Symbolic interactionist and neurophysiological models of action towards an integration

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SYMBOLIC INTERACTIONIST AND NEUROPHYSIOLOGICAL MODELS OF ACTION: TOWARD AN INTEGRATION

by

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Introduction and Abstract

This research proposal introduces an integrated study of action and human conduct from the perspectives of symbolic interaction and neurophysiology. Because of their traditionally disparate subject matter, the fields of sociological social psychology and the neurosciences seldom meet; however, I have found significant common ground to justify an integrated approach to the study of action. Symbolic interactionists study human group life and conduct in society. The neurosciences deal with the physiology of the central nervous system, its structure and functions in behavior, its chemical composition, and electrochemical activity, and the effects damage has on behavior. Both fields analyze the same empirical world, and their parameters of study overlap.

Neuroscience studies the central nervous system (CNS) under the assumption that it evolved according to its usefulness for survival; therefore, the subject matter of the neurosciences is relevant ultimately if it takes into account the whole of the organism’s active use of the CNS. Human beings use their brains socially in interaction with themselves and others. Similarly, symbolic interactionism, though a powerful sociological perspective, has its roots in sociological social psychology. Interactionists propose that such capacities as mind, consciousness, meaningful action, thinking, and language, could not exist without social interaction and a human society which is temporally prior to any given individual. Interactionists, however, do not isolate the social individual from the biological organism. They hold a strong conviction that the social phenomena they study are tied to physiological processes that are consistent with the nature of the empirical world. There is, therefore, an overlap between neuroscience and symbolic interactionism. If they study the same empirical world, there should be certain consistencies in their theoretical approaches and their basic data. This paper explores the possibility that symbolic interactionism and the neurosciences, particularly neuroanatomy and physiology, can support consistent perspectives.

I have found that such consistencies do exist, and that there are several significant links between the symbolic interactionist conception of human action and the neurophysiology of the brain. Though I will describe some of these specific links between these fields, the focus of this proposal is upon their basic theoretical assumptions about the nature of action, both for humans and other biological organisms. Both symbolic interactionism and neurophysiology support a consistent "meta-theory" concerning the nature of an organism’s active relationship to an emergent reality, and the processes by which living things handle reality. These consistencies justify future efforts to integrate interactionist and neuroscience approaches toward a more unified understanding of human conduct and group life.

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1 The social psychological roots of symbolic interactionism, however, are quite different from those which have led to the current psychological perspective of social psychology. Though there may be overlap between the psychological and sociological schools of social psychology, symbolic interactionism was formulated by Herbert Blumer (see below) as a sociological theory, and sociologists tend to continue to claim the perspective as his or her own. The term sociological social psychology reflects the rather unfortunate distinction between the two schools of thought.
The focus of this study is upon action, encompassing human action and group life, but also action as a basic process of all living systems. Both the symbolic interactionist and neuroscience perspectives embrace the study of action in this holistic sense. The study of action, then, will provide a medium for our comparison. Focusing upon these goals, this proposal will be organized in four chapters. The first two chapters will present a general introduction to symbolic interactionism and neurophysiology focusing upon their understandings of human action. Chapter one will describe basic concepts of symbolic interactionism drawing from the works of Herbert Blumer, and especially from George Herbert Mead. Mead's writings, though rather complicated, present a holistic perspective of action and reality common to human beings and other life forms. The second chapter will present a text-book styled tour of human neurophysiology, and will then focus upon the evolution of the brain and the neural connectivity of the cerebral cortex. These sections will draw upon the research of Dr. Deepak Pandya and Dr. Edward Yeterian, whose studies of neocortical evolution, neural connectivity, and information processing provide the basis for several of the links I have found between neuroscience and interactionism. The third chapter will describe the general theoretical similarities shared by these perspectives. The final chapter will sample some of the specific comparisons which can be made between the two fields through an integrated analysis of the act, as described by George Herbert Mead.

The purpose of presenting a neurophysiological model of action is not to reduce symbolic interactionism to physiological mechanisms in the central nervous system. As described above, our purpose is to take a more holistic look at different aspects of human action. The neurosciences deal with a specific component of action, the physiological systems which interpret the world and organize the activity by which the organism persists. Interactionists study human conduct and group life, and the processes by which we coordinate, or attempt to coordinate, our lines of activity with others. Each focus is necessary but not sufficient in itself to explain an active organism's relationship to the world. Although a fully unified theory is perhaps impossible to achieve, to begin to unify these perspectives we must look beyond what have evolved as traditional boundaries of both fields.
Chapter 1: Symbolic Interactionist Model of Action

The name of this perspective, symbolic interactionism, was coined by the sociologist Herbert Blumer. Blumer's work and writings, especially those presented in his book *Symbolic Interactionism: Perspective and Method*, give one of the more comprehensive descriptions of the tradition of theory and methodology of this perspective. His description spells out a "distinctive approach to the study of human group life and human contact" (Blumer, 1969: 1) Symbolic interactionism has its foundations in the work of W.I. Thomas, Robert E. Park, William James, Charles Horton Cooley, and John Dewey among others. The concepts of George Herbert Mead, a philosopher of the school of American pragmatism, played a major role in Blumer's formulation of the perspective. Blumer developed these theoretical foundations of Mead and others into a perspective and methodology of sociology and sociological social psychology.

Symbolic interactionists deal with many traditional and non-traditional sociological issues. These perspectives and methods are used to study a wide variety of topics such as deviance, power, politics, racism, social organizations, and even trends in clothing styles.

For those following the interactionist approach, Blumer's formulation of perspective and methods provides a set of guiding concepts or premises about the nature of human action and group life. One of the virtues of the interactionist approach is that these guiding concepts can be used to describe the activities of real people interpreting and acting in an empirical world. Interactionist descriptions encompass both the routine and non-routine events which people encounter in their everyday lives. Examples of actions include a diplomatic discussion which leads to an argument and a declaration of war, or a scene in a grocery store where a little girl mistakes a stranger for her mother, or a routine act such as waiting for a traffic light and then making a left turn. The analysis of action is relevant to each of these episodes and everything else human beings do. Analyzing these episodes brings up countless questions. How do these people handle the situations they encounter? How do they pose and solve problems? How do they define the meanings of their own actions, those of others, and of the events taking place? How do people communicate their intentions to one another? How do people plan for future events? These and other such questions could be asked concerning how and why people go to war, or steal a car, or run for president, or think about South Africa. These larger issues still describe human beings individually and collectively acting, interpreting, and dealing with their worlds. Action, therefore, is ubiquitous, and the study of action and human conduct in its basic form is a relevant topic of study for both sociology and the neurosciences.

This chapter will describe the basic concepts of symbolic interactionism as they pertain to human action. As mentioned, I will draw primarily from the work of George Herbert Mead. The chapter will begin with the interactionist concept of situation, as an introduction to the interactionist perspective of reality and human action. I will then describe Mead's concept of the act, which encompasses the processes by which organism handle situations. The discussion of objects, meaning and indication will set the ground for the discussion of symbolic interaction, mind, self, and role-taking, processes characteristic of human beings, which allow the conscious control of actions. These capacities also allow the social coordination of activities through joint action, and the
development of society. Although it is in the issues of social coordination of action that symbolic interaction has received the most study, I will emphasize here the basic assumptions of physiological processes underlying Mead's and Blumer's concepts; however, I am not attempting to reduce symbolic interaction to psychological mechanisms. The logic behind their concepts may stand out more clearly in comparison to the neurophysiological approach if I attempt to bring out their essential assumptions about the biological aspects of symbolic interaction which other interactionists tend to gloss over.

Situations:

To analyze action we should consider first the reality in which action takes place. For symbolic interactionists, reality and the organism's relation to reality are encompassed by the concept of situation. The situation describes an individual's ongoing reality through time.

The situation has a somewhat different meaning in the interactionist perspective than in its common use. The situation in everyday use refers to some abstract or specific event in a certain place at a certain time. People speak of particular situations by pointing out some occasion or activity bounded by a particular time and space, such as the "budget deficit situation" or the "situation in Russia," or more specifically, "that was a tough situation last night." Interactionists use the term more broadly to include the reality people experience and their changing relationships to changing situations (Morrione, 1985). People's actions continue from one situation to a next. The descriptions of common actions above took place in different situations. The girl was experiencing the situation of looking for her mother, the diplomats were dealing with the situation of a heated debate, and the driver in the car was in the situation of waiting for a stop light. The people in these examples are not acting in a vacuum, but in specific contexts and circumstances. They had a general awareness of where they were and what they were doing. Similarly, the people did not experience reality as a continuous stream of random sensations. The little girl knew she was in the store and that her mother was missing and that the woman she saw in front of her might have been her mother. Using these assumptions, she rugged on the woman's pants leg. In other words, the girl's reality was organized according to how she interpreted the situation she was in, and she was prepared to act on the basis of this interpretation.

Situations, then, are not just the reality of the moment, the time and space in which one exists, but are also the meaning that reality has to those acting within it. People interpret reality in order to handle the changes each moment brings, whether they do so successfully or not. In other words, they deal with reality by making it meaningful. Meaning includes the orientation of how one is prepared to act in a particular situation. We go from moment to moment by bringing something with us from the past by which we orient toward the future. The girl was oriented toward the immediate scene in front of her by bringing to it her understanding that she was in a store, and that she was looking for her mother, and remembered what her mother was wearing, and on this basis, she interpreted or defined the woman in front of her as her mother.

The continuous interpretive process by which we handle changing situations is the essence of activity. Herbert Blumer described this interpretive relation of human action to the situation. "We must recognize that the activity of human beings consists of meeting a flow of situations in which they have to act and that their action is built on the basis of what they note, how they assess and interpret what they note, and what kind of projected lines of action they map out" (Blumer, 1969: 15). An individual's projected line of action, however, does not determine the exact behavior the person will eventually carry out. Though the little girl was prepared to act on her interpretation of who the woman was in front of her, her definition of the situation changed abruptly when the girl discovered that the woman was a stranger. People, therefore, project courses of action into situations which are continuously changing and presenting new information. Interpreting or defining the situation does not predetermine what the person will do, because the action must be carried out in a "now" which is never perfectly predictable. Action, then, is a combination
of what a person brings to the situation and how the reality of a situation acts back on a person, to modify or often resist the activity one brings to it. Action, therefore, is situated in a reality which is continuously changing (Morrione, 1985: 162). Situated activity, then, does not follow a predetermined course; rather, ongoing activity follows "careers," Blumer's term for the course of the line of activity including the fluctuations and redirections the line of action may take as one confronts the flow of changing situations (Blumer and Morrione, 1987; Morrione, 1988: 8).

Action occurs in situations which consist of the reality people meet which is unpredictable, yet actively organized by the individual who must interpret reality in order to anticipate future events, and to construct and guide lines of activity. An analysis of action, therefore, cannot be separated from the reality of the situations in which they occur. One purpose of this paper, however, is to present a generic analysis of the nature of action in which such processes as the meaningful interpretation of situations makes sense. This analysis cannot be divorced from the reality in which actions occur. In order to proceed, then, a brief description of the common characteristics of reality as situation and the nature of action as situated would be helpful.

There are three general characteristics of the concept of situation as described by symbolic interactionists. The situation encompasses the idea that reality is emergent, that the relation of living things to reality is an active process of adjustment, and that human beings can interpret the situation and guide actions on the basis of the meanings of things, meanings which are derived from the social interaction one has with oneself and others. These characteristics are fundamental to the symbolic interactionist perspective of human conduct.

The reality of a situation is emergent. Emergence describes the dynamic and changing nature of matter and energy in process. The physical universe is continually changing through time, and nothing exists which is absolutely static. Therefore, the events living organisms experience, as well as the organisms themselves are in process. Emergence also expresses the indeterminacy of the universe. No two moments are numerically identical, nor can all the events of one moment be the causal source of the next moment; therefore, we cannot predict exactly what will happen in the future. The concept of situation, then, includes the stream of emergent events in reality which change over time in an indeterminate fashion.

All living things handle emergent reality by actively changing with it. Living systems change in different ways than non-living systems. The inanimate object changes passively. The structure of a rock, for instance, persists by the coherency of its chemical bonds that resist change up to a certain threshold. Machines are also passive systems. The quarter in a soda machine initiates a series of events. *Living organisms do not change passively with emergent events, but confront a stream of situations which they must handle to maintain themselves.* There is nothing in the mechanism of the soda machine by which it maintains itself, it merely responds in the way it is constructed, while the person drinking the soda is maintaining his or her supply of fluids. This is an active process because the living thing must reorganize itself from moment to moment to not only deal with change, but also to keep intact its own life processes. Blumer describes the active relation to the environment in similar terms. "[T]he human individual confronts a world that he must interpret in order to act instead of an environment to which he responds because of his organization. He has to cope with the situations in which he is called on to act, ascertaining the meanings of the actions of others and mapping out his own line of action in the light of such interpretations. He has to construct and guide his action instead of merely releasing it

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1 This is evident in the Heisenberg Uncertainty Principle among other principles of non-linearity, but is also true by common sense. We do not act through time by figuring out how the position of each atom in one moment is causally related to the position of each atom at another moment.
in response to factors playing on him or operating through him. He may do a miserable job in constructing his action, but he has to construct it" (Blumer, 1969: 15).

Blumer calls the active process of self-maintenance or self-organization by which a living thing persists adjustment (Morrione, 1988: 8). Living things meet a stream of emergent situations by adjusting to them. An amoeba adjusts to its lack of nutrients by searching for food; the little girl adjusts to her situation in the store by looking for her mother. Situations, then, are both emerging reality and the adjustment of organisms in relation to reality. Thus, the tree falling in the forest makes a sound, but that particular event is not a situation unless someone is there to hear it (including animals). It is then a situation for that listener. Adjustment is a continuous process, since there there are always emerging, developing aspects of situations which an organism must handle; therefore, activity is unceasing, even in sleep, which is simply a different form of adjustment.

Adjustment and Interpretation:

I mentioned above that human beings adjust to situations by interpreting them, a process by which situations become meaningful. Though other animals interpret their realities to various degrees, the human being interprets situations in several characteristic and unique ways. Situations are interpreted by bringing an orientation from the past (involving memory) to handle the immediate emergent events to construct a line of activity for the future which fits the emerging system. Again, the prediction is never perfect, but action is always constructed in this way, and reconstructed with each novel event. The past is represented by some form of memory of both the immediate and often more distant past. Both animals and human beings draw upon past experiences to meet novel situations; however, for human beings these experiences may include certain social experiences. While the girl was defining her situation, she knew that the place she was in was a grocery store because that is the way others referred to the place. She also referred to her mother as a social entity; she may have recalled her mother saying "don't wander off," and was predicting getting scolded, then when she saw the woman she may have said to herself "there's Mommy." These past social experiences and the social interaction she had with herself and others went into the way she interpreted the situation she was in. She used this social interaction to make the situation meaningful in ways which went beyond her immediate sensory experiences, and she guided her actions on the basis of this meaning. Nonhuman animals are incapable of using this specific sort social interaction in constructing lines of action, as will be explained below.¹

The interpretation process which utilizes social interaction and socially derived experiences in adjusting to situations is a necessary aspect of what Blumer defines as action for the human being. Action encompasses overt dimensions of activity, such as observable behavior, and also covert aspects such as thinking, or physiological processes. "Fundamentally, action on the part of the human being consists of taking into account of the things he notes and forging a line of conduct on the basis of how he interprets them." This form of interpretation that is characteristic to human beings is what Blumer calls symbolic interaction (Blumer, 1969: 1). The concept of symbolic interaction is difficult to define in a few words, and will take the rest of this chapter to explain sufficiently; however, a simplified definition of the term here will show where the chapter will eventually lead. Symbolic interaction is a certain form of social interaction in which symbols, such as words, are used to designate situated events taking place or things that one encounters. In such cases the individual indicates, or points out to oneself the intent or future relationship implied by the symbol before that implied action is carried out. The interpretation can then be used to guide one's action on the basis of the meaningful

¹ Nonhuman animals appear to act based on memories of past social experiences as well, such as past fights, mating, or other encounters; however, these experiences contribute to conditioned responses rather than memories of which we may be consciously aware. This distinction will be detailed below.
implication of the symbols. When the girl saw the woman she did not run up to her instinctively like a gosling to a mother goose, but instead pointed the woman out to herself with the symbol "Mommy." The use of the verbal symbol helped her to organize her further actions on the basis of what Mommy meant to her in that particular situation. The symbol "mommy" is social because, first, she learned what the term meant in part by the way others used it to refer to her mother, and secondly, because the symbol "mommy" can be shared with others (such as those reading about this episode) and interpreted by others in much the same way the girl was using the symbol in that particular situation. People can interact symbolically with others, whether present or not, and with themselves. Also, it will be shown that the symbols themselves are not just the words, but are, in a sense, anything we point out consciously to ourselves, whether or not we actually name the conscious objects in the process. As will be described below, it is this social process of symbolic interaction from which consciousness and the mind emerges, from which self and others emerge as social objects, and by virtue of which human society exists and is perpetuated.

Understandably, this discussion of symbolic interaction will require many more details to make sense. The relevant point here, however, is that human beings can adjust to situations through the social process of symbolic interactionism by which people can consciously construct lines of activity on the basis of meaningful interpretations of situations. Human beings have this capacity of adjustment in addition to the processes of adjustment we share with other animals, such as eating, sleeping, walking, and maintaining posture. In addition to our biological world human beings live in a social world which gives more flexibility, variability and control in coordinating our own actions. Individuals can also coordinate their lines of actions with others, and by this process, according to Blumer, groups, institutions, organizations, and societies are formed. "Such instances of societal behavior, whatever they may be, consist of individuals fitting their lines of action to one another" (Blumer, 1969: 16).

Blumer formulated the perspective of symbolic interactionism on the basis of three axiomatic premises which are embraced in the discussion of situations above.

"Symbolic interactionism rests in the last analysis on three simple premises. The first premise is that human beings act towards things on the basis of the meanings that the things have for them... The second premise is that the meaning of such things is derived from, or arises out of, the social interaction one has with one's fellows [and with oneself]. The third premise is that these meanings are handled in, and modified through, an interpretive process used by the person dealing with the things he encounters" (Blumer, 1969: 2)

People do not react passively or mechanically to emerging reality, but act on the basis of what that reality means for a given situation, how they interpret it, and how this interpretation orients them toward future action. People adjust to situations by drawing largely from past social experiences through the process of symbolic interaction by which action can be guided consciously. This is all part of the interpretive process by which people handle situations.

The remainder of this chapter will explore the theoretical origins of Blumer's three premises of symbolic interaction and consider to what extent they form a comprehensive description of human action, and social conduct. To do so I will draw primarily from the work of George Herbert Mead, whose social psychology and philosophy of action comprise the bulk of the "meta-theory" behind symbolic interaction. Mead's introspective philosophical work and lucid observations of both human and non-human behavior will focus attention on the issue of action in general and as it applied specifically to our comparison of neurophysiological aspects of action.

The act
For Mead, action as an ongoing adjustment to emerging situations is expressed by his concept of the act. Like Blumer, Mead did not consider an organism's relation to the environment to be passive like a machine, but active. Living things persist by actively reorganizing their relation to emerging reality, and Mead's concept of act expressed the whole of this process, from the beginning of the adjustment process, to the perception of the world and the behaviors involved in dealing with that world, and the end of an act which led directly to new acts as new situations emerged.

Mead's concept of the act was different than the predominant psychological model at the time of his writing, Watsonian behaviorism. Mead developed his concept of the act during the early 1900's, and the bulk of his concept was compiled in his book *The Philosophy of the Act* (Mead, 1938), a collection of his unpublished works published after his death in 1931. Mead, together with several other philosophers and psychologists, especially Mead's colleague John Dewey, opposed the behaviorist model because it failed to present an adequate account of action.

Watsonian behaviorism follows the positivist tradition which held that empirically observable behaviors are the aspects of action most relevant to scientific study. Animal behavior was a problem in this respect because many aspects of the animal's activity were difficult to point out and measure objectively. The central nervous system, for example, was a mass of tissue and connections and electrochemical reactions which, on the surface at least, gave no hint of its internal mechanism. Such a mechanism had to be constructed theoretically by the researcher. The behaviorist solution to this problem of how to model action was to limit their model to only what was readily observable, the behaving animal, and the environment in which the animal's behaviors took place. The analysis of action, then, became a matter of discovering which occurrences in the environment led to which behavior of the animal. Action began with the stimulus, some occurrence in the environment which is sensed by the animal; and the response, the behavior which the stimulus elicits. Thus activity consists of chains of stimuli and responses. The internal element in this model consists of the link between responses and the various stimuli which cause the responses. These links were formed on the basis of what was learned in past experience. Attention in behaviorism, however, is not focused on internal mechanisms, but upon the observable behaviors, and upon finding out which environmental conditions elicit which responses, how are these responses learned, and so forth. The internal process of action was otherwise unimportant.

Mead, in contrast, considered the internal processes to be the more important part of action, and emphasized that they must be included in a model that will provide an adequate understanding of action. Stimuli and responses were relevant to action, but insufficient on their own to explain why action occurs. The stimulus-response model ignored the internal processes of organizing and interpreting stimuli in constructing a line of activity. By ignoring these internal processes, Watsonian behaviorists were left with only the stimuli and the causal chain of responses which the stimuli must set off. The role of the organism itself in these chains was to respond, and carry around the set of links which make these responses possible. The active participation of the organism in constructing behaviors is not clear in the S-R model. Rather, the organism is described as a passive vehicle for environmental forces. For Mead, the stimulus was not the causal force of action. Stimuli are relevant to action, but only if they are interpreted by an adjusting organism who actively constructs a response.

Though Mead focused upon internal as well as externally observable elements of action, he did not take the dualistic position that these internal processes, such as "subjective" experiences, were distinct from the "objectively" observable behaviors. The unobservable internal processes did not exist as a separate "substance" or plane of reality.

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1 (c.f. Dewey, 1896).
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separate from the mechanisms of empirically observable behavior. Instead, his approach was to describe all of action, the "objective" relationships of an organism acting in the real world and the "subjective" world of inner experience, as occurring through functional, physical processes.

Mead, then, conceived of action as a holistic process which encompassed the entire process of adjustment to emerging situations. In other words, action encompasses all that a living thing does, including both overt behaviors and covert physiological and psychological processes. Action encompassed the organism's orientation from past experience used to project a future line of activity, the processes by which these plans were executed, and the ongoing modification of the action as it met changing situations. Such a holistic approach could not begin with the stimulus, since the stimulus itself did not determine how the organism was using its activity. Mead, in his analysis of action could not use the stimulus and response alone because this left out the internal processes involved in action; nor could the internal be simply the mechanistic linkages between stimuli and responses. Instead, Mead took the act as his fundamental unit of analysis for his concept of action. "The act, then, and not the tract, is the fundamental datum in both social and individual psychology when behavioristically conceived . . ." (Mead, 1934: 8). By "tract," Mead refers to the tracts of the central nervous system that he considered "only a specialized part of the entire organism" (Mead, 1934: 111). Though analysis of the central nervous system was important to understanding action, Mead stressed that, in addition to this, social scientists must study the "whole process of conduct" in order to understand action (Baldwin, 1986: 55). For human beings, this "whole process" includes social conduct. Mead, then, also looked beyond the individual to society to be included in a holistic study of action. "The social act is not explained by building it up out of stimulus plus response; it must be taken as a dynamic whole—as something going on—no part of which can be considered or understood by itself—a complex organic process implied by each individual stimulus and response involved in it" (Mead, 1934: 7).

The act:

From the holistic process of action, Mead drew the act as a basic unit of analysis. Although "[A]nalysis breaks up, for the time being, this organic unity and these relationships" (Mead, 1914: 31), each act consists of four interrelated components or phases: 1) impulse, 2) perception, 3) manipulation, and 4) consummation. Though for the purposes of analysis, the phases are separated into certain characteristic processes, Mead makes it clear that the act is not a strictly serial or causal stage model of action, but rather is a dynamic, organic process in which the four phases are facets of action as a dynamic whole. All animals handle situations by acting, and though social conduct is a more elaborate form of adjustment, the social act involves these four phases as well. Acts occur in many forms and degrees of complexity. Examples of human acts include going to work, picking up a cup of coffee, or having an idea.

Mead described the act of a dog getting food as a typical example. The organization of action begins with the impulse of hunger, by which the dog is prepared to look for food as a goal of the action. The impulse orients the process of perception, in which the dog selectively scans its surroundings for something to eat. If food is found, the dog manipulates the object, which involves overt behaviors of obtaining, tearing and chewing the food which is means to the end of consuming the food. A common act for a human being would be would be stopping a car at an intersection, seeing a green light and making a left turn.

The green light is not the stimulus which causes the driver to begin moving the car. Rather, the impulse in this case is the readiness to act in the new situation which followed the previous act of stopping for the red light. The perception phase involves the selection of stimuli relevant to the action at hand, which is initiated with the impulse. The driver perceives the light and the stopped cars in the other lane, as well as those cars coming toward her. Manipulation involves the behavior necessary to make the turn. The driver
manipulates the wheel, gas, clutch and gear shift, and that particular act is consummated as
the driver successfully makes the turn. Having made the turn, a new act of driving down
the road is underway.

Though these stages may appear to follow a linear sequence in these examples, the
act is not strictly a serial process. The stages are not isolated from one another; rather, the
four phases are interwoven and each phase is present, in some form, throughout the act.
The driver perceives the gear shift in terms of how she will manipulate it in the future. The
anticipation of later phases, such as the goal of making the turn, can feed back to influence
earlier phases, such as turning the wheel in the correct direction. Similarly, acts do not
always lead smoothly to consummation. Novel occurrences may emerge at any time. For
example, the car may have stalled, so the driver cannot make the turn. The person must
adjust to such emerging, unanticipated occurrences which occur throughout the act. With
ongoing adjustment and modification throughout, acts vary in their complexity. Any one
act, such as going to work, is actually composed of various sub-acts, such as going out the
door, walking to the car, getting into the car, starting the car, and so forth (Blumer and
Morrione, 1985). Thus the act as a basic unit may be hard to distinguish analytically. For
descriptive purposes, however, the act represents a process of adjustment to conditions of a
given situation, and can be distinguished in the way they incorporate these four phases.

Acts, then, do not lead simply from impulse to consummation in a direct causal
sequence. Like like the situations they handle, acts follow “careers” (Blumer and
Morrione, 1985). Mead's model of the act answers to a reality of emergent unpredictable
events, and an organism's adjustment to such a world. Action is a process of
development, and the act is built up through interaction and the co-presence of the four
phases. A more thorough analysis of the phases of the act will show how Mead’s model of
the dynamic, holistic process fits an emergent, organic reality.

Impulse

The act, according to Mead, begins with the impulse. Among the four phases,
Mead gives relatively few details about this initial phase; however, the concept of impulse
is the crucial element in Mead’s description of action as an adjustive, interpretive process. I
will explore how the impulse fits into Mead’s general theory of adjustment in chapter three.
Three aspects of the impulse will be presented here to show the impulse’s important role in
organizing the entire act. First, the impulse represents the dynamic tendency by which the
organism adjusts to emerging reality, in other words, the impulse begins the interpretive
process of the act. Mead argues that, because of the interpretive process of action, it is the
impulse and not the stimulus which begins an act. Second, this tendency to adjust has a
direction, or goal of action which sensitizes all phases of the act and begins the process by
which the line of action is built up. Third, the impulse is present throughout the act as the
ongoing process of adjustment to novel events. In this way, the impulse allows lines of
activity to be holistically organized around situations, rather than occurring as causal chains
of activity.

The impulse is a dynamic tendency for the organism to adjust to changing
conditions. In other words, the impulse begins the active process by which an organism
handles emerging reality. A more thorough description of what Mead means by "tendency"
will be presented in Chapter 3. For now, we can think of the impulse as arising in the flow
of meeting emergent events with a fluctuation which changes the organism’s current line of
activity. The fluctuation may be internal or external. For example, the pang of hunger is a
fluctuation brought about by an empty stomach. Another fluctuation would occur if a
pedestrian stepped in front of the driver’s car while she was making the turn. In both of
these cases, the novel situation was handled in such a way as to change the course of action
one is in. In the driver’s previous situation, her projected course of action offered no major
difficulties. With the impulse, the previous line of action requires more than minor
modifications to deal with novel events in the situation at hand, and requires instead a new act to handle a new situation.

The organism is actively dealing with these fluctuations through an active process by which it interprets incoming stimuli on the basis of the previous situation. Thus the act has its beginning in the organic active process by which the organism meets incoming stimuli. The stimuli themselves do not begin the act. In the stimulus-response model described above, the stimulus is assumed to be the source of the action, starting the chain of responses linked to various stimuli. This implies that the stimulus controls the act, by setting off the fixed response linked to it. Mead describes the impulse as selecting the stimuli upon which it acts. "We cannot interpret the act in terms of stimuli; if we do, we miss its significance. Rather, an impulse or a tendency to act is present, and it makes use of stimuli or selects them to act, and this is characteristic of all life forms" (Mead, 1927: 109).

Though the act begins with the impulse and not the stimulus, the impulse is not simply the cause of a predetermined chain of events; rather, the impulse gives a direction to emerging action which can best handle the emergent events. The impulse, therefore, orients the organism toward a new line of activity. The impulse of hunger orients the dog's action toward finding food. The sight of the pedestrian is handled by an impulse directed toward putting on the breaks. In this way, the impulse sensitizes later stages of the act. Thus the impulse begins the organization for the whole act.

The direction of action given by the impulse comes in part from past experience, in which certain stimuli become more relevant than others. The hungry dog knows that certain things which it encounters qualify as food, and others do not; thus the organism brings to the stimuli the criteria for their selection. "Impulses, therefore, require certain types of stimuli. The impulse is thus this tendency to act in the course of the life process, like the movement of moths toward a light, or of sap to the tree top. The impulses are there ready to be carried out, depending on a certain contact with nature. The stimulus is thus dependent on the structure of the organism itself" (Mead, 1927: 112-114). Thus the impulse mobilizes, in a sense, the selective attention one gives to certain elements of a situation.

Mead suggests the impulse functions to sensitize all parts of the act; it orients the organism toward certain relevant stimuli, the type of manipulation, and refers to the goal of the particular act (Baldwin, 56). In this sensitizing process, past experiences are related to present conditions in anticipating future events. Anticipating the result of an act, such as making the left turn, influences how one is prepared to perceive things and manipulate things. The impulse, for instance, brings out what Mead refers to as imagery, both sensory imagery, such as the anticipated green light, and motor imagery, such as the motions necessary to drive the car. "We find the precondition of the act in imagery, the sense imagery which controls the selection of stimuli and motor imagery which facilitates the response" (Mead, 1914: 28). Through this sensitizing process, an anticipation of later phases of the act can be used to organize earlier stages. Thus the organism begins to construct its line of action on the basis of a future which it interprets. In this way the organization of the entire act begins with the impulse.

Though the impulse projects a future line of activity, the impulse does not determine the future course of action. The hungry dog may be ready to eat, but may not find food. As an individual's activity continues, the environment continually present novel conditions and stimuli which modify the course of the act. The act requires many mid-course adjustments which re-orient the direction of the act. The impulse then, is present throughout the act, continuously modifying the direction of activity by calling out new sensory and motor imagery and new responses. The impulse orients the act toward a future, but the organism still meets a reality which is not perfectly predictable. Thus the activity itself is built up in the interaction of the impulse and the emergent reality to which it adjusts. The impulse, then, helps build up the career of an act (Blumer and Morrione, 1987; Morrione, 1988: 8).
Since the impulse calls out all phases of the act throughout the course of activity, the impulse plays a part in unifying our experience of the act as a whole. In other words, the impulse helps to organize emergent reality and our own experiences as situations, rather than as unrelated streams of events. An awareness of the situation helps unify the various components of activity along a more unified goal or direction. For example, the driver is involved in the situation of making a turn in which the various steps, such as shifting gears, turning the wheel, and pressing the accelerator, can be unified around the purpose of the situation. Again, this differs from the S-R model in which the stimuli can only call out chains of responses, and cannot sustain a purpose of the resulting act.

Impulse, then, begins the act, directs action to a future, and helps orient the selection of relevant information for handling that future. The impulse also helps to sustain that orientation while the given act persists. Though the impulse orients the direction of action and sensitizes the other phases of the act, it is in the next phase, perception, that the tendency to act is filled out by what is actually encountered.

**Perception**

The phase of perception continues the process, initiated with the impulse, of interpreting emergent conditions and events. Perception is an active process encompassing both the structuring of experience into a line of action, and the indeterminate process by which the anticipated line of action meets emerging reality. In this phase of the act, one's experience of the present situation becomes meaningful in terms of the future line of action one constructs.

The phase of perception is not simply the intake of stimuli in one's surroundings, but an active structuring of the sensory world in which experience becomes relevant to the organism's emerging line of action. This is accomplished through an active process of selection. The process of selection is active in two respects. It is a physically active process in the muscular sense of the organism orienting itself to either the immediate or anticipated source of the stimuli, such as looking toward the traffic light.

Perception is also an active interpretive process as the organism selects the stimuli relevant to the situation at hand, particularly those stimuli relevant to the completion of the act. As mentioned, the selective process was initiated by the impulse. The impulse, calls out what Mead calls "imagery" anticipating what sort of stimuli would be relevant in the future. Mead is not clear whether this imagery is an actual sensory image; rather, the imagery expresses the direction of adjustment called out at the impulse (Mead, 1934: 338; 1938: 3, 54, 161, 227). For example, the impulse occurring with the green light orients perception toward certain stimuli over others, such as the road ahead, the other cars and pedestrians. Perception, then, involves both what occurs from moment to moment, and what is organized with the impulse. The driver still experiences the full sensory field, such as the street corner, and the shapes and colors of the cars going by, but the driver perceives primarily those sensory experiences which are relevant to making the turn at the green light. Other stimuli are still present, however, and may attract one's attention, such as a pedestrian stepping in front of the turning car. Perception, therefore, is the ongoing mixture of the stimuli in one's surroundings, and what one brings to those stimuli in the process of selecting and interpreting stimuli. It is through this selection that the individual organizes his or her sensory experiences according to the interpretation of the situation at hand. In other words, *perception transforms emergent reality into a situation experienced by the individual*.

The selective process of perception, in effect, creates the individual's environment. This is an important point, because it shows that the environment which is relevant to action is not external to the organism, but is a combination of the reality which is "out there" and what the organism brings to it. If the environment is partially dependent upon the organism, it cannot consist of fixed conditions to which the organism passively responds. This gives another reason why the stimulus is not the causal force of an act.
The stimulus is not a fixed condition impinging upon us, but must be interpreted to be relevant to action. Our relation to the world is therefore co-determinant. The environment changes and affects us, and we also change the environment in adjusting to novel conditions. There is therefore no clear distinction between the organism and its environment. There is instead the dynamic relationship of a living system adjusting to its surroundings.

This interpretive process by which individuals organize the things they perceive creates an environment of "objects" which are relevant to future action, and are organized into some form of situation. "Environment is thus the creation of objects and, by this relationship, giving new content to things that did not have it before" (Mead, 1914: 29). The objects are organizations of things in the sensory field into both sensory experiences and the relationships they will have to future action. The cars in the road are objects relevant to the situation as obstacles to be avoided. The "content" of objects is the future relationship the individual will have with the object. Perception, then, anticipates later stages of the act. Perception uses memories of past experiences in terms of their relevance to the immediate and future situation. "The perceptual world is made up of means and ends" (Mead, 1914: 31). Perception sees things in terms of means (manipulation) and ends (consummation) and experience is organized such that action is guided through to consummation. Individuals do not act on the basis of stimuli but on the basis of the interpretation of stimuli through which they are related to some future action. In other words, individuals act on the basis of the meaning of the object. The meaning of an object is the implication of a future relationship we bring to sensory experience. The individual does not have to actually handle a thing in the future for it to be meaningful in the present. One can perceive a thing in order to avoid it, such as perceiving cars as obstacles to avoid.

The environment, then, is interpreted as meaningful objects, objects which call out some relation to future action. This image of future action can guide the formation of the line of activity by bringing later stages of the act into the present. Past experiences used in relating meaning to objects can "fill in" elements of the sensory field. "[O]ur imagery fills in what we do not actually see, hear, etc. In reading, there are perhaps only two or three points in a line which we actually take in. A word may be incorrectly spelled and we may actually see it spelled correctly. Past experience is present in the perception. The past experience which comes in is one in which we have acted upon the same or a similar stimulus" (Mead, 1927: 114). By "images" Mead means not only visual or other sensory images, but also motor images which anticipate what we will do with a thing once we get hold of it. Thus perception refers to both manipulation and the consummation phases of the act. By projecting the forms of manipulation related to the meaning of the object, perception of meaningful objects organizes sensory stimuli into a situation of things relevant to our action. Mead calls perception the "collapsed act" because it anticipates all later phases in the present. "A perception is what we call a collapsed act." "This imagery gives us the result of an act before we carry it out" (Mead, 1914: 29).

Though perception builds up an environment of objects relevant to future action, the objects do not determine the course of action, just as the impulse does not determine action. One may anticipate that a tea kettle is empty, but will not be sure until it is picked up. Perception, then, builds up a hypothetical future which is confirmed by later activity. "Such an aroused future act always has a hypothetical character. It is not until this initiated response is carried out that its reality is assured" (Mead, 1938: 25). Meaning does not determine the resulting action; instead, both sensory experience and action are built up in the interpretive process and are modified continually in the course of an act. There is therefore both structure and indeterminacy in the process of perception. The organism structures reality into objects related to future actions, but cannot predict those actions absolutely.

Through perception, an individual brings to the reality of a situation a hypothetical future which guides the formative line of action. Anticipating the meanings of things at a distance gives more control to the emerging action because immediate stimuli can call out
several future directions to the act before one carries them out. An individual may see a banana and plan to eat it, but then remembers that the bananas are to be used for a pudding. The ability to associate various future relationships before they occur adds variety and flexibility to the types of actions one may have. An object of perception, then, is not linked to a single response. Associating present stimuli with past and present conditions gives choice to the acting individual.

Objects created through perception are not limited to the immediate sensory experience at hand. The object as an organization of experience may extend, in a sense, beyond one's immediate surroundings in both space and time. Visual or auditory imagery may also be identified as an object since they can be related to the projected line of action. Thus one can experience a visual image of one's childhood home, or the auditory image of a song. Though past experiences are utilized in the perception of objects, memories are reorganized in novel ways in the present conditions. For example, one recalls what a traffic light is and that a traffic light will turn green without necessarily recalling some specific instance of experiencing a traffic light. Although emerging memories generally fall into relevant patterns, past experiences are recreated in the present, and have their relevance in the anticipated future. In this sense, both past and future are constructed during the course of the act. "[Imagery] only refers to the past in so far as it has a future reference in some real sense. It may be there without immediate reference to either future or to past. We may be quite unable to place the image" (Mead, 1934: 344). Past responses, then, in no way determine future responses. Even the most habitual act is reconstructed in a novel act, and always involves the variations and modifications of adjusting to an emergent reality (Blumer, 1969: 11). Emotions and physiological phenomena such as pain can also become objects since they play a large factor in guiding the course of action.

Perception continues throughout the act, as new information is interpreted. The anticipated line of action, then, is continually modified throughout the act. Since the act is constantly reorganized with the impulse interpreting new stimuli, perception of things at any point in the act can be related to the definition of the situation at hand. Novel occurrences, therefore, are handled by the interpretive process. If a person jumps in front of a car, the driver reacts to the event immediately by slamming on the brakes, but that particular response is consistent with the overall experience of driving the car.

The phase of perception, then, encompasses the interpretation of relevant stimuli selected on the basis of the impulse. The representation of past experience is bound to the present to create an environment of objects meaningful to future action. One's line of activity can be guided, but not determined, by the hypothetical future relationship represented by the meaning of objects. Perception continues throughout as the act and meanings are continually modified through an ongoing interpretive process.

**Manipulation**

With his description of the phases of impulse and perception, Mead shows that the line of action is organized to a large extent before it is actually carried out in manipulation. Both the type of response as muscle movements and the anticipated results of the act are organized in earlier phases. In the phase of manipulation, the line of activity which had been largely covert becomes overt in the sense that behaviors, or observable actions, are carried out. Manipulation, however, is not simply the movement of muscles. Just as perception as an active process has motor as well as sensory components, manipulation also has sensory components. The motor movements are guided by the anticipated response organized by processes of impulse and perception.

Anticipating the form of motor movement does not determine the actual muscle movements, however, because these movements are interacting with the conditions of the physical world as they are carried out, and are therefore open to continual modification. The sensory components of manipulation enter with this emergence of behavior. When one manipulates a thing, such as a coffee cup, one encounters the reality of the cup in the resistance it offers to the touch (Mead, 1938: 22, 150, 186, 212). The hand strikes a hard
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surface through which it cannot pass. The cup, like any physical object, has mass and weight and is composed of molecules which push back upon our contact. These properties are traditionally called the primary properties of physical things, but Mead refers to mass, weight, and resistance as contact experiences (Mead, 1927: 120-122; 1938: 22-23). This term includes not only the physical properties, but the organism's active relation to the physical thing in making contact. The organism adjusts to contact experiences and modifies ongoing action. As one lifts the coffee cup the individual automatically modifies the force exerted by the muscles according to the cup's weight.

Contact experience through manipulation confirms the hypothetical nature of perception. The process of confirmation involves the sensory experiences of contact as well as the motor process of handling the thing. Manipulation can reveal discrepancies in what is anticipated; therefore, contact can feed back to modify the results of these earlier stages. The driver, for example, may press the accelerator but find that the car does not move because it has stalled. Manipulation in this case reveals a problem with one's current line of action that becomes the impulse for an new or modified act.

The contact experience confirms anticipated perception not only physically, but temporally. Contact must occur in the present, the "now." Perception of objects at a distance, according to Mead, involves not only a separation of space between the object and the perceiver, but of time as well. The chair in a room is so many steps away, and the clock on the wall is farther. With contact through manipulation, however, the object has its temporal reality in the present. If one bumps into the chair the contact is not anticipated, but is real now as it occurs.

Mead considers spatial relationships among distant objects to be handled in perception by projecting future contact experiences on distant objects. Perception, then, involves the anticipation of how a thing will be handled, and thus guides the manipulation one will have of a thing. Actual manipulation subsequently confirms the reality of this hypothetical object and modifies the action as it occurs, thus reorganizing the form of perception. Both these processes can, and often do, occur simultaneously; for example, manipulation may reveal a car which will not move and at the same time the driver perceives a red light on the dashboard and does not hear the engine running. By interpreting all of these elements through no particular order, the driver realizes that she is dealing with a new act, a stalled car. Again, this shows that action is not a serial chain of events, but a developmental process which can operate both sequentially and in parallel.

Anticipating the future relationship one will have with an object at a distance gives the meaning of that object. The meaning of distant objects develops from past contact experiences with things. Mead describes how our ability to act toward distant objects develops in early childhood. We are not born able to anticipate future contact relationships among objects; rather, this capacity develops through the infant's interactions with physical things. The child understands the contact qualities of a hammer by first picking it up and experiencing its hardness and weight in addition to its visual appearance, and other sense qualities. When the child sees the hammer again, he or she can associate the meaning of this distant visual experience on the basis of past experience. With repeated contact people can understand the meanings of things at a distance more clearly because they are better able to anticipate the various experiences they may have if they contact or manipulate the things. The many types of future relation one may have can therefore be anticipated from a distance (Baldwin, 1986: 58). It is this ability to anticipate the relationship of objects to actions which gives meaning to objects in one's surroundings.

The variety of contact one may have with a thing adds flexibility to the type of meaningful relationships organisms may have with their surroundings. The human hand is

1 The types of relationships do not necessarily involve actual contact one is going to have. One may perceive a thing in order to avoid it, such as the pedestrians and the other cars. This will be described further in the discussion of "objects" below.
significant for Mead in this respect because it allows a larger variety of contact experiences with a thing. "In manipulation or contact the hand is of fundamental importance, and its high development is a mark of the intelligence of the human" (Mead, 1927: 119). The hand is therefore important in evolution since human beings can deal with the things across a wider range of meanings. Other animals have only limited contact experience with things, and therefore have a more limited world of objects (Baldwin, 1986: 58-59). "Our world, as a physical world, is built up of contact experience through the hand. The dog's world is built up of odors. There is no world of physical experience between the stimuli for him, but we separate the mediate experience from the consummatory process" (Mead, 1927: 119). Manipulation, then, is a means to the end of consumption, and is in this sense "instrumental" to consumption (Mead, 1938: 24).

Consummation
Mead considered consummation to be the phase in which an impulse subsides (Mead, 1938: 23ff, 445-457). Consummation completes, in some fashion, one's adjustment to the given act. Mead gives the example of hunger subsiding with eating and "satisfying the impulse" of hunger (Mead, 1938: 136). Although consummation represents end of a given act, it is also present throughout the act as a referent for action.

The impulse, as a tendency to act, mobilizes action toward some goal or general direction. With the green light, the driver's goal or consummation was to be achieved upon making the turn. The goal of action is modified and often changed as the act proceeds, however, most acts are generally directed toward some purpose. Although the goal of an act is anticipated, the actual consummation is never predetermined. The rest of the act, in a sense, fills out early stages of the act with perception manipulation that may subsequently modify the act as it is carried out. With constant opportunity for novel events to modify or redirect the act, the act may consummate differently than expected, and will always be slightly different than anticipated. Even the most habitual action is recreated anew (Blumer, 1969: 17). Brushing one's teeth each night is similar, but never exactly the same as it was the night before. The consummation is in this sense, the result of the emergent, developmental process of a given act, and the passage to a new act.

Though the given impulse is resolved, action does not stop with consummation; rather, the organism goes on with some other activity, act, and situation. As mentioned above, the activity of dealing with emergent situations and reality is a continuous process. The activity of an organism stops only when the organism is dead. Even sleeping is an activity of a different sort. Thus an impulse may be resolved in various ways, from a redirection of one's previous line of action in problematic situations, to the slipping of one's attention from one topic to another when one is day-dreaming. If an act is redirected, such as when the car stalls, the consummation is simply the shift to a new stimulus to act. The present impulse, then, may be resolved successfully, or may change to some other problem, but the active adjustment process is continuous for living systems.

Mead describes consummation as giving the value of the act in one's experience. Consummation, then, is more than the completion of a given act, but is also an experience of the organism. "Consummation is satisfaction and, if you will, happiness" (Mead, 1938: 136). Having eaten, one may feel the physical experience of satiation or satisfaction. In other acts, the physical experience of consummation may be difficult to distinguish from

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1 The act beginning with impulse therefore should not be interpreted as an organism proceeding from some occasion of disequilibrium with its surroundings to equilibrium (c.f. Johnathan Turner's interpretation of Mead's act in Turner, 1989: 459-460. "For Mead, an impulse represents a state of disequilibrium or tension between an organism and its environment" Turner, 1989: 459). Equilibrium is the cessation of self-organizing or adjustment activity and is not characteristic of life processes. As mentioned in the description of situations, adjustment to emergent reality is a never ending process as the organism lives. Mead's description is characteristic of living systems which maintain conditions far from equilibrium in adjusting to novel occurrences. This will be discussed further in Chapter three.
other experiences occurring simultaneously; but with introspection, one can often
distinguish the ending of an act as a physical sensation. As an example, think of your last
thoughts or sentences, and there seems to be a shift or sensation "marker" of the pause
between thoughts or sentences. Mead suggests that various aesthetic experiences and
emotions may be associated with the consummation of acts, though emotional experiences
may be present throughout action (Baldwin, 1986: 59).

The value given to the consummation may help to preserve the act in memory,
making the experiences useful for future acts. Consummation gives the reality of the act in
the sense that what has occurred has occurred. Though all phases of the act are in
development and are basically indeterminate or emergent, a given act, when completed, has
a history which one can recall, though only indirectly through reconstruction of the past in
the present. Thus the memory of a given act or experience can be value laden, often
depending on the success of the results. Events and objects within the act can be recalled as
"good, bad, indifferent, beautiful or ugly, and lovable or noxious" (Mead, 1938: 25).

In this way, perhaps, past experience as consummation of past acts may become
components of future acts, in anticipating the nature of the results of action. "In terms of
these values we can analyze the act" (Mead, 1938: 452).

From these analyses of the phases of the act, we can see that Mead describes the act
as an organic process of adjustment which encompasses both structure and indeterminacy.
Emergent reality is met by the impulses that occur with fluctuations in the adjustment
process. The impulses reorganize the past line of activity and mobilize future phases of the
act. In the phase of perception, stimuli are selected and interpreted on the basis of past
experience to create an environment of objects meaningful for a hypothetical future line of
action. Through manipulation, the action is carried out, yet modifies perception and the
entire act by feedback from contact experience. With consummation, the impulse is
resolved and activity continues with new acts and situations. Emergent reality, therefore, is
structured and made meaningful to a future line of action. People act on the basis of the
meanings of things, and not by the causal force of the stimuli. The projected line of action,
however, meets the emerging reality of the present, and is therefore indeterminate. Action
then, does not lead simply from impulse to consummation in a direct causal sequence.

Mead’s model of the act, instead, answers to a reality of emergent unpredictable events,
and an organisms adjustment to such a world. Action is a process of development, and the
act is built up through interaction and the co-presence of the four phases. Mead’s model of
the dynamic, holistic process of action fits an emergent, organic reality.

Mead’s concept of the act has shown how action can be built up through the
meaningful interpretation of emergent reality. Much of the description of the act presented
so far applies to all higher animals, such as the hungry dog at the beginning of the section.
All animals go through some form of the four phases of the act in interpreting and adjusting
to the situations they meet. Human beings, however, construct and control their actions in
certain ways differently than other animals. Both human and non-human animals act;
however, the discussion above has left implicit the social process of action. As mentioned
above in the introduction to the concept of situations, human conduct is characterized by
symbolic interaction with ourselves and others, a process which transforms radically both
the way human beings act toward the world and the way they experience the world.

The reason for leaving the social process implicit in the introduction to the act was
to show that all forms of action, including human conduct, have their roots in the process
of adjustment; therefore, many aspects of human conduct are shared with all other animals.
The social process of symbolic interaction is in essence an elaboration of the process by
which we adjust to, interpret, and act toward the situations we encounter. From this basic
description of the adjustive process, we can now build upon the characteristic processes by
which human beings construct lines of activity consciously, through the process of
symbolic interaction with others and themselves. From this process emerges the mind,
self, and society. Since these capacities arise as an elaboration of processes of the act,
Mead can describe mind and consciousness as biological processes arising by virtue of our symbolic interaction with others and oneself. He can therefore reject the dualistic separation of mind and body, subjective and objective experiences, and describe instead the physiological and social origins of psychical processes.

Mead's line of reasoning for this conclusion stems from his concepts of the distance experience and contact experience. Mead proposes that people construct meaningful objects by imposing contact experience on distant objects. Individuals can then act on the basis of the meanings of the objects. This process of perception, however, involves two phases for human beings from which emerge two sorts of meaning: implicit and explicit meaning. Meaning is the process by which past experiences are interpreted with present conditions to project a line of activity in the future. On the basis of implicit meaning, the line of action is carried out directly. All animals act on the implicit meaning of things; however, humans can act on the explicit meaning of things when the implicit meaning of the object is pointed out, or indicated, to oneself. Through this process of indication, explicit meanings become conscious, and human beings can then guide action consciously.

People can become conscious of the explicit meanings only through the social process of symbolic interaction. Before describing the social process, however, I will briefly elaborate the arguments leading to this point.

Symbolic interaction

People act on the basis of the meaning of things. The relationship of meaning and action was mentioned earlier in the context of the act in the relationship of perception and manipulation especially. I mentioned that in perception, together with contributions of other stages, the environment is built up both as stimuli which release the tendencies of the impulse, and the interpretive process which the organism brings to stimuli. We do not act upon the stimulus alone, but act as a result of this co-determinant organization of experience. Interactionists refer to that which is indicated as objects. In this section, I will describe Mead's concept of the object as the integration of experience and meaning, meaning which forms the basis of action.

Objects:

The organization of the world into objects involves the relationship of contact and distant experiences described above. As mentioned, these are Mead's functional alternatives to the philosophical concepts of primary and secondary qualities. Primary qualities are mass, solidity and resistance to movement, the basic physical properties of matter and energy. Secondary properties are those experiences had by a perceiver of a thing at a distance. They include color, shape, sound, taste, and odor. Mead rejected the notion that primary and secondary properties should be separated when used to describe the experience of organisms, especially when they are split into subjective and objective experience. Descartes, for example, split reality into the mental "substance" of subjectivity and the material substance of "extended things." Mead considered the experience of both primary and secondary qualities to occur through physiological processes of adjustment to the reality of physical things; thus, there is no clear distinction between subjectivity and objectivity. Further, he claimed that such a distinction tends to lead to dualistic separations between the perceived and the perceiver.

Mead's task, then, is to describe the functional relationship between "objective" contact with emergent reality, and the "subjective" experience of meaningful objects upon which we act. Mead describes this functional relationship as that between contact and distance experience of objects. According to Mead, we are able to act on the basis of meanings of things by giving distant objects contact characteristics. The contact is both an active manipulation of things and a sensory process of confirmation, and the distant experience is a projection of contact qualities from a distance. It is through this relationship
that the individual perceives an object in terms of a hypothetical future relationship which guides action in the present.

The ability to act upon objects at a distance evolved as an elaboration of the action toward contact objects. For Mead, experience has its reality in contact. As mentioned, the contact experience is gained through manipulation of physical things. In a more basic sense, however, contact is the direct adjustment to emergent reality. The living system is in contact with its surroundings in the constant exchange of energy and matter by which the living system maintains itself. In this sense, contact experience is common to all organisms. The amoeba's world, according to Mead, is only of contact experience. It adjusts to the proximal conditions of its immediate surroundings. It takes in food when it contacts the food's chemical signal and avoids damaging materials, such as corrosive chemicals, when it contacts them. The sense organs work by contact and proximity at their basic level. The rods and cones in the retinae fire when struck by photons. Likewise, the interaction of neurons in the brain is proximal. Neurons fire when they receive electrochemical signals from neighboring neurons. Contact, then, is both a basic experience and a basic activity of adjusting living systems.

Most of our experience, however, consists of objects perceived at a distance. Our ability to perceive distant objects goes beyond the direct adjustment to contact experience. Only a portion of our world or experience is of direct contact. "We do not live in a world of photochemical work of the retinae. We live in a world of distant objects, of automobiles, of symbols" (Mead, 1927: 117). While manipulation deals with contact of a thing, perception is largely of distant objects, and most of our sense organs, vision primarily, deal with things at a distance. Distance experience gives such properties as color, shape, sound and odor, but does not give directly the physical resistance of a thing. This ability to act on things at a distance goes beyond the contact experience. "Energy comes in from the sun and currents move the amoeba about, but in this instance the response is to the contact object and experience, not to the distant. The amoeba cannot get into relationship with objects at a distance" (Mead, 1927: 117).

We are able, then, to act on things without first having contact. This is an obvious capacity, but what is the process by which this is possible? As mentioned, Mead suggested that the relationship with objects at a distance is possible by imposing contact experiences on distant experiences. What the organism adds to the experience are aspects of contact in terms of a future relationship. The contact is experienced only in the sense of an implicit response or tendency. One does not feel the actual texture of a brick wall at a distance. "For general purposes the percept has contact content not different from actual contact experience. I need not have contact experience of a distant stimulus to be able to see it as hard, soft, cold, pleasurable, or painful" (Mead, 1927: 125). This content comes from binding past experiences or their generalized qualities, to present experiences in order to anticipate future relationships among things. The nature of this time binding and its development of this capacity in humans was mentioned above. This future relationship becomes the meaning of that distant object.

The object, then, as Mead uses the term, has two aspects. An object is both the sensory experience of a thing and the tendency toward some future relationship with a thing. The object as experience includes its distance qualities, the so-called "secondary qualities," and also the actual somatosensory experience (touch) should we be manipulating the object at the time. It is the second aspect, however, which relates the object to action. The tendency toward some future relationship with the object is the meaning of the object. For example, the meaning of the armchair is something in which the perceiver will sit.

Perceiving the meaning of a thing as future contact does not replace the distance experience we have of a thing. Instead, both forms of experience occur simultaneously in one's field of experience. "There are distant objects, but what they are in perception is

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1 c.f. Ch. 2
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contact experience that we may have when we get hold of them" (Mead, 1927: 120). In other words, we experience shapes, patterns, and colors of the changing visual field among other sensory experiences, but we organize these experiences in terms of some active relation we would have with them in the future, such as would be had in manipulation of the object. To give a more concrete example, we can see this simultaneous relation in how we deal with three-dimensional objects. If one looks at an armchair from the side, it's immediate "raw" appearance shows that there is not space enough between the arms to fit one's body; however, we know despite this visual information that the chair is wide enough to sit in. We add contact content to the visual image of the chair. Similarly, Mead gives the example of a penny which when manipulated by the fingers may appear as an oval, or a line if only one side is seen. Yet at the same time we see it as an oval, we also see the penny as round. This is not a case of one visual image or sense datum being fused to another. "The datum in this case is there never as a mere visual content but as an indication of the experience of manipulation, and our percept of the penny is then in terms of the action under the conditions of the most advantageous conduct" (Mead, 1936: 128). The round penny is advantageous in the sense that we use and grasp a round shape, not an oval shape, and we act toward to the penny as round, thus the round penny is the dominant nature of what we see.

Through the relationship between contact and distant objects, therefore, Mead describes a functional relationship between perception and action. The meaning of an object is an expression of some future form of conduct in relation to that object. The stimulus, or sensory experience by itself has no motivating force in action without being related to the tendency to act in relation to it. Therefore, we act not on the basis of stimuli, but on the basis of the meaning of objects. Action, such as the form of manipulation, is organized and guided according to the meaning of objects one perceives. Thus meaning is, in this sense, the organization of means to ends which leads the act to consummation. Again, there is indeterminacy in this organization of experience. Objects and meaning are not static products of perception which control action, but rather are built up throughout the act. The distant object has a hypothetical nature which is confirmed, dis-confirmed, and modified with each moment and each change of conditions. Thus, objects and their meanings, as with the entire act, are developed in an ongoing manner and are emergent.

Implicit and explicit meaning:

Although all animals act on the meaningful perception of objects, human beings add a future process of perception by which we become conscious of the meanings of things and can guide actions consciously. Mead expressed the difference between these forms of perception as implicit and explicit meaning. The relation of these forms of meaning to action can be observed in the way humans and other animals control their conduct. Human beings deal with objects differently than do other animals. An ape in a zoo, acting on an impulse of hunger, reaches for a banana and consumes it. A boy in a kitchen, acts on a similar impulse of hunger, sees some bananas on the kitchen counter and begins to reach for one. The boy then stops his action, however, when he remembered his mother was going to use the bananas for a pudding.

What is the difference between the act of the ape and the boy? The difference, according to Mead, is in perceiving and acting on the meaning of the banana as an object. The boy constructed his line of activity through two phase of perception. "There are two different phases of perception: (1) selection of the stimuli - we approach the hammer to grasp it, and thus the later part of the act is present in the earlier stage; (2) the response that brings this attitude into the experience to develop the control that we exercise. The latter is what social conduct has established. When we perceive, we not only control the approach, but our attitude to it stands out as an experience that can control the whole process" (Mead, 1927: 133). The first phase is the implicit meaning of an object and the second involves the explicit meaning of an object. It is the second phase where experience becomes conscious.
The first phase is implicit in the sense that the stimuli are organized according to their tendency toward response. As mentioned, this tendency comes from anticipating contact experiences on distant objects in organizing the form of manipulation the organism will have with it. Mead often refers to this tendency as the "attitude" of conduct toward a thing. "We can speak of attitude as the tendency to move toward [or in relation to] an object which changes as the approach is made - all of which enters the object and make it what it is. Our perception involves the attitude of going out, covering the distance from the organism to its content, and this is part of meaning" (Mead, 1927: 127) The attitude does not determine the response, but is built up as an organization of movement, and modified as the action proceeds. Implicit meaning, then, is the direction of conduct in relation to the stimulus, by which an act is guided to consummation.

In the second phase the implicit meaning of a thing becomes explicit. This is accomplished through the process of indication. In the second phase of perception this tendency to act is itself experienced and thus can become a new standpoint for organizing action. The meaning of the object is explicit because the tendency is pointed out or indicated to oneself. With the process of indication, the tendency becomes an experience, and, just as other experiences or stimuli, it can be re-associated with other lines of action organized on the basis of memories or new information in one's surroundings. The boy, for example, indicates to himself his own actions of getting the banana and then remembers his mother's future use for the bananas, and possibly imagines her anger should he take one having been told not to. By indicating his action, the boy is able to reorganize his line of activity and act by choice rather by reflex. With indication the implications of the implicit meaning enter experience and can be used to reinterpret the act at hand, and modify or redirect action before it is carried out. In this way, the anticipated line of action itself can become an object in addition to the thing one perceives. With indication of explicit meaning, one becomes conscious of his or her own actions and those of others. The conscious or explicit meaning of objects and actions as objects allows greater control of emerging action.

Notice that Mead calls these two types of perception phases and not stages. This implies that explicit meaning need not proceed sequentially from implicit meaning; rather, the two forms may occur simultaneously. Explicit meaning is a future processing of implicit meaning, and is therefore dependent on implicit meaning. One can, however, act on implicit meaning alone, such as when one grabs a doorknob and opens a door without taking note of one's actions. If the door is locked, however, the person indicates the fact to himself or herself. Many habitual or "automatic" activities are organized through implicit meaning alone and most acts of human beings involve both implicit and explicit meanings in carrying acts to consummation.

Non-human animals, however, cannot act upon the explicit meaning of things. Objects in their surroundings have only implicit meaning by which they organize the manipulation they have around the goal of consummation. The line of action organized may be quite elaborate, such as the acts of lions on the hunt. Non-human animals, however, carry implicit meaning directly through to consummation. The tendencies to act

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1 I will use the term implicit meaning instead of attitude, because the later term often has a different meaning in psychology and in common usage. For instance, one has an attitude toward racism. Other psychological theories often give attitude a deterministic form, such that attitude sets the behavior one will have toward a thing; thus if you can know a person's attitudes, you can predict their behavior in some given situation. Mead's use is of a more basic organization of behavior. Mead's use of "Attitude" is comparable to its use in aeronautics, the attitude or orientation of approach, which is constantly adjusted as one flies along.
are, in a sense, simply released and are not presented back to oneself to be acted upon.\(^1\) Non-human animals, then, cannot act upon the explicit meaning of objects because they cannot present the implication of action to themselves before the act occurs. This capacity, according to Mead, requires the social process, or the capacity to interact symbolically with others and oneself.

I will discuss the social process below, but we might first ask why explicit meaning is important in organizing action. What does this capacity allow? As mentioned, the social process allows the implications of future relationships of objects to be experienced before they are carried out. This process essentially makes the meaning of objects *conscious*. They are conscious in that they are presented to oneself as objects of experience. Subsequently, one can become aware of oneself as an object, a capacity which other animals do not have. Others can also become conscious objects and their actions can be understood in relation to one's own actions. This is possible because explicit meaning as represented by *symbols* such as language, can be shared among those for whom the symbols have the same meaning. Thus, we are able to coordinate activities socially on the basis of shared meanings and common definitions of objects and acts. This capacity for symbolic interaction is instrumental to the formation and maintenance of *society*. The use of symbols and shared meanings by the individual in guiding action is what Mead calls *mind* and *thinking*. The mind, then, is not a spirit or substance separate from the material world such as in Cartesian dualism. The mind is instead a functional relationship of the organism and its surroundings, the manifestation in the brain of the organism of the social process of symbolic interaction.

**Symbolic interaction:**

The discussion above has concentrated upon the biological or physiological elements of human action, which interactionists recognize as the foundation of behavior. I will continue to focus upon physiological aspects of human conduct as we briefly discuss symbolic interactionism and its related processes described above. Mead, and Herbert Blumer especially, recognize that only through acknowledgement of the many social factors in the human conduct could a theory of human action and group life be adequate. It is in their treatment of the social processes of human conduct and group life where the perspective of symbolic interactionism is most unique and insightful. Mead and Blumer considered the use of symbolic interaction, and the use of language especially, to be of primary importance in understanding the nature of human action. According to Blumer, people can act on the basis of meanings which arise from social interaction one has with others and oneself (Blumer, 1969: 3). Only through living in a social environment can one gain language, and with language the enhanced capacities of experiencing and adjusting to the world, through the mind, self, and society. As a sociological perspective, then, the concepts of symbolic interactionism deal with people acting in and adjusting to a social world—a world where people converse with others and coordinate their actions socially. Herbert Blumer and other interactionists have used these concepts to analyze many important sociological aspects of the social world, such as social organizations, socialization, social problems, and other topics. Since the focus of this paper is to compare interactionist and neurophysiological aspects of human action, I will introduce the social factors of human conduct emphasizing the physiological processes which Mead recognized as important in mediating symbolic interaction.

**Gestures and significant symbols:**

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\(^1\) Though the responses are released in this sense, they are not organized and carried out in a deterministic fashion. The action which the animal starts may be blocked or modified at any point, and thus even implicit meaning is developed ongoingly.
The capacity for symbolic interaction among humans has its roots in the less complex communication of animals. Mead compared animal and human communication to trace these roots (Mead, 1934). According to Mead, the primary forms of communication among higher animals is the gesture. The gesture is an overt behavior which is directed toward other animals. Examples of communication through gestures include various calls, and species-characteristic movements of body parts or displays such as plumage, or sometimes chemical signals such as odors. An animal's gesture functions as communication by signaling to other animals some future activity or event. For example, the bird may call signaling others of danger, or the dog growls signaling its intention of future aggressive activity. "The term 'gesture' may be identified with these beginnings of social acts which are stimuli for the response of other forms" (Mead, 1934: 43). Both the gestures and their responses can be innate or learned, or a mixture of both. In either case, they serve to alert other animals of future conditions.

In relation to the act, then, the gesture is an overt manipulation which conveys to other animals information about the whole act (Mead, 1934: 43). Other animals select gestures as stimuli, and as impulse for redirecting their actions; thus the gesture communicates a "truncated" act to other animals. For example, the dog's growl is a sign of the whole aggressive act (Baldwin, 1986: 73). The importance of an animal's gesture in communication, then, is that it allows other animals to adjust to the prediction of future action before the actual event occurs. Rather than attacking immediately, the dog can signal its anger to the other dog who might then back off; thus a potentially damaging conflict is avoided. Gestures may also signal danger, such as the approach of predators, before their attack occurs. The use of gestures, then, is adaptive for the survival of social animals.

Animals communicate by adjusting directly to the implicit meanings of the gestures of other animals through an exchange of conditioned behaviors. Mead calls the exchange of gestures among animals a "conversation of gestures" (Mead, 1934: 43). Mead uses the example of a dog fight. "The act of each dog becomes the stimulus to the other dog for his response. There is then a relationship between these two; and as the act is responded to by the other dog, it, in turn, undergoes change" (1934: 42-43). The growl of one dog evokes a growl in the other, to which the first dog adjusts with another growl or behavior. Since other animals interpret a gesture by relating it to a behavior that is carried out directly, the gesture has implicit meaning to those observing it. The meaning is implicit since it calls out a direct response. The animal interprets the gesture it selects as a signal for some later stage of the act that allows an animal to organize a response in the present.  

Since the implicit meaning is sufficient for organizing a response to a gesture, an animal need not be aware of the meaning of the gesture in order to adjust to its predictive information. The meaning of the action need not be indicated, or pointed out to oneself, for some form of responses to take place. "We do not assume that the dog says to himself, 'If the animal comes from this direction he is going to spring at my throat and I will turn in such a way" (Mead, 1934: 43). Instead, the animals adjust directly to the implicit meanings of each other's approaches. One dog's gesture as a stimulus is interpreted only insofar as it signals the organization of a corresponding action. "The mechanism of meaning is thus present in the social act before the emergence of consciousness or awareness of meaning occurs" (Mead, 1934: 77). Human beings often respond to gestures without explicitly indicating them. A person may smile at another and that person may "automatically" smile back.

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1 Though animals respond to gestures directly, Mead does not describe the conversation of gestures as a mechanistic exchange of stimuli and responses. As mentioned above, even action based on implicit meaning is still an interpretive and indeterminate process by which the organism selects and interprets the stimuli on the basis of its orientation to the impulse. There is always a degree of flexibility and indeterminacy in the type of response an animal may make to a gesture or to any other stimuli.
It is, however, through the self-reflexive process of indication that human beings do become aware of the implicit meaning of gestures, such that the meanings become explicit. This occurs when the gesture calls out the same meaning to both the sender and the receiver. The gesture not only calls out a future line of response, but isolates the line of action as an experience, such that we can experience the meaning of the gesture and use it as a standpoint for controlling actions. In such cases the gesture is significant, and when significant gestures are represented by symbols such as words, people interact with significant symbols.

According to Mead, the ability to interact with significant gestures or symbols evolved from the use of the vocal gesture. With the vocal gesture such as a spoken word, the speaker hears essentially the same sound as the listener. This distinguishes it from other gestures such as facial expressions, where the person seldom can see his or her own gestures. "The importance, then, of the vocal gesture is that the person can hear what he says and in hearing what he says its tending to respond as the other person responded" (Mead, 1934: 69-70). In other words, the vocal gesture can represent the same meaning to both the speaker and the listener. For example, if two people are in a room reading and the phone rings one may say to the other "get that, will you?" Both individuals understand English, so when the phone rings the speaker assumes the other understands the action he is requesting. Both the speaker and listener identify the same future act, and understand who is being asked to perform the act. Thus, the person it able to communicate his intentions to the other by exchanging vocal gestures.

"It is in this which gives such peculiar importance to the vocal gesture: it is one of those social stimuli which affect the form that makes it in the same fashion that it affects the form when made by another. That is, we can hear ourselves talking, and the import of what we say is the same to ourselves that it is to others" [Mead, 1934: 62].

If a gesture has a same, or a functionally similar meaning to both those receiving the gesture and those using it, then that gesture is significant. When the gesture is a symbol, such as a spoken or written word, then interaction is taking place using significant symbols. "Gestures become significant symbols when they implicitly arouse in an individual making them the same responses which they explicitly arouse, or are suppose to arouse, in other individuals, the individuals to whom they are addressed ..." (Mead, 1934: 47). Though in Mead's terms the "same" meanings are communicated, he implies that meanings people interpret are functionally similar rather than numerically identical. The word "ouch," for example, does not arouse the same response in all persons who hear it. When one person tells the other to get the phone, they share a similar idea of the future act of getting the phone. Words do not transfer fixed meanings from one person to another; rather, symbols, like any other stimuli or emergent events, are selected and interpreted, and therefore their meaning is formulated in use through an indeterminate process. Though both understand the meanings of the symbols used, the speaker interprets his relation to the situation differently than the other. When people do not share the meaning of symbols, such as when one asks directions of someone who doesn't speak English, those symbols are not significant; however, they are both involved in a significant situation in that both know they are misunderstanding each other. Thus, people can share the meanings of words, acts, objects, and situations.

Symbols have the same meaning for the speaker and listener by being perceived in ways which call out a similar future relationship concerning the objects, actions, or situations indicated. Through perception of the symbol, both experience that future relationship as explicit meaning, rather than the implicit meaning characteristic to conversations of gestures. In non-symbolic interaction, an animal sees the gesture of the other which has implicit meaning for future action, but the animal making the gesture does not perceive its own gesture in the same way. With symbolic interaction, the gesture made
toward another is also made to oneself. Thus as the other perceives the gesture in terms of a future activity, the individual making the gesture will have perceived a similar future relationship, the one intended to be communicated. Indication, then, is an internalization of the processes of making significant gestures to others. One's own gestures are significant to oneself as well as to others if the meanings of the symbols are shared; thus in symbolic interaction, one is making explicitly meaningful gestures to oneself. "That is fundamental for any language; if it is going to be language one has to understand what what he is saying, has to affect himself as he affects others" (Mead, 1934: 75). In the context of the act, symbolic interaction involves a self-reflexive feedback between the phases of manipulation and perception. Symbols and gestures made by individuals are forms of manipulation which are simultaneously perceived by oneself. Therefore, one indicates the resultant action of the act to oneself as well as others.

Indication of the explicit meanings of symbols or objects mediates perception and overt action. "With us the individual does not carry out the act, he only indicates it to himself and others. It is, then, this mechanism of indication, showing the final result of the act in the present activity, that gives importance to language and communication. We emphasize this meaning of the symbol, the later part of the act insofar as it determines the present situation" (Mead, 1927: 160). The indication of the future line of activity can be used as a new standpoint for organizing actions in the present. If one moves to open a door and someone tells the person it is locked, the words are interpreted in terms of the explicit meaning of what will happen if the person tries the door; thus, that person can reorganize his or her actions before carrying out the act. In this way, one can gain further control of actions by use of the explicit meanings of things represented by significant symbols. Since symbols can be shared, people can fit together and organize actions socially, rather than through individual trial and error.

Mind:

People interact symbolically with themselves as well as others. Symbolic interaction allows people to understand each other, communicate, share ideas, and coordinate actions on the basis of the explicit meaning of objects. Symbolic interaction also allows the individual to organize his or her actions through the inner conversation an individual carries on with himself or herself. People talk to themselves through the same social process by which they talk to others, and Mead called this "inner forum" that which constitutes the field of activity called mind (Baldwin, 1986: 81). Mind, like the process of indication, is an internalized form of symbolic interaction. "The internalization in our experience of the external conversations of gestures which we carry on with other individuals in the social process is the essence of thinking . . ." (Mead, 1934: 47) Mind and thinking exist only where there is exchange of significant symbols. "Only in terms of gestures as significant symbols is the existence of mind or intelligence possible; for only in terms of gestures which are significant symbols can thinking—which is simply an internalized or implicit conversation of the individual with himself by means of such gestures—take place" (Mead, 1934: 47). A social world of symbolic interaction therefore precedes the existence of any individual mind.

Mead's concept of mind rejects in several ways the dualistic separation between mind and body. First, it claims that the mind emerges as a functional process of symbolic interaction with ourselves and others which we experience in addition to our perceptual experience and physiological activity. The functional relationship resolves the gap between an "objective" material world and a "subjective" world of conscious experience. Second, the individual mind is not isolated from the minds of others in that people think using the same significant symbols as others, thus ideas can be shared.

Objects:

Indication of the explicit meanings of things through symbolic interaction with oneself and others gives the experience of objects a 'new content' which goes beyond the
implication of contact experience in the distant object. By perceiving a language symbol, the individual organizes an object which can substitute for other forms of experience. "In auditory experience we make use of speech in place of contact experience. We may have experience of the dog from the mere word 'dog.' If someone denies that we are having this experience, saying that our definition is wrong, we appeal to a dictionary, still having no contact experience with the dog. Here is the difference between the word and image" (1927: 125). The word can substitute for the distance imagery and contact experience with the dog. "Speech stands for the content of the act itself; we can tell ourselves and others what a spade is. This content mediates what we ourselves feel in a spade, it describes the perceptual object, so that language is a medium for communication. It makes the content explicit so that we can tell others what the object is." By sharing the explicit meanings of objects with others, people can coordinate their activities according to shared definitions of the objects.

With symbolic interaction a wider variety of objects may be identified and acted upon, giving the human being a world of experience vastly more complex than that of other animals. Herbert Blumer, for example, defined explicitly meaningful objects as "anything that can be indicated, anything that is pointed to or referred to." He distinguishes three categories of objects: "(a) physical objects, such as chairs, trees, or bicycles; (b) social objects, such as students, priests, a president, a mother, or a friend; and (c) abstract objects, such as moral principles, philosophical doctrines, or ideas such as justice, exploitation, or compassion" (Blumer, 1969: 10-11). Thus, office workers can organize their activities around an abstract object such as a publishing deadline, whereas animals are limited to acting upon concrete things or physical events. Objects for human beings then may extend beyond immediate space and time, and may be both fictional and real.

Social coordination of actions. Role-taking, self, and joint action:

Just as people organize actions around the shared definitions of objects, individuals also act towards others and themselves as objects. Indicating the self and others as meaningful objects is part of the process of coordinating actions socially. There are three aspects of the social coordination of action: taking the role of others, taking the role of oneself, and the joint actions identified in interaction.

An essential part of the process of coordinating one's actions with others involves predicting what another will do in a social situation. One predicts and adjusts his or her own line of action largely on the basis of both what another is observed to do, and what one predicts another will do. In order to predict the actions of others, one must, in effect, put oneself in the imaginary standpoint of another. This process Mead calls "taking the role of the other" or role-taking (Mead, 1934: 73,109, 138,153). A person anticipates another's behavior by drawing upon the words, gestures, and mannerisms that he or she understands from past experience with the other. During interaction, the person evokes in himself or herself the imagined responses that approximate those of the other. These imagined responses of the other can be used to anticipate what the other will do, and how the individual should act in return. In the example above, the phone rang, and the man may have started to ask his friend to get the phone, but stopped when remembered that she hates to answer phones. In this case, he organized his activities by taking the role of his friend. People also take the role of others to understand another's past actions. The man, for instance, might later ask himself: "why doesn't she like to answer the phone?"

Role-taking is involved in coordinating activity with those we know from past experience, but also with those whom we don't know. People in most situations act in more or less predictable ways, and individuals and people organize their own actions by predicting some aspect of the actions of others. We know, for example, that store clerks, police officers, teachers, or pedestrians tend to act in predictable ways in the situations in which we encounter them. People can coordinate actions by anticipating actions characteristic of the roles people people play in their everyday activities. People organizing their own actions rely heavily upon the roles they expect others to take. Subsequently,
people tend to act in ways appropriate to the meanings of roles they have come to share simply because doing so allows a less problematic interpretation of one's social world. Although people may act in predictable ways, the roles they play do not determine their actions. People often act unpredictably, and seldom act exactly as one predicts. Also, the specific roles are not always pre-defined for social situations. In every situation, the roles of others and oneself are interpreted anew, and the success in one's role-taking in anticipating the actions of others is confirmed in actual interaction; therefore, roles and role-taking, just as all phases of action, emerge from the formative and indeterminate process of interaction, both in organizing our own actions and assessing those of others.

According to Mead, role-taking occurs in various degrees of complexity (Mead, 1934: 61). The character actor strives for the highest degree of role-taking; however, role-taking is also a basic component of any symbolic interaction. Mead described role-taking as instrumental to all types of interpersonal behavior. We take the roles of others habitually in communicating with oneself and others. Role-taking is implicit in Mead's definition of the significant symbol in which the symbol evokes similar responses or explicit meanings in both the speaker and listener. Role-taking is also involved in the internalized conversation of the mind. "We are, especially through the use of the vocal gestures, continually arousing in ourselves those responses which we call out in other persons, so that we are taking the attitudes of the other person in our own conduct" (Mead, 1934: 69). Role-taking, according to Mead, is a process essential for thinking. "Where the response of the other person is called out and becomes a stimulus to control his action, then he has the meaning of the other person's act in his own experience. That is the general mechanism of what we term 'thought,' for in order that thought may exist there must be symbols, vocal gestures generally, which arouse in the individual himself the response which he is calling out in the other, and such that from the point of view of that response he is able to direct his later conduct" (1934: 73). Role-taking, then, is crucial to our own ability to think and also to understand others' actions and communication. For example, when someone observes communication in which he or she is not participating, such as in watching a television show, one takes the role of those involved in order to understand what the actors are doing.

Self

Individuals also take the roles of themselves in coordinating actions with others, a process by which the self becomes an object. Coordinating actions with others requires that the individual assess not only the other's general intent in a situation, but also the other's responses toward himself, and the person's own responses and feelings toward the recipient or observer of his action. Just as one's conception of the roles of others are useful in guiding actions, an individual takes the role of the self in organizing actions, both in choosing and inhibiting responses. People present different "selves" for different situations. We are sometimes the "customer," sometimes the "employee," the "son," "daughter," "student," or "stranger." The roles or selves we take on, in most circumstances, are those which we are trying to make fit the roles of others in the situation at hand.

The self as an object emerges through the process of indication. When objects are indicated there is self-reference, the objects are pointed out explicitly to oneself as experience. This is especially the case when one indicates himself or herself directly. When individuals indicate their own actions in the future or past, they are taking the role of a future or past self. For example, the anticipation of getting ice cream involves an implication of a future self with ice cream. Similarly, one reconstructs one's own past actions by making the past self an object. The self, then, arises out of the "inner forum" one caries on in thinking.

The social self, however, is only a functional part of one's total experience. A person has conversation with oneself and others, but one also has personal experiences, emotions, and sensations from one's unique standpoint which cannot be shared. An
individual may describe what another may see, but does not actually see through his or her eyes. Thus the self has a dual nature. Though the self is created as a conscious object through the reflexive process of indication, one maintains the fullness of one's own experience. The self is the object which is indicated by the social process, named in various ways in different situations and referred to in relation to objects and others. There is also the aspect of self which is doing the indicating, carrying out actions and experiencing a world of sensations. There is, then, the self as process as well as the self as the object indicated. Both operate simultaneously and are interdependent. Biological processes are essential to the processes of the social self, but the social self can regulate lower processes such as the impulse. For example, one may pinch one's finger in a crowded auditorium but repress the impulse to cry out. Symbolic interaction, then, provides a new degree of flexibility and control for guiding actions and coordinating activities with those of others.

The capacity to organize activities by indicating the self and others as objects develops in early childhood as infants first learn to use significant symbols. The child first interacts with objects on the basis of how others, especially his or her parents, have interacted with and referred to them. Thus the child first takes the role of its parents in designating things. The child also learns to indicate himself or herself in relation to the variety of gestures and activities which parents make in referring to the child; for example, the mother asks "where is baby's nose?" In answering, the baby is indicating himself or herself as an object. The remarks that the baby can remember and repeat gradually increase in complexity from simple words to sentences, to entire conversations which can be rehearsed in imagination (Lindesmith, Strauss, and Denzin, 1975).

As the child gains more experience and encounters a wider variety of others, it becomes no longer necessary to refer to specific others to organize his or her conduct. The child may take the role of a specific other in his or her inner conversation, such as the child's mothers voice saying "don't cross the street;" or may take the role of a more generalized other, such as "the teachers." Subsequently, the child learns to present different selves in different situations, becoming a son, friend, student, and so forth. The social self and the others to which individuals refer become increasingly complex. Adults in their inner conversations can interact with oneself, specific people, imaginary people or "generalized others" which is an abstracted composite of our interactions with others. A politician may ask herself what the voters think, and the "voice" she hears answering is the generalized other (Baldwin, 1986: 82). Social selves also become more complex as a reference of action and thought, and the self changes over time as the experiences one draws upon change.

Coordinating activities socially involves taking the role of others and oneself. There is, however, a third element to the social coordination that Herbert Blumer calls "joint action." People interacting in social situations tend to share a mutual understanding or definitions of the situation; for example, both the customer and the cashier in a store designate their situations and activities as those appropriate for business transactions. They organize their activities partly on the basis of past experiences of handling business transactions. These people would interact differently at a cocktail party. According to Blumer, people engaged in such mutual adjustment and designation of roles, selves, and situations are engaged in joint action.

1Mead distinguishes these dual aspects of the self as the "I" and the "me" (c.f. Baldwin, 1986: 115-122).

2 Several authors have described in detail the symbolic interactionist concepts of socialization and child development. Mead also wrote extensively about child development (c.f. Baldwin, 1986: 89-107, and Lindesmith, Strauss, and Denzin, 1976). The discussion here barely skims the surface of the interactionist descriptions of the development of the self and the social individual.
"As stated earlier, human group life consists of, and exists in, the fitting of lines of action to each other by the members of the group. Such articulation of the lines of action gives rise to and constitutes "joint action"—a societal organization of conduct of different acts of diverse participants. A joint action, while made up of diverse component acts that enter into its formation, is different from any one of them and from their mere aggregation. The joint action has a distinctive character in its own right, a character that lies in the articulation or linkage as apart from what may be articulated or linked. Thus, the joint action may be identified as such and may be spoken of and handled without having to break it down into the separate acts that comprise it. This is what we do when we speak of such things as marriage, a trading transaction, war, a parliamentary discussion, or a church service. Similarly, we can speak of the collectivity that engages in joint action without having to identify the individual members of that collectivity, as we do in speaking of a family, a business corporation, a church, a university, or a nation. It is evident that the domain of the social scientist is constituted precisely by the study of joint action and of the collectivities that engage in joint action" [Blumer, 1969: 17].

When we speak of the interaction between customer and cashier, we do not need to describe their every word and action, but can refer to the episode in terms of "customer relations" or "making a purchase" and so forth. Blumer implies, however, that joint action is more than a convenient means by which we can abstract descriptions of the complex acts of human groups. Joint action is itself an essential characteristic of how the reality of human group life is organized.

Common definitions of objects, self, and others are shared by participants as they interpret and make sense of joint actions. Social life, however, is not an expression of pre-established joint actions. Joint actions are always undergoing a process of formation. Even the most ritualized activities are formed anew in the sense that individuals are still constructing lines of action and fitting them to the actions of others (Blumer, 1969: 18).

Since one can never predict exactly what another will do in a situation, there is an inherent degree of uncertainty in joint action. In other words, collective behavior is emergent. Situations, then, are not streams of "organized" actions, such as a ritual, or "norms" of appropriate conduct, or "roles" that reflect the norms. The joint act is primarily an "organizing" process emerging from the ongoing process of the participants' devising lines of action in light of what they indicate.

Blumer's concept of joint action ties the "macro" world or "large-scale" social phenomena to the "micro" world of individuals interacting symbolically. Sociologists who study sociocultural systems such as complex organizations and institutions study, in part, the joint actions individuals create, modify, and maintain through interaction. The process of joint action outlines how social levels of organization transcend the action of individuals of which society is comprised.

To speak of society or collective behavior as a transcendent level of organization does not imply that human group life is a mere aggregation of the psychological makeups of the individuals. Symbolic interaction occurs among biological human beings. The psychological and physiological processes of the individual become social by the very fact that people indicate things in the world, rather than respond to them. The process of indication and of symbolic interaction with objects, others, and oneself involves transcending an individual organism's direct reaction to a physical environment. Meaning, as it is entailed in this process of interpretation, is at its roots social. Human action, then, is built up from a biological process by which the entire organism adjusts to emerging situations, but also encompasses the social process of indication shaped by social interaction. Thus, human action is primarily a social process. Society, likewise, must be understood and described in the terms of the joint actions of individuals. Society emerges from the fitting together of peoples lines of activity on the basis of the meanings that are
created in interaction and shared through the process of symbolic interaction. In short, society is symbolic interaction.

**Summary:**

To summarize Mead's concepts of action and symbolic interaction presented in this chapter, I will return to Herbert Blumer's three premises of symbolic interaction.

"Symbolic interactionism rests in the last analysis on three simple premises."

Premise 1: "Human Beings act towards things on the basis of the meanings that the things have for them" (Blumer, 1969: 2).

People do not act on the basis of stimuli alone; rather, stimuli, or any changing event or condition, are actively selected and interpreted by the individual. The individual builds up a world of meaningful objects through an interpretive process in which past experiences are used to interpret present conditions to project a future line of activity in relation to those objects. The interpretation of some future relation one will have with an object gives the meaning of that object. All animals act on the implicit meaning of objects when the future action called out by interpretation of stimuli is carried out directly. Human beings, however, can also act on the explicit meaning of objects in which the future relation given to the object is indicated to the self. In such cases where explicit meaning is used in the interpretation process, Blumer's second premise applies.

Premise 2: "The meaning of such things is derived from, or arises out of, the social interaction one has with one's fellows [and with oneself]" (Blumer, 1969: 2).

The explicit meanings of objects derive from the use of significant gestures or symbols which indicate the same future relationship of objects to oneself as others. Through the use of significant symbols, the explicit meanings by which people interpret objects can be shared with others. Through this process of symbolic interaction, individuals can act toward a thing in the way others act toward the person with regard to a thing (Blumer, 1969: 4). This is the process of role-taking, in which people are able to indicate to themselves their own actions from the imagined viewpoints of others, either specific or generalized others. In this way, people learn the meanings of things which arise in social interaction with others. A person can also take the role of himself or herself and, therefore, interact symbolically with himself or herself. From the indication of explicit meanings to oneself arise conscious objects in experience, including physical, social, and abstract objects (Blumer, 1969: 10-11). Others and oneself also emerge as meaningful objects. From the processes of indication and symbolic interaction with oneself emerge what Mead calls the mind. Taking the role of oneself and others through symbolic interaction allows the social coordination of joint actions, a process by which organizations of human group life is possible and through which human society persists.

Symbolic interaction, however, is a characteristic elaboration of the general process of interpretation by which all living things exist.

Premise 3: "These meanings are handled in, and modified through, an interpretive process used by the person dealing with the things he encounters" (Blumer, 1969: 2).

The use of the meanings of things as a basis of action is not merely the application of responses conditioned by social interaction. According to Blumer, "[w]hile the meaning of things is formed in the context of social interaction and is derived by the person from that interaction, it is a mistake to think that the use of meaning by a person is but an application of the meaning so derived" (Blumer, 1969: 5). The meanings of objects are constructed and used in the course of interpreting emergent situations. Meanings of even the most familiar things are, in this sense, created anew in the course of action. Meanings of things arise in the course of the interpretive process in which future relationships of things are indicated to oneself.
Symbolic interaction, then, is part of a larger interpretive process by which the human being handles emergent reality, the process of adjustment. Human beings have the capacity of adjustment through social processes in addition to the processes of adjustment we share with other animals, such as eating, sleeping, walking, and maintaining posture. In addition to our biological world human beings live in a social world which gives more flexibility, variability and control in coordinating our own actions.

The process of adjustment which embraces the whole process of adjusting to emergent reality is encompassed by Mead's concept of the act. The impulse arises to handle or confirm emergent stimuli. Perception is the process in which information selected builds up an environment of meaningful objects which integrates the sensory experience of things with their use in future action. With manipulation, actions are carried out and actively modified as contact experience confirms the hypothetical nature of the distance experience of objects. Manipulation is the means to the end of consummating the act. In order for the organism to maintain itself, the adjustment process, and therefore activity, are continuous as the organism meets, interprets, and acts upon a continuous stream of situations.

The perspective of symbolic interaction proposed by Blumer and Mead was developed from the intellectual foundations of others, observations of behavior, and careful introspective reasoning on their own part. Ultimately, however, Mead and Blumer strove for a theory of human conduct which was consistent with the empirical world. Blumer states: "It is my conviction that an empirical science necessarily has to respect the nature of the empirical world that is its object of study. In my judgement symbolic interactionism shows that respect for the nature of human group life and conduct" (Blumer, 1969: vii)

Symbolic interactionism describes processes which go beyond the individual in the sense that only the social world makes human action as such possible. Interactionists do not claim, however, that the social dimensions of human action should be, or can be, isolated from the biological essence of human group life, either in theory or in empirical study. On the contrary, symbolic interactionists, and Mead especially (c.f. Baldwin 1986: 50-68), assumed they were describing processes involving the central nervous system, though not in exclusion from its social use by the whole organism. Mead and Blumer would agree therefore, that a model of action which respects the nature of human group life deserves exploration of the physiological aspects which are necessary, though not sufficient, for a more unified analysis of human conduct. The next chapter will present a tour of the central nervous system, the structure and functions of the brain and its evolutionary development. The goal of the chapter is not to provide grounds for reducing symbolic interaction to neurophysiological mechanisms; rather, I will explore the possibility that both neuropsychology and symbolic interactionism describe the same empirical world, and that there may be many features of the two perspectives which overlap.
Chapter 2: The Central Nervous System: Physiology and Evolutionary Origins

In this chapter, I will approach the analysis of action from the point of view of neurophysiology. This chapter will present a synopsis of the physiology of the central nervous system (CNS), its major structures and functions, as well as an overview of the evolutionary origins of the human brain. Though this seems to take a major leap away from the social psychological analysis of action, the physiological approach is not alien to the thinking of George Herbert Mead. In developing the theories described in the previous chapter, Mead drew heavily from his background in physiological psychology which he studied during graduate work in Germany (Baldwin, 1986: 30). The theory of evolution was also a constant influence on his work. Before examining neurophysiology in depth, then, it would be worthwhile to explore briefly why these approaches were important to Mead's perspective of human action.

Baldwin (1986) describes two main themes in Mead's writing on physiology, both advocating the use of neurophysiological data, but warning against its overuse (Baldwin, 1986: 60). Mead used physiological data whenever possible to explain elements of the mechanisms of thought, perception, meaning (as a tendency based in part on past experiences), emotion and action. Mead, then, advocated the neurophysiological approach in general. For example, he was interested in the brain's role in human decision making and purposive action. "Human intelligence, by means of the physiological mechanisms of the human central nervous system, deliberately selects one from among the several alternative responses which are possible in the given problematic environmental situation." (Mead, 1934: 98). The second theme in his neurophysiological approach, however, was to acknowledge the limits of neurophysiological data to explain behavior. He was especially critical of those who used only physiological mechanisms to explain language and symbolic thought in behavior (Baldwin, 1986: 61). Instead, Mead considered the central nervous system to be a necessary component of symbolic thought, but not sufficient in itself without including the role of social interaction in its development. The potential for consciousness, reflexive intelligence, and internal conversation, which take place in the CNS, is developed only through social experience. "The process [of symbolic interaction] does appear in a certain sense in the central nervous system, as we take the role of others; still, the unity or pattern does not belong to the organism but to the group" (Mead, 1927: 173). Mead did not consider the neurophysiological approach and symbolic interactionist approach as contradictory; in fact, he advocated the study of action from these approaches, and believed both would complement one another to form a more unified account of human action (Baldwin, 1986: 64). "The two are necessary in an adequate statement of behavior" (Mead, 1927: 175). Both could be integrated in a nondualistic model of social and physiological processes.

Mead also advocated an evolutionary approach to the study of human conduct. He assumed humans and human group life to be products of evolution, and therefore understanding human nature lay in the scientific study of the evolutionary process as a unifying paradigm (Baldwin, 1986: 51). As examples for many of his concepts, Mead
often used animal behavior from various phylogenetic levels, from insects to apes. His analysis of the conversation of gestures was an example of the origin of symbolic interaction with human beings. He also considered the evolution of the CNS in providing the capacity for more flexible and adaptive adjustment to situations. Behavior as mediated by the CNS evolved from rigid stimulus and response behaviors to increasingly more complexity in the connectivity between motor input and sensory output. Added complexity allowed animals to organize a wider variety of behavioral sequences and also added ability to delay response for choosing among alternative lines of activity (Baldwin, 1986: 61). For Mead, the human being and other animals were not the passive products of evolutionary forces, but co-evolved, actively reorganizing their environments. "The organism in a real sense is determinant of its environment" (Mead, 1934: 215). The human brain is used socially, and therefore evolved in a way consistent with its social use. Thus a study of both the human brain and social behavior may reveal a complementary understanding of this co-evolution. With Mead's appreciation of both the physiology and the evolution of the central nervous system and its importance in human conduct and symbolic interaction, a comparison of the interactionist and neurophysiological perspectives of action is consistent with Mead's own approach.

In the 1920's, the neurosciences were in their relative infancy, and knowledge of the structure and function of the central nervous system was limited. Mead was obviously hampered in his ability to use detailed descriptions of the role of the CNS in action. In the late 1980's, our understanding of the structure and function of the CNS has increased exponentially, though there are still far more unknowns than answers. In fact, modern neurophysiology, despite mountains of data, is not much further along in understanding the "why's" and "how's" of the CNS's role in action than was Mead. Thus we can follow Mead's lead in using the CNS in the study of human social action, and update his contributions with some recent findings. We can also update his evolutionary approach by describing theories of how the brain evolved according to its use in action. In making these comparisons, we have found remarkable consistency in the way Mead conceives of the relation of the CNS to action, and in how the brain has evolved in this respect. We will present these similarities in chapters three and four, after first presenting a synopsis of the structural and functional organization of the brain, and the latest theories of how the brain evolved.

Organization of brain

Before we can consider these relationships, it is necessary to give a brief tour of the organization of the brain, its major structures and functions. This, of course, will be a very simplified tour of the central nervous system but it should familiarize the reader with the generally accepted functional areas and systems which underlie some of the processes which Mead and other interactionists have dealt with in their concepts. The first part of the tour lists the names and major functions of CNS regions and shows their location in several diagrams. Isolated structures are then integrated with discussions of their connectivity and function, using an evolutionary approach. I will begin with the basic units and structures of the CNS starting from the spinal cord, and work "up" to the neocortex, where most of the later discussion will focus.

The brain is composed primarily of neurons and a variety of supporting cells such as glia which hold neurons in place and provide other important functions, such as removing dead cells. Neurons process and transmit information, and are distinguished from other cells of the body by their ability to communicate with surrounding neurons by transmitting electro-chemical "messages." There are several types of neurons of different shapes and sizes. The typical neuron is comprised of four structures, the cell body, or soma, axons, dendrites, and terminal buttons. The soma contains the nucleus and provides for the maintenance of the cell's life processes. The neuron sends messages down an axon. The axon ends at the terminal button which transmits messages to receiving cells. The terminal button releases transmitter substances, which affect the receiving cell's ability
to "fire" or send a message. A transmitter substance may excite a cell, or induce it to fire, or it may also inhibit the firing of the receiving neurons, depending on the type of chemical. When transmitter substances are released at the terminal button, they travel across a synapse or gap between neuronal membranes. The dendrites branching out from the cell body receive messages from the terminal buttons of axons. Terminal buttons may also synapse directly on the soma membrane (Kolb and Whishaw, 1985: 32).

The cumulative effects of the transmitter substances from terminal buttons reaching the dendrites and soma help determine whether a neuron will fire a message down its axons to the neurons with which it communicates, though the condition of the neuron itself is also a factor in whether it will fire. Thus the communication among neurons is not a simple system of serial chains which trigger one another in direct causal fashion; rather, neurons fire by some form of consensus of the right internal and external conditions. Thus interacting processes of the brain, even in basic units, are already quite complex (Kolb and Whishaw, 1985: 47).

Despite this complexity, there are characteristic structures, connections among cells, and functional systems composed of groups of cells. Neural structures can be distinguished by their location and often by differences in composition. These structures are interconnected by neuronal structures such as fiber bundles which are comprised of axons and protective coatings of glial cells. The major structures of the brain are classified by three major divisions, the hindbrain, midbrain, and forebrain. The midbrain is located at the top of the spinal cord. These structures together with the midbrain form the brain stem. The forebrain in humans comprises most of the brain tissue, including the cerebral cortex. The subdivisions of these three divisions and their principal structures will be presented in this order.

Before touring the brain, however, it would be useful to learn navigational terms common to neuroanatomy. Figure 3 shows common anatomical directions. The dorsal surface is the top of the head and back. The chin and the front of the body are ventral surfaces. Dorsal and ventral surfaces are also described by the terms superior, above and inferior below. A rostral or anterior direction is toward the chin, or the front of the brain, and a caudal or anterior direction is toward the back of the head. A medial direction is toward the midline, and lateral is toward the side (Carlson, 1985: 87).

**Hindbrain**

**Myelencephalon**

Structures of the myelencephalon perform rudimentary but essential functions. The structures of the myelencephalon sit at the top or most rostral end of the spinal cord, and are the most caudal structures of the brain. The primary structure in this subdivision is the medulla (Figure 1). Autonomic functions, such as breathing, regulation of heart rate, muscle tone, and gastro/intestinal processes take place in these structures. Some relay nuclei are found here, such as those conveying somatosensory information from the spinal cord to higher levels in the brain. Nuclei are groups of neurons which are distinguishable by their cell structures, and often by their characteristic connections and functions.

**Metencephalon**

Nuclei at this level are involved in respiration, blood pressure, and also some motor activity such as elements of facial expression. Two major structures in this area include the cerebellum and the pons (Figure 1). The cerebellum is important for the coordination of movements and sensory information. Integrating information from several sensory areas, the cerebellum smooths motor output such as standing, and walking. Rehearsed movements, such as playing an instrument or swinging a golf club, seem to be stored in this area as a form of "motor programming." The cerebellum is connected by a bundle of white matter to the pons, bulging from the brain stem. The pons contains nuclei important for sleep, attention, and motor behavior.

**Midbrain**
Mesencephalon

Completing the rostral tip of the brain stem is the *mesencephalon*, which includes the *tectum* and *tegmentum* (Figure 1). The tectum is involved in orientation toward stimuli in three-dimensional space. This structure adjusts automatically to auditory and visual stimuli, and locates the direction of the stimuli. The tegmentum contains nuclei important for motor systems. Dopamine, a neurotransmitter important for many functions in the rest of the brain, is produced in the tegmentum. Pain perception and certain species-specific defense behaviors have been linked to the *periaqueductal grey matter*.

Forebrain

Diencephalon

The *diencephalon* contains many more structures than the midbrain and hindbrain, and little is known about several of these structures. Two major structures, the thalamus and hypothalamus, will be mentioned here (Figure 1). The *thalamus*, dorsal to the brain stem, contains important relay areas for virtually every area of the cerebral cortex. Several nuclei in the thalamus are specific for sensory areas. The optic nerves from the eyes, for example, have their first synapse, or connection to another neuron, in the lateral geniculate nucleus of the thalamus. Nuclei in the thalamus relay axon fibers to the visual areas of the cerebral cortex, and also have important subcortical connections. The thalamus also has connections with the motor areas of the cerebrum and has a role in motor behavior, as well as connections to association cortices and limbic cortices, which will be defined below. The functions of many of the connections in the thalamus are not well understood.

Ventral and rostral to the thalamus is the *hypothalamus*. This structure is involved in such "survival" functions as feeding, drinking, sleeping, reproduction, defensive behaviors, and flight behaviors. The autonomic nervous system and endocrine system are also regulated by the hypothalamus.

Telencephalon

As mentioned above, the structures of the *telencephalon* will receive the most attention in the following chapters because these structures are most heavily involved in higher cognitive processes of the brain, such as consciousness. The telencephalon encompasses *cortical* and *subcortical* structures. Cortical structures include the two cerebral hemispheres, which are subdivided into *neocortex* which covers most of the surface of the hemispheres, and the *limbic cortex* forming the medial-most edge of the cerebral hemispheres. The neocortex is divided into four lobes, the *frontal*, *parietal*, *occipital*, and *temporal* lobes (Figure 2).

Several more navigational terms will be useful here in describing the cerebral hemispheres. The cerebral cortex in human beings is highly convoluted. These convolutions are characterized by sulci, the folds or grooves, and the gyri, the cortex bulging between the folds. Sulci and gyri form characteristic patterns in the brain, and provide useful landmarks for locating different functional areas of the brain. The *central sulcus* in the dorsolateral neocortex, divides the frontal and parietal lobes. Dividing the temporal lobe from the frontal and parietal lobes is the *lateral sulcus*. The *calcarine sulcus* forms a spur in the medial surface of the occipital lobe (Figure 2). A large sulcus separates the two cerebral hemispheres. The hemispheres are connected by the *corpus callosum*, a large bundle of axon fibers beneath the neocortex which connect geographically similar regions of each hemisphere (Figure 1). Specific gyri in the cerebral hemisphere are often given names, such as the angular gyrus, or supramarginal gyrus.

Another system for demarcating specific cortical regions is the *Brodmann numbers* (Figure 2). Brodmann gave numbers to cortical areas of the brain based on their cytoarchitectonic characteristics. This term refers to the microscopic distinctions in the cell structure and patterns of layering of various brain tissues. It was found that these structural areas tended to correspond to functional roles. Brodmann numbers are therefore useful as navigational shorthand for the often complex names given to gyri.
Figure 2. Lateral view of the neocortex with major areas, Brodmann numbers, and common anatomical directions (Pandya and Yeterian, 1985).

Figure 3. Medial surface of the brain with structures of the limbic cortex and Brodmann numbers (Kolb and Whishaw, 1985: 22).
The central sulcus separates two major functional areas in the neocortex, the motor areas rostral to, or in front of, the central sulcus, and the sensory areas located caudal to the central sulcus. Proceeding caudally, the parietal lobe is specialized to process somatosensory information, touch, temperature, pressure, and pain received from neurons throughout the body. Certain physiologically defined areas within each of the sensory cortices receive and process sensory information differently. These areas may be divided into primary cortex and association cortex. Primary cortices receive direct input from the sensory specific and motor specific nuclei in the thalamus. Primary cortices are the “first stop” at the cortical level for sensory input, and thus receive “raw” unelaborated data. The primary somatosensory cortex is located in the postcentral gyrus of the parietal lobe, adjacent to the central sulcus (Figure 2). This area is often designated as SI, or by Brodmann numbers 3, 1, and 2. Cells in this area form mosaics of columns which register either touch, pressure, kinesthesis (movement), pain or temperature. Groups of neurons in this area correspond to very specific sensations. A low-voltage electric shock applied by a wire to a specific area of SI will give the patient the feeling of pressure or heat on a small portion of the arm, for example, or even the sensation of a breeze blowing across the arm (Kolb and Whishaw, 1985: 200).

Adjacent and caudal to primary somatosensory cortices are the somatosensory association cortices of the parietal lobe, labeled SA, (Brodmann areas 5 and 7). Everything which is not primary cortex is traditionally considered association cortex. In association cortices, information is elaborated from sensations in specific parts of the body to a more generalized experience or representation of sensations. All the somatosensory qualities of an object are experienced simultaneously and comprise sensory gestalts, forms, or images which can be identified. People with damage to somatosensory association areas may have sensory agnosia (meaning “to be unknown”) or difficulty in identifying an object by touch alone. Place a key in the hand of such a patient such that he or she cannot see it, and it will be described as hard, or pointed, but not identified as a “key” (Kolb and Whishaw, 1985: 224-225). Thus association cortices seem to be related to memory or the ability to use memory to identify objects. We cannot, however, conclude that association cortices are the “centers” for memory. Memory involves several other areas in the brain; further, it is not known exactly how or where memory is stored. A simplified description of the relationship between primary and association cortices will suffice for now. Primary sensory cortices process sensory data in their “purest” form, much like binary bits of data in computers, which are then elaborated in the association cortices. Various association cortices have other functions beside their role in memory. Area 39 for example, the inferior parietal cortex, is important for reading. Damage to this area has been linked to dyslexia.

Some areas of the association cortex are able to process more than one form of sensory information simultaneously, such as somatosensory and visual information. Moving ventrally to the boarder of the occipital and temporal lobes above the lateral sulcus is the supramarginal gyrus of the parietal lobe (area 40). This is one of the “multimodal” areas of the neocortex. Input from sensory areas of hearing, vision, and touch converge on the neurons in this area. The area is also highly connected with other areas of the brain. Little is known about the exact role of multimodal areas in processing information; however, the existence of such areas suggests that the boundaries between sensory cortices are neither structurally nor functionally distinct.

The occipital lobe is the most caudal lobe of the cerebral cortex. The primary visual cortex, (V1 or area 17) is located at the most anterior extreme (Figure 2). V1 is also called “striate” cortex after the characteristic striped pattern in cross sections of tissue formed by

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1 Again, the thalamus is the first structure to receive input from the sensory organs, and one of the last major stations before motor output reaches the spinal cord.

2 For now, I am using the term "object" in the general sense of everyday usage rather than the definition used by symbolic interactionists presented in the previous chapter.
six layers of cell bodies. Again, it receives sensory data from the thalamus as a raw code. Certain neurons, the "simple cells" in the primary area have basically a one-to-one correspondence with specific neurons in the thalamus, and a corresponding rod or cone in the retina of the eye. Thus, as a photon strikes a cone in the retina, it causes the firing of a single neuron in the primary visual cortex. Other neurons in V1, however, the "complex" and "hypercomplex" cells fire when certain patterns of simple cells fire, such as a series of cells forming a straight line, or a straight line in a particular orientation. Thus objects we see are broken into a simple code of light, dark, and color, and are elaborated by increasingly abstract patterns of firing neurons (Carlson: 193). Elaboration continues in the *circumstriate*, visual association cortex (areas 18 and 19), which surrounds the striate cortex. These areas are involved in binocular depth perception as well as rudimentary perception and memory. Visual information may be elaborated into basic gestalt images in these layers (Kolb and Whishaw, 1985: 194-195).

Other visual association areas are located in the temporal lobe. The *inferotemporal cortex* (areas 21 and 20) in the caudal regions of the temporal lobe, is the location of the most complex processes of visual perception and the association of visual information. Damage to this area can cause visual agnosias similar to sensory agnosias described above. The person can see an object, but fails to identify the object beyond simple dimensions of shape or color (Kolb and Whishaw, 1985: 213-215).

The *primary auditory cortex* (A1 or areas 41 and 42) is located in Heschl's gyrus, part of the *supratemporal plane* (Figure 2). This area is found on the top part of the temporal plane which borders the lateral sulcus. Auditory sensory data from this area flow down into the *auditory association cortices* in the superior temporal lobe, area 22 (AA). These areas function much as other sensory association cortices, involving recognition and memory of non-language sounds. Comprehension of spoken words, however, involves a specialized area in caudal region of area 22, called *Wernicke's area*. This area is crucial for understanding language. Patients with damage to this area may develop *Wernicke's aphasia* in which they are able to speak and write, but what they produce is "word salad," a meaningless jumble of words, though the speech retains the tonality and some of the gestures associated with normal conversation. Patients are unable to understand the spoken or written words of others, or of themselves, therefore they may not even realize that they have a problem communicating. Though Wernicke's area is traditionally described as an area for comprehension, very little is known about its exact function; further, Wernicke's area does not operate autonomously, but is part of a system involving other structures which will be described below. Language itself, however, may involve most of the cerebral cortex in some integrative way.

Other sensory systems in the neocortex include the *olfactory cortices*, which are less developed in humans than the other senses, located in area 28, the ventromedial temporal cortex. *Gustatory cortices* which register taste are located in area 43, the pericentral operculum. Electrical stimulation of this area can elicit in the patient very specific tastes. Some *vestibular systems* which register balance may be located cortically in either the parietal lobe or caudal areas of the temporal lobe. The vestibular system, however, is not well understood at the cortical level.

The *frontal lobe* comprises all the neocortex rostral to the central sulcus and dorsal to the lateral sulcus (Figure 2). The primary function of the frontal lobe is behavior. All the planning and execution of movements occurs here; therefore, our ability to interact

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1 There is more to vision than what is seen at the level of the neocortex. There are in fact three other visual systems which involve mainly the structures in the thalamus, with certain other subcortical areas (Kolb: 194). These systems are important for the localization of visual objects. There are also different neural pathways handling central vision and peripheral vision. Vision, then, is a process combining several systems, rather than stemming from a single "center" of the brain.
overtly with the world and act upon sensory information generally involves the frontal lobes, in association with the rest of the brain. Primary motor cortex, located in area 4 of the precentral gyrus, is involved in the movement of individual muscles or small groups of muscles. Premotor cortex (area 6), an association cortex, processes more elaborate motor information, coordinating the movement of several motor groups simultaneously. This area might be considered to contain "motor programs" since electrical stimulation of portions of the premotor cortex may elicit complete movements. The patient may clench and unclench the fist, or move the arm in a particular direction. This area is often damaged by strokes which result in hemiparesis, or partial paralysis of the face or body on the side opposite to the site of brain damage. The frontal eye field (area 8) directs voluntary eye movement in three dimensions of space.

The primary, premotor and frontal eye field cortices may be considered the "non-thinking" areas of the frontal lobe. Though these areas are involved in voluntary movement, the movements themselves are not planned out in these areas but are "released." The relationship is somewhat like a piano player pushing piano keys, however, though this analogy is mechanistic. The planning of behavior, or the movements which will be initiated, occurs at the cortical level mainly in the prefrontal association cortices, which include areas 9 through 12. Damage to these areas may leave one unable to sequence and carry out behavior. A patient may try to reach for a glass of water but is unable to get beyond the first step, swinging her or his arm in the general direction of the glass, but unable to grasp and bring the glass to the lips. Prefrontal lobotomies were once used to destroy these areas typically to stop violent behavior. Metabolic scans which show the activity of various areas of the brain have shown medial area 6, the supplementary motor area (SMA) to be constantly active, even when the subject being scanned is told to sit and do absolutely nothing. It is speculated that this area may be where certain aspects of thinking take place, specifically, the sequencing of behaviors, and possibly the subjective motivation of voluntary movements (Smith and Fetz, 1987: 337), though other association areas are also involved, including, it seems, those sensory modalities which are relevant to the particular type of thinking (Roland and Friberg, 1985).

Another area of interest in the frontal lobe is Broca's area (area 44 above the lateral sulcus.) This area is crucial for the production of language, spoken as well as written. People with Broca's aphasia can comprehend speech and writing but cannot communicate beyond simple gestures. Thus Broca's area is the production end of the language system of the cerebral cortex which is connected to Wernicke's area by a large bundle of axon fibers, the arcuate fasciculus. Since Broca's aphasics are able to understand that they have a disorder, they are far more traumatized by their inability to communicate than Wernicke aphasics (Kolb and Whishaw, 1985).

1 There are certain movements, however, which bypass the frontal motor areas. The spinal reflex is the simplest among these. The majority of behaviors, however, involve the frontal lobes.
2 Neurons in the premotor and primary motor regions, though they are getting their commands from elsewhere, are still adjusting and selecting transmitter substances from other areas partly on the basis of their own internal conditions. This is not a mechanistic relationship, but an adjustive relationship. The nature of such relationships will be described below.
3 I will speculate in chapter 4 upon the relation of this motor aspect of thinking and Mead's concept of thinking.
4 This relationship between production and comprehension areas of language seems at first glance to involve those areas most pertinent to the discussion of symbolic interaction, especially given Mead's suggestion of vocal gestures which are subsequently comprehended by another area. Though this relationship will be mentioned in later chapters, this paper will give little direct attention to studies of language systems in the brain. This is for several reasons. First, language involves more than these specific structures. These areas, for instance, seem to involve the overt production aspects of language. Broca's aphasics, for example, cannot produce words overtly, but can think to themselves, using inner
From the above discussion it may seem as though information from the environment flows directly from the sensory and association cortices to the motor cortices, a process relatively isolated from the structures below. This is not the case. Beside the connections between cortical areas and subcortical structures such as the thalamus, there is a third system, the limbic system, which is an important mediator between sensory and motor areas of the neocortex. The limbic system is comprised of a number of structures, some at the cortical level, others in subcortical regions of the telencephalon. At the cortical level is the limbic cortex, which considered a subdivision of the association cortex. These structures form a ring around the corpus callosum, hence their name *limbus* meaning "fringe" or "border." Figure 3 shows the limbic cortices and their Brodmann numbers.

Proceeding from rostral to caudal structures is the *orbital frontal cortex* (area 13), the *cingulate gyrus* (areas 24 and 23), the *parahippocampal gyrus* (areas 36 and 37), and the *temporal polar cortex* (area 38), at the rostral tip of the temporal lobe. The subcortical structures of the limbic system discussed here include the *hippocampus*, *amygdala*, and *septal area*. Other subcortical structures not considered part of the limbic system include the *basal ganglia*, which will be described after a brief analysis of the limbic system.

The limbic cortex is is often referred to as "paralimbic" because of its location surrounding the sub-cortical limbic structures. The functions of the limbic cortices are not well understood. However, they seem to subserve important functions including emotion and motivation, and are also related to memory. The *orbital frontal cortex* (Figure 3, area 13, located above the eye socket) is involved in subjective feelings of emotion, and certain behavioral aspects of personality. Also, together with its relation to other areas and the prefrontal areas in particular, the orbital frontal cortex plays a role in the control of spontaneous behavior and behavior in social situations. This is inferred from studies of damage to this area and, often, surrounding cortex. Patients may show one of two types of personality change, *pseudodepression*, with symptoms such as outward apathy, little overt emotion, less speaking, and reduced sexual interest; or *pseudopsychopathology*, with quite opposite symptoms such as immature behavior, coarse language, lack of tact and restraint and other social graces (Kolb and Whishaw, 1985: 440). There have been no systematic studies of this area as a discrete entity, however, so it is not clear how much or in what way the orbital frontal cortex is involved in personality and regulation of social behaviors.

Surrounding the corpus callosum is the *cingulate gyrus* (areas 24 and 23, Figure 3). This area may provide the primary motivation for behavior at the cortical level. It motivates in the sense of "energizing" the plans made in the frontal areas to allow them to be carried out. The cingulate gyrus has connections to the supplementary motor area (MII) which may sequence and plan voluntary movements. The cingulate gyrus may "energize" MII so that these plans can actually be carried out. This is inferred from patients who lose the connections between the cingulate gyrus and the frontal lobe. These patients are able to plan behaviors, but not carry them out. Stroke victims who lose this area may will themselves to get out of bed or scratch and itch, but are unable to carry out the behavior. The cingulate gyrus also connects with other secondary sensory association areas (Kolb and Whishaw, 1985: 182), and may influence perceptual and memory as well as motor processes.

The *parahippocampal gyrus* at the base of the temporal lobe seems to have a role in recognition of familiar faces, or specific members in categories of objects (Figure 3). Patients who lose this area are not only unable to recognize the faces of "significant others" like friends or family, but are also unable to distinguish makes of cars, or the names of animals (in the case of a farmer who lost this area.) It is doubtful that such information is stored in this area; rather, this area may be important for retrieval or access of certain conversation. A detailed analysis of language systems would therefore detract from discussion of the central themes of this paper.
memories stored in other areas of the cortex, and matching the information to incoming stimuli; thus it seems to be involved in labeling certain information as significant.\(^1\) The parahippocampal gyrus, as implied by its name, is also closely connected with the hippocampus (described below), which is an important structure for memory (Passingham, 1987: 87).

The temporal polar cortex (area 38, Figure 3, at the rostral tip of the temporal lobe) is another area related to emotion and emotional reactivity. Patients who lose this area act emotionally "flat" in that they do not employ emotional emphasis in communication or behaviors. This area is commonly damaged in head injuries. Such injuries are often accompanied by a noticeable change in personality. These changes may indicate that the temporal pole, together with the orbital frontal cortex, contribute to the characteristic personality traits which are observable in our behavior, though personality is not dependent exclusively upon these areas\(^2\) (Kolb and Whishaw, 1985: 182).

The subcortical structures of the limbic system are connected with both subcortical structures and the neocortex via the limbic cortex, and contribute important functions to all of these areas. The hippocampus is an area crucial for memory. This small seahorse-shaped structure located beneath the parahippocampal gyrus is involved in the conversion of short term memory to long term memory. H.M. is the famous patient who had his hippocampi and amygdalas removed to cure his epilepsy. This operation resulted in anterograde amnesia, such that he is unable to recall anything beyond a thirty second period, the duration of short term memory. He does have memories of events occurring previous to the operation, but not after. He did, however, have normal motor learning of procedural tasks such as doing manual puzzles, though he did not remember having done the puzzles (Kolb and Whishaw, 1985: 481-485). This area has connections to the sensory association areas as well as certain frontal lobe areas via the parahippocampal gyrus (Passingham, 1987: 86), and so may be able to select and label certain information as significant to future action, but does so in association with other areas of the brain (Kolb and Whishaw, 1985: 491-494). The hippocampus is also involved in fear and flight.

The amygdala, an almond-shaped structure rostral to the hippocampus within the temporal lobe has a role in sex and aggression and is involved in regulating some autonomic functions such as blood pressure. This structure may also have a role in memory or the selection of significant stimuli, since H.M had both the amygdala and hippocampus removed, and in studies with monkeys, both of these structures had to be removed to reproduce amnesia similar to H.M.'s (Kolb and Whishaw, 1985: 494). This area has connections to the sensory association areas, limbic cortex, and frontal motor areas, and so may be able to orient action toward stimuli relevant to survival, such as food (Passingham, 1987: 85); however, little is understood about the amygdala's role in human perception and selective attention.

The septal area (also called the septum or septal nuclei) is the final subcortical structure of the limbic system described here.\(^3\) The septal area is the rostral and medial most structure of the limbic system, located directly beneath the rostral tip of the corpus callosum. This structure is related to the inhibition of aggression and rage, but this is seen more clearly in animals than in humans. Electrical stimulation of this area also brings about subjective sexual feelings and euphoria.

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1 Significance is used differently than Mead used the term. Here, significance refers to the selection of certain stimuli over others in the sensory field.

2 For interactionists, personality is very much a product of social interaction and the social selves we present to others reflect the way we take the roles of others in adjusting our own actions. This view does not rule out, however, the affective qualities in behaviors we present to others, some aspects of which may be inherited, such as habitual body postures.

3 The mammillary bodies, caudal and ventral to the septum, are also considered part of the limbic system, but little is known about their functions.
Beneath the limbic system are the *basal ganglia*, the other major subcortical structures of the telencephalon. This group of nuclei has several functions in sensory-motor integration, and in adjusting one's behavior to fit changing environmental conditions. Damage to some of these areas may result in changes in movement such as hyperkinesia (excessive rapid involuntary movements) or akinesia (a lack of spontaneous movements) (Kolb and Whishaw, 1985: 254), or a syndrome called *obstinate progression* in which patients have difficulty avoiding obstacles in their path such as tables and chairs, even though they may clearly perceive these obstacles. Parkinson's disease and several other motor disorders have been linked to abnormalities or degeneration of these structures. Basal ganglia structures include the *caudate nucleus* and *putamen*, the *nucleus accumbens*, and the *basal nucleus of Meynert*.

**Evolution of the central nervous system**

This brief tour of the CNS updates the background in neuroscience which Mead utilized as a basis of many of his concepts. As mentioned, Mead also drew from the emerging paradigm of evolutionary theory in his understanding of physiology and animal conduct. Since the time of Mead's writings, much has been learned about the evolution of the brain and its relation to behavior. These recent theories of brain evolution, however, remain consistent with Mead's basic assumptions about the evolutionary process.

In the discussion above, the major structures and functions of the CNS were presented in seemingly isolated sections. This does not imply, however, that the brain is a set of isolated structures; rather, the CNS has evolved as an integrated system composed of many interdependent subsystems. As mentioned above, little was known about the exact functions of many structures because they did not act in isolation, but as part of a system. Damage to these areas causes changes in behavior attributed not only to the loss of a crucial functional "center," but also a break in the system in which it is involved. Such integration of systems presents a dilemma for those trying to infer brain functions in human beings from symptoms related to damage to local areas. Each structure in the brain is part of at least one, but more often several systems in which the same area may carry out several different functions. The old notion of neuroanatomy was that the brain was divided into autonomous "centers" which performed various functions such as memory, speech, or aggression. With clinical study of various disorders and with neuroanatomical study of the connections each structure has with other structures in the brain, the "centers" theory was seen as inadequate. Instead, the brain is seen as an integrated system of interdependent processes, which show some localization and specialization of structures, but nevertheless do not act in isolation.

The anatomy of the CNS as interrelated systems corresponds with its evolutionary development. Isolated centers could not have evolved in a piecemeal fashion, such that motor systems developed independently of sensory systems. The brain evolved according to a certain "theme," the survival, or self-maintenance of the organism in its environment. This process we have called adjustment. The brain evolved not in terms of separate functions, but rather increasingly complex and elaborate ways for the organism to adjust to occurrences in its surroundings. Higher functions of the brain, such as those of the neocortex, provide certain unique capacities, but in many ways, the "highest" functions of the CNS are simply elaborations or enhancements of functions which were present from the beginning of the CNS. Even the most advanced capacities, consciousness and symbolic language, seem to share with all other life forms qualities of the basic process of adjustment. A study of how the brain evolved, then, would demonstrate the composition of the brain as interrelated parts, and elaborations of various aspects of the adjustment process, allowing organisms to better perceive, interpret, and handle changes in their surroundings, and this goes on in the social world as well. Discussion of brain evolution will show the interrelatedness, connectivity, and dynamics of many of the structures of the brain described above. The discussion will proceed with a general introduction to the
development of the CNS in various species, then a presentation of MacLean's triune brain model which shows the hierarchical yet integrated relationship of the hindbrain, midbrain, and forebrain. The forebrain, especially the neocortex and limbic system, will be the focus of the final section of the chapter. This discussion will describe the origins of the neocortex, and its connections and dynamic relationship with the limbic system.

Tracing the development of the nervous system from its earliest roots shows its role in the adjustment process in increasingly complex life forms. The predecessors of the nervous system incorporated three basic functions, sensing changes in their external and internal environment, response in these changes, and integration of these processes in the maintenance of the organism's metabolism. With early single-celled organisms, these functions were diffused among the activity of the whole organism, which functioned as autonomous units. The first clusters of such cells began to lose some autonomy in favor of the adaptive benefits of symbiosis, in which various groups of cells specialized for tasks which supported others. As multi-cellular organisms continued to develop, communication and integration of the various processes of different cells required a more specialized system of coordination. The cells which specialized in these functions were the predecessors of the nervous system. The early systems developed around two functions, sensation of the environment and motor response. This system eventually developed into the first primitive nervous system, the spinal cord (Figure 4). The spinal cord was at first a simple tube which received sensory fibers from various parts of the body and sent motor fibers for response to the environment (Kolb and Whishaw, 1985: 9).

As the rostral end of the spinal cord became specialized for sensory functions, the brainstem developed. Three enlargements in the spinal cord developed for more adaptive analysis of the sensory world, more efficient and flexible response, and better integration of sensation and response, which is also crucial to adjustment. Olfaction and taste were located in the prosencephalon at the front of the brain stem. Vision and hearing were located in the mesencephalon, the second enlargement, and the rhombencephalon became specialized for vestibular functions, such as equilibrium and balance, necessary for better coordinating motion and a sense of location within the environment. These structures comprise the brains of fishes and amphibians, and form the basis for development of the mammalian brain (Kolb and Whishaw, 1985: 9). The primitive brain continued to develop in a similar pattern, with sensory areas located dorsally, motor areas located ventrally, and areas for coordination and integration medial, by the base of the spine. As the mammalian brain evolved, the prosencephalon developed into the diencephalon and telencephalon which included the cerebral hemispheres. Ventrally, the rhombencephalon formed two divisions as well, the metencephalon, and the myelencephalon (Kolb and Whishaw, 1985:9 - 10).

The central nervous system, thus developed through both a structural and functional elaboration of basic adjustment processes present in the nervous systems of predecessors; these are the sensory processes, motor response processes, and integrating processes. Further, the functions of the older areas were not abandoned in favor of more recent developments. Many of the basic structures of the hindbrain and midbrain were left relatively unchanged, or were adapted to new developments to become part of systems involving more recent evolutionary developments. There are several several reasons for this. Though new levels added to various capacities for adjustment and adaptiveness to the environment, they developed from the brains of earlier species, and therefore, had to be integrated with the processes which maintained earlier organisms. Once these new systems evolved, however, they could re-organize the lower structures to become part of newer systems. Bipedal locomotion, for example, as a means of watching for enemies on open plains, could also leave the front paws free for manipulating objects. There is not a clear hierarchy of control, however, between upper and lower levels because no level is truly autonomous. Though upper levels may do more sophisticated processing of information, without the contribution of the lower levels they have nothing to process. The different
A SPINAL CORD

B BRAINSTEM

C MAMMALIAN BRAIN

D HUMAN BRAIN


(Kolb and Whishaw, 1995: 9)
levels of the brain, therefore, are structurally and often chemically different, but maintain both interdependence and a degree of autonomy.

The "triune brain" model of evolution corresponds, to an extent, to this view of new capacities added to old, maintaining interdependence. The model was developed by Paul MacLean, a neurophysiologist who headed a laboratory for the study of brain evolution and behavior in the 1970's (Jantsch, 1980: 165). The "triune brain" expressed the phylogenetic development of the brain as comprised of three brains in one, each level chemically and structurally different, but each highly interconnected and interdependent. The three divisions he proposed are the protoreptilian brain, the paleomammalian brain or limbic system, and the neomammalian brain. These three structures had increasingly complex interaction with the "neural chassis," the spinal cord and brain stem which handled autonomic functions such as respiration, and relayed information to and from higher structures. Though these early structures once functioned autonomously in early organisms, the three levels of the brain developed as "drivers" of the neural chassis, influencing these basic survival functions and each other in increasingly complex ways.

The protoreptilian brain (or R-Complex) forming the core of the nervous system, consists of parts of the hindbrain and midbrain, the diencephalon, and the basal ganglia (Isaacson, p. 240) The R-complex originated approximately 250 or 280 million years ago (Jantsch, p. 166) and maintains many of the functions found in early reptiles (though R-complex structures in the mammalian brain are quite different than the brain structure of today's reptiles.) The R-complex manages many autonomic and metabolic functions of the nervous system, and thus represents a level of control over, and autonomy from, these systems. MacLean also associated certain stereotyped behavior patterns with the reptilian brain, such as territoriality, ritual fights, greetings, primitive social hierarchies, and other behaviors exhibited by modern reptiles. R-complex structures, however, are slow at learning and adapting to new situations, and thus have limited flexibility. (Jantsch, 166)

These functions, however, are still crucial for upper-level systems. In fact, many studies of decorticate animals, animals which have had portions of their brains removed, are able to survive without their neocortex or limbic system. If the animals possess basal ganglia, for example, they are able to link voluntary movements and automatic movements sufficiently well to maintain themselves, with such behaviors as eating and drinking in a simple environment. Linking voluntary and involuntary movements involves the inhibition or excitation of these behaviors. For example, they can see food, move toward it, stop their movement, and eat the food; thus they are able to modify their behavior and act on new information in their surroundings. Decorticate cats display some normal feline behaviors, but many behaviors are poorly executed and often inappropriate, which suggests the role of higher areas in integrating and sequencing behaviors (Kolb and Whishaw, 1985: 154). These studies, however, should not be taken to suggest that higher areas are independent from lower areas, since removing the cortex creates artificial conditions in which what is left of the nervous system reorganizes and, thus, the functions of these areas may change as well. Also, human beings born without cortices do not survive.1 These decorticate studies, then, can be taken only as a general example of the role of the cortex in nonhuman animals.

The second level in MacLean's model is the paleomammalian brain. The paleomammalian brain is essentially the limbic system, containing those structures listed above, and the limbic cortex. The limbic system originated in mammals roughly 165 million years ago. (Jantsch, 1980: 167) It provides more flexibility and control over the R-complex structures, yet it is also interrelated with the functions of the neocortex in significant ways. The limbic system receives information from both the outer and inner

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1 There has, of course, been no systematic study of the effects of removing various portions of the human brain, so there is no clear understanding of the functional relationship among various evolutionary levels leading to human beings.
world, and may, as MacLean suggests, provide a primitive form of self-awareness as it relates the outer environment with information of internal conditions. This awareness takes the form primarily of emotions or feelings which can be used to guide behavior, integrated with the motivation for carrying out the behavior, though the response may be sequenced mainly in the neocortex. (Isaacson: 241) Certain structures in the limbic system such as the hippocampus are also important for learning, which allows more efficient utilization of past experiences in adapting to new experiences. With the more complex integration of information, the stereotyped behaviors of the R-complex can be overridden by a more complex interaction of outer and inner models of the world.

The neomammalian brain, which originated perhaps 50 million years ago, includes the most recently developed structures of the brain which have become predominant in primates, the neocortical structures. MacLean considers neocortical structures to provide abstract, non-emotional analysis of the environment (Isaacson: 241). Abstract images of language, logic and mathematics are superimposed on a "neural screen" upon sensory information which reaches the primary sensory cortices. MacLean proposes that the neocortex operates "unhindered by signals and noise generated in the internal world" (Isaacson: 242) Recent studies of cortical connectivity between the neocortex and limbic system, however, dispute MacLean's description of the relationship of these two areas. The neocortex is not isolated from the limbic system, either in function or connectivity; rather, all the most complex "higher" processes of the neocortex, such as consciousness, reflexive intelligence, and symbolic communication, seem to require for their functioning the interaction of the limbic system. This conclusion will be detailed below; however, we can consider the importance of memory, emotion, and motivation of voluntary behavior as necessary contributions of the limbic system. The neocortex in combination with the limbic system, however, allows a far more complex, flexible, and faster adjustment for survival and adaptation. With the neocortex, learning and memory become more complex, as well as the ability to select and adjust to significant events from both the organism's surroundings and its internal conditions. The organism can also sequence voluntary motions for a more complex manipulation of things. The neocortex also provides the animal with a more complex representation of the world, one which includes, in addition to emotions, objects with both the past and anticipated future, and location in three-dimensional space (Kolb, 156-157). With most animals, these capacities are rudimentary, but the evolution of social interaction, it seems, has further elaborated these capacities, and also added awareness of self and others and physical things as conscious objects (in Mead's sense), the capacity for symbolic interaction with others and oneself, reflexive intelligence, and construction and coordination of a social world.

As a brief aside, we might consider whether the functional differences between human brains and other neomammalian brains correspond to structural differences. The major structures described at the beginning of this chapter are more-or-less present in all other mammals, and MacLean's triune brain is common to all higher mammals. In our own order, the primates, there are no qualitative differences at all. In other words, all the structures described above (and those not described) are found in all Old-World and New-World monkeys and apes, in roughly similar configurations. The major difference between our brain and a chimpanzee's is size. The ratio of the human brain is 6.3 times larger than expected given the average ratio of brain size to body weight among other mammals. The chimpanzee's are 2.48 times larger than average for its weight (Kolb and Whishaw, 1985: 88). Thus size is the major difference between human brains and those of other primates. A comparison of brain size across species found that the relative size of the brain increased, with humans having the largest brains following this trend, having the most neocortex. This increase, however, did not result in any marked structural changes, nor did certain

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1It is possible for the limbic system itself to be the primary source of certain actions, such as emotional gestures.
areas increase in size in greater proportion than others, with the exception of association
cortex, but not much more than predicted given the amount of neocortex in human brains
(Kolb and Whishaw, 1985: 90). Thus, Kolb and Whishaw conclude "there is no
compelling evidence that there is a qualitative difference between the brains of humans and
those of other mammals" (1985: 91).

The anatomical studies by which these conclusions were reached did not consider
differences in connectivity among humans and other primates. Our knowledge of the
connectivity in human brains is limited, however, by the techniques of mapping
connections which require destruction of areas of the animal's brain. There may be no
homologue for certain speech structures, such as Broca's area (Passingham, in Kolb, 90),
but such evidence is not clear. Would functional changes resulting from the evolution of
social interaction reorganize the structure or connectivity of the brain? There seems to be
no reason why some structural differences would not be possible, but more study is
needed. Mead's system, then, started with the social, and it may be that the social process
is the main ingredient to the functional differences, aside from more association cortex.
This would be an area for further study, requiring new technology for study of the brain.
Given the similarities in structure, however, we can still infer much about the evolution of
the brain using monkey models. These inferences imply much about human information
processing that need not wait for verification by new technology to be relevant to our
analysis of action.

From the presentation above, it is clear that major structures in the brain did not
evolve in isolation, but instead, developed as increasingly complex systems, which
provided new capacities, but which were highly integrated with the systems which existed
before. They are integrated functionally, in that the processes of "higher" structures such
as the neocortex depend upon information and support from "lower" systems, but the
higher systems can also redirect lower systems. They are also integrated structurally. The
lower regions of the brain, such as the limbic system, are the phylogenetic source of higher
regions, such as the neocortex. As new regions evolve, they maintain relationships with
their structures of origin through axonal connections by which different areas
communicate. It is this communication which allows different areas to act as systems, and
is what makes the CNS itself an integrated system which functions in the adjustment to
new conditions. These evolutionary trends in the development of the CNS can be seen in
recent studies of the evolution of the neocortex. Pandya and Yeterian (1985; 1988) have
recently summarized data on the evolution and connectivity of the neocortex. Their own
studies of cortical connectivity show how the neocortex has evolved from the limbic system
and how the limbic system maintains a "hold" on neocortical information processing.

Pandya and Yeterian follow the evolutionary approach to studying the development
of the neocortex. This approach was developed primarily by Friedrich Sanides, who
compared across several species the cytoarchitectonic changes in cellular composition in the
telencephalon. From these studies he found that evolutionarily older areas of the brain shift
to newer areas of the cortex through a progressive differentiation of cortical
cytoarchitecture, the characteristic patterns of cell structures. The differentiation was seen
best in the layering of the neuronal cell bodies found in the grey matter of the cortex. In
the neocortex there are six layers of cell bodies, each with characteristic connections to
other layers. The composition of limbic system structures such as the hippocampus,
however, shows less differentiation among the cell bodies. This was noted in the late 19th

1 Most of their findings presented here were taken from two sources, "Architectonic Features of the Primate
Brain: Implications for Information Processing and Behavior" (Yeterian and Pandya, 1988). Dr. Yeterian
presented a simplified version of these findings in "Making Sense of the Cerebral Cortex", an unpublished
presentation. The discussion below follows his presentation, which outlines the essential aspects of the
model.

2 The white matter is composed of axons going to and from neocortical grey matter.
century by a German neuroanatomist, Vogt. Vogt named these undifferentiated areas allocortex, meaning "other cortex" (Yeterian, 1985: 2), and named the six-layered neocortex, isocortex. Sanides found that cell layering from the allocortex to isocortex followed very systematic shifts. Proceeding from the allocortex to the limbic areas, the cortical layering shifted progressively in the region of the limbic cortices to less than six layers which lacked clear definition, to a clearly defined six-layered neocortex, culminating in the primary cortices. This shift, Sanides concluded, followed an evolutionary trend from the allocortex, through intermediate stages of the periallocortex and pro-isocortex in the paralimbic region, and finally to isocortex in the association and primary cortices (Figure 5) (Yeterian and Pandya, 1985: 5). Sanides found that there were two such trends in the cortex which had their source in the allocortex of the limbic system. From these two sources, which Sanides called the "prime moieties," the entire neocortex evolved. The two moieties are the hippocampal (or archicortical) and the olfactory (or paleocortical) moiety (Figure 5). Interestingly, each moiety was the source of both motor and sensory cortices, as well as association cortex. The hippocampal moiety is the source of certain limbic cortices, including the cingulate gyrus. From there, this trend developed into the somatosensory cortices and the motor cortices from which served the trunk and limbs. These include the dorsal premotor and dorsal prefrontal areas, the supplementary motor area (MII), and the supplementary somatosensory cortex (MII). From these areas arose the primary motor and primary somatosensory areas respectively. The olfactory moiety is the source of other sensory cortices, including visual, auditory, gustatory, and vestibular cortex, and the primary sensory cortices. This moiety is also the source of somatosensory cortices serving the neck, face and head region and the ventral motor, premotor, and prefrontal areas in the frontal lobe. The olfactory moiety proceeded through the insular region of the limbic cortex (near the medial temporal lobe), and from there to the secondary sensory area (SII).

To summarize, Sanides' studies of the progressive architectonic shifts show that each of the major sensory and motor areas of the cortex evolved systematically from the limbic system. The sensory and motor areas, however, did not evolve along single pathways; rather, each of the two moieties in the limbic system branched into motor and sensory areas. In general terms, these two areas handle different aspects of activity. The hippocampal trend leads to areas which deal with manipulation of the lower half of the body and somatosensory experience had by that manipulation. From the olfactory trend evolved areas subserving central vision and audition which handle distant sensory objects, and also the motor and somatosensory functions serving the head, neck, and face.

Yeterian and Pandya supplemented Sanides' work with studies of the cortical connectivity of the neocortex and limbic system. Their findings support the notion that the neocortex evolved from the limbic system by showing that patterns of connectivity correspond to these architectonic patterns. Their studies involved two sorts of connections, "intrinsic connections," and "long connections." Intrinsic connections describe the axon fiber bundles which connect adjacent areas of the cortex within each lobe of the cerebrum; for example, the intrinsic connections of the auditory cortex (Figure 6). Long connections are fiber bundles which connect distant areas of the brain, such as the connections between sensory association cortex and the frontal association cortex (Yeterian and Pandya, 1985: 6).

The intrinsic connections within functional areas of the neocortex parallel the architectonic development of these areas. Each major sensory area shows a stepwise progression of intrinsic connections. The auditory cortex, for example, has sequential connections from the primary areas to association areas down to the proisocortex of the olfactory moiety at the temporal pole; thus they follow the trend from the olfactory moiety (Figure 6b). There are also sequential reciprocal connections flowing from proisocortex back to the primary auditory area. These reciprocal connections show that information flows in both directions between the limbic system, the primary areas, and all points between. Connections in each direction also follow a pattern of "laminar specificity" in that
Fig 5A-C. Schematic diagrams showing the progressive development of cortical areas from the two primordial moieties (archicortical and paleocortical) through successive steps: periallocortex (PALL) to proisocortex (PRO) to isocortex, and culminating in pre- and post-Rolandic sensorimotor and association areas. A: auditory areas; A1, primary auditory area; A2, second auditory area; CC, corpus callosum; CS, central sulcus; G, gustatory area; M1, primary motor cortex; M2, supplementary motor cortex; MT, middle temporal visual area; OLF, olfactory cortex; PRO, proisocortex; S1, primary somatosensory cortex; S2, second somatosensory cortex; SSA, supplementary sensory area; V, visual areas; V1, primary visual area; V2, visual area MT in the superior temporal sulcus; P3, vestibular area.

(Pandya and Victorin, 1987)
each connection begins and terminates in a specific cell layer. The forward connections from the primary areas originate from the third layer of the isocortex and terminate primarily in layer IV, while those connections flowing back from the proisocortex originate in layers V and VI and terminate in layer I, the outer-most layer of the isocortex. These patterns of intrinsic connections and laminar specificity are present in all the sensory cortices, visual, auditory, and somatosensory, and are also found in frontal association cortex (Figure 6) (Yeterian, 1985: 9). Thus both evolutionary trends are integrated with a sequential, bi-directional flow of intrinsic connection between limbic areas and cortical areas.

Two sorts of long connections are also consistent with Sanides' evolutionary trends, the connections between the limbic cortex and frontal and sensory association areas and between various areas within the neocortex itself. In addition to the short intrinsic connections relating limbic cortices to the neocortex, there are also long connections which relate sensory and motor association areas and the limbic cortex directly (Figure 7). For example, the cingulate gyrus located above the corpus callosum in the hippocampal trend has direct connections to the dorsal motor areas, such as MII, and to somatosensory areas such as SII (Yeterian and Pandya, 1985: 6). As with the intrinsic connections, these long connections are also reciprocal; thus information can flow in and out of the limbically related cortices to all sensory and motor association areas. The limbic system, therefore can influence and be influenced by these areas (Yeterian and Pandya, 1985: 29).

Direct connections between association areas, called "cortico-cortical connections," relate the different sensory association areas to the frontal association areas. Like other connections, these connections are bi-directional. Thus information can flow from sensory to motor areas, but information can also flow from motor areas back to sensory areas. This backflow of frontal lobe information is called "re-afference," which allows sensory areas to adjust directly to what occurs in motor areas (Kolb and Whishaw, 1985: 431).

An interesting feature of the long cortico-cortical connections is that the most heavily interconnected sensory and frontal association areas are those which occupy the same evolutionary position within their respective regions. Thus, the orbital frontal cortex and the rostral auditory cortex which are both close to their evolutionary source in the limbic allocortex are most heavily interconnected; similarly, the areas far from their limbic source such as the caudal auditory association cortex and the premotor cortex of the frontal lobe are interconnected (Figure 7b) (Yeterian, 1985: 11).

The primary areas are the major exceptions to these patterns of connectivity. They receive long connections from neither the limbic areas nor other association areas. Their only connections are the intrinsic connections to adjacent cortex, and the direct connections to the thalamus, mentioned above. The primary motor and sensory cortices, then, are relatively isolated from the heavy interconnections seen in the association and limbic areas.

The architectonic and connectional data show that the two evolutionary trends did not evolve in a piecemeal fashion, such as the development of a visual system in isolation from a motor system; instead, the neocortex evolved from limbic cortex through the gradual layering of whole integrated systems, including sensory, motor, and associational systems. The primary areas seem to be the latest to evolve, since they are the furthest removed from the limbic system and have the least direct interconnections with limbic areas. The primary areas, however, can still receive limbic influence indirectly through the intrinsic connections. The limbic system, therefore, maintains its grip, so to speak, on the entire neocortex.

These data show that the neocortex evolved in a similar fashion as the rest of the CNS, as described by MacLean's model. The brain evolved through addition of integrated layers, each of which deal with sensory input, integration and interpretation, and motor output. These recent findings, however, disagree with MacLean's notion that the neocortex was isolated from the influence of the limbic system. Whereas MacLean proposed that the neocortex performed higher cognitive functions in relative isolation from the survival functions of the limbic system, Pandya and Yeterian have shown the limbic...
Common patterns of cells of origin and terminations of forward and reciprocal connections are shown in the bottom diagrams. B Diagrammatic representation of the sequence of intrinsic connections of visually related areas of the occipital lobe and interotemporal region. The bottom diagrams show cells of origin and laminar terminations of forward and reciprocal intrinsic connections of visually related areas of the occipital lobe and interotemporal region.

(Pandya and Yeterian, 1995)
Figure 7 Diagrams showing three subdivisions of auditory association areas of the STR (A), and their frontal (B), superior temporal sulcus (C), and paralimbic (D) connections.

(Pandya and Yeterian, 1975)
system to have either direct or indirect connections to the entire neocortex. Also, these connections are reciprocal, so limbic areas have access to motor and sensory information and, in turn, can influence sensory and motor processes.

These data allow some interesting speculation about the significance of the limbic system in "higher" cognitive functions. All cortical areas have access either directly or indirectly to limbic influence, and the interaction is more intense the closer one gets to the limbic cortices. Figure 8 shows a schematic representation of the degree of limbic connectivity and influence as one moves further away from primary areas in the sensory or frontal lobes. The primary areas, then, are furthest removed from limbic influence, and the association areas show the most intense interaction with limbic information. These areas in the neocortex with increasing limbic influence will be called the "limbic diamond" areas, with areas high in the limbic diamond being those with the most complex interaction among limbic and association areas. Figure 8 shows a schematic representation of the increasing limbic connectivity among frontal association cortex, sensory association cortices, and limbic cortices.

Yeterian and Panda (1988), and Yeterian (1985: 12-14) have proposed a model of information processing and behavior based upon their data. They propose that the higher cognitive functions, including consciousness, thinking, language, and planning of action may rely most heavily upon the interaction of areas with heavy limbic influence. This is implied by the relationship of the primary areas to those of the limbic diamond—the neocortical association areas, and limbic cortices (Figure 8). As mentioned, the primary sensory areas receive sensory data in its "raw" form, as discreet signals for heat, pressure, or pain in the primary somatosensory areas, for instance. These sensations are elaborated as they move toward association cortices, into gestalts of sensations at various points on the body. However, as the information moves beyond the primary areas, it involves increasingly more limbic influence, as well as influence from other association areas via the long cortical-cortical connections. Likewise, motor information interacts with limbic and sensory areas before being released as behavior. There is also a backflow of information from the motor areas to limbic and sensory areas via both intrinsic and long connections. Therefore, the most intense and most complex information flow, and the most possibilities and directions, occurs where two-way interaction among the limbic diamond areas is most intense. The most complex elaboration of information occurs where limbic connectivity is highest. Where the limbic system has the least influence, in the primary cortices, the information processing is rudimentary (Yeterian, 1985: 13).

The functional significance of limbic connectivity with both sensory and motor processing is that limbic influences are necessary for most "higher" cognitive functions to take place. The limbic system interacts with the sensory association cortices that are involved in memory of objects, used in identifying objects, and forming cognitive representations of our surroundings (including imaginative representations). The frontal association areas with high limbic influence include the prefrontal and supplementary motor areas which are involved with planning and sequencing behaviors, or, in short, thinking. Areas important for language are also located in areas of high limbic influence. The limbic system itself can contribute important elements to this process. The cingulate gyrus seems to provide the motivation necessary for plans of action to be carried out. The temporal pole and orbital frontal cortex can add to action and emotional context, by drawing from sensory information and influencing motor behavior as well. If experiences are to be remembered, they must reach the hippocampus. These are just a few suggestions of how the limbic areas are involved in action and cognition.

1 Certain other subcortical structures are highly interconnected with the neocortex as well. The thalamus, especially, sends connections to all points of the neocortex. It thus serves as a relay station for other subcortical structures, as does the limbic system. Many of the exact functions