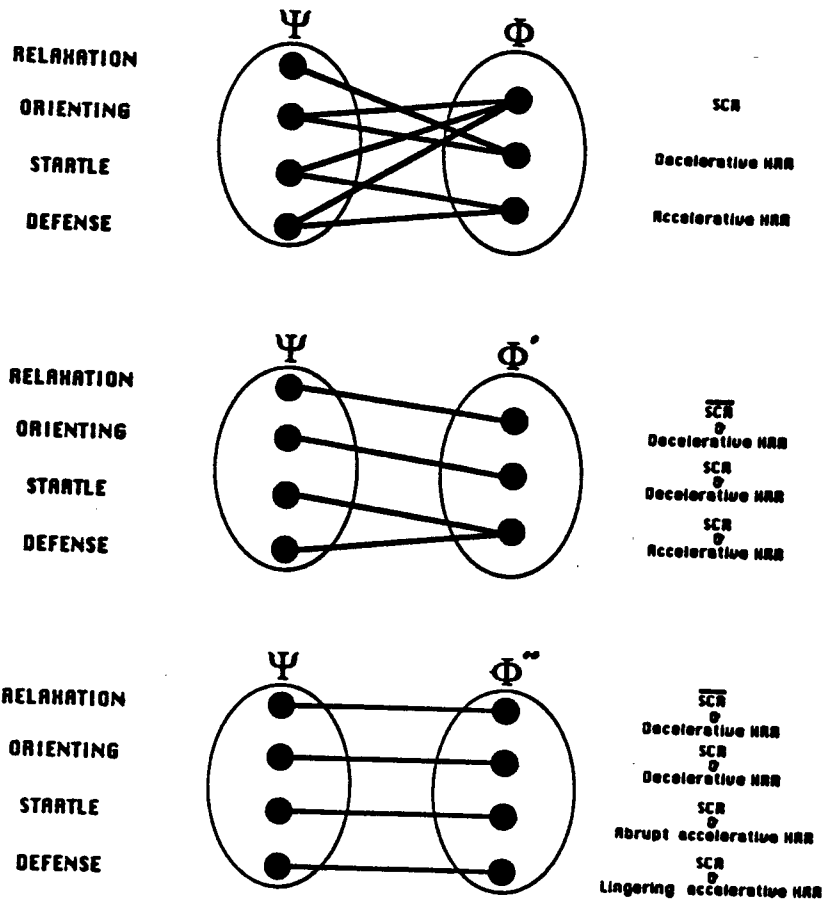


FIGURE 3.14. Depiction of relations between the psychological constructs of relaxation, orienting, startle, and defense and the physiological measures of heart rate (HR) and skin conductance response (SCR). Top panel: Links between the psychological elements and individual physiological responses. Middle panel: Links between the psychological elements and the physiological response pattern. Bottom panel: Links between the psychological elements and the profile of physiological responses across time. From "Psychophysiological Approaches to the Evaluation of Psychotherapeutic Processes and Outcomes, 1991: Contributions from Social Psychophysiology" by J. T. Cacioppo, G. G. Berntson, and B. L. Andersen. *Psychological Assessment: A Journal of Consulting and Clinical Psychology*, 3, 321-336.

it plausible to relate physiological functions to associated psychological processes, states, or disorders.

Several assumptions were made to simplify this illustration. Most importantly, we assumed robust effects—that is, that the physiological events ($\Phi_1 \dots \Phi_n$) constituting a response syndrome (Φ') covary reliably with the corresponding element in Set Ψ . The importance of establishing a robust effect, even if only in a well-defined assessment context, cannot be overemphasized. We also assumed that all of the relevant elements in Sets Ψ and Φ could be specified, and the mappings between the elements in Set Ψ and Set Φ were generalizable. This we know to be an oversimplification, but we have shown that neither of these assumptions is necessary (e.g., see Cacioppo & Tassinari, 1990a). Consider the property of generality. Peripheral physiological events are influenced by a host of local physiological and

social events, only a small subset of which might be psychologically or clinically significant. The psychological significance of physiological events may therefore be clarified when irrelevant determinants of the physiological events are controlled. This is true for a variety of laboratory tests in medicine (e.g., blood glucose tolerance tests) and cognitive psychology (e.g., reaction times), where the measures are interpretable only if taken in accordance with specific protocols. The relation between the physiological data and the theoretical construct is said to have a limited range of validity because the relation holds only for certain persons or situations.

Turning this complexity to advantage, we find that a number of normally complex (e.g., many-to-many) relations between psychological and physiological phenomena might be specifiable in simpler, more interpretable forms within

restricted assessment contexts. In addition to considering the configural and temporal form of the elements in Sets Φ and Ψ , one usefully can think of psychophysiological relations in terms of their *specificity* (e.g., one-to-one, many-to-one) and *generality* (e.g., situation or person specific vs. cross-situational or pancultural). The cells depicted in Figure 3.15 represent the four quadrants within this two-dimensional space. The causal relations between the psychological and physiological elements, and whether the relations are naturally occurring or artificially induced, constitute yet other, orthogonal dimensions. The category in Figure 3.15 labeled "concomitants," for example, refers only to the conditions and implications of covariation and is not intended to discriminate among instances in which the psychological operation causes the physiological event (or vice versa), reciprocal influences exist, or a third variable is responsible for their covariation (e.g., see Cacioppo, Martzke, Petty, & Tassinari, 1988). Strong inferences about the psychological significance of physiological concomitants are possible only using hypothetico-deductive logic, whereas the epistemology of physiological markers and invariants is not as limited (Cacioppo & Tassinari, 1990a).

In sum, theory and research on the mechanisms underlying social psychological phenomena have been constrained by a reliance on commonsense notions and verbal reports. As Boorstin (1983) noted in his history of scientific discovery:

Nothing could be more obvious than that the earth is stable and unmoving, and that we are the center of the universe. Modern Western science takes its beginning from the denial of this commonsense axiom . . . Commonsense, the foundation of everyday life, could no longer serve for the governance of the world. When "scientific" knowledge, the sophisticated product of complicated instruments and subtle

calculations, provided unimpeachable truths, things were no longer as they seemed. (p. 294)

The development and application of physiological concepts and recording procedures can contribute to our understanding of social psychological phenomena, as previously unobservable phenomena are rendered observable, previously contested predictions are resolved, and previously unconsidered influences and mechanisms are discovered. The concept of arousal has contributed to personality and social psychology in each of these ways, and has given birth to a set of principles that have helped organize data on individual differences and social behavior. If this is the impact of the simplistic concept of arousal, the future should be bright as more sophisticated neuroscience concepts and paradigms are brought to bear on social psychological phenomena.

NOTES

1. Contrary to this unidimensional view of endocrine function, some evidence suggests that anxiety may be more closely related to the activation of the hypothalamic pituitary adrenal cortical axis whereas fight or flight reactions are more closely related to the activation of the sympathetic adrenal medullary axis (cf. Henry & Stephens, 1977).
2. Lindsley's (1952) theory fared poorly when the behavioral domain was restricted to normal waking states (e.g., see reviews by Fowles, 1980; Shapiro & Crider, 1969). Thus, although there is a strong linear relationship between the EEG and arousal when data are derived from behavioral extremes, the restriction of the (behavioral) range to an ecologically realistic and interesting set of social behaviors eliminates this covariation. This attenuation is, of course, predictable based on the restriction of range. However, when the restricted range is the behavioral domain to which a theory is to be applied, then predictions based on studies of behavioral extremes should be examined empirically to determine whether they still hold within the more restricted, ecologically representative behavioral domain.
3. Most somatic systems (e.g., facial nerve nucleus and seventh cranial motoneuron pool) are capable of complete relaxation and can lie dormant until ignited to action. Furthermore, even though homeostatic (e.g., autonomic) systems are relatively stable about some set-point under basal conditions and generally respond bidirectionally, their activity is determined in part by neural (i.e., sympathetic, parasympathetic) systems whose activity can, at least theoretically, range from zero to maximal input (see Berntson, Cacioppo et al., 1991). Because the focus here is on the peripheral nervous system, a sigmoidal function can be used to approximate their system operating curve.
4. Subtle or stimulus-specific patterns of activation also exist within the sympathetic, parasympathetic, and somatic nervous systems. Facial expressions differ across emotions, for instance, because of an activational patterning within the somatic nervous system. Similarly, the pattern of sympathetic discharge differs across the viscera in the orienting response. Within this global patterning, however, operating characteristics (e.g., sensitivity or gain functions) such as the one illustrated in Figure 3.7 continue to characterize the input-output relationships of each effector organ.
5. PATTERNS allows one to focus on any number of systems operating characteristics (e.g., threshold, sensitivity, linearity, recovery function). We focus here on sensitivity for two reasons. First, sensitivity is a straightforward system operating characteristic and, therefore, it is useful for didactic purposes to illustrate the heuristic power of the model. Second, the psychophysiological manifestation

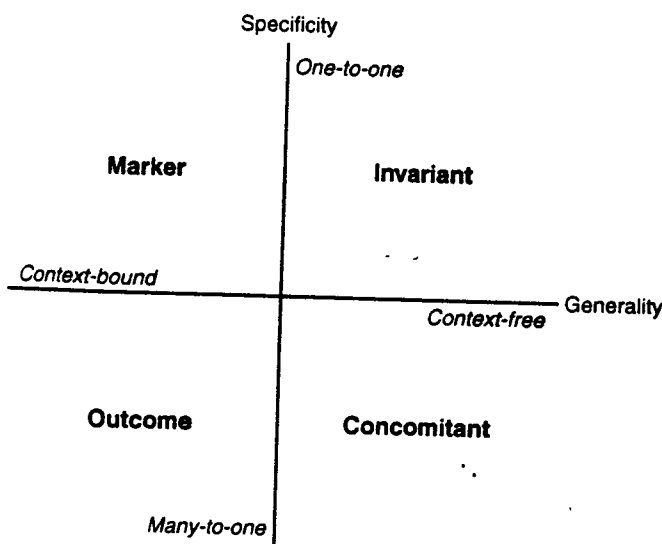


FIGURE 3.15. Major dimensions and classes of psychophysiological relations. From "Inferring Psychological Significance from Physiological Signals" by J. T. Cacioppo and L. G. Tassinari. *American Psychologist*, 45, 16-28.

of sensitivity, reactivity, has been the focus of a large body of relevant research.

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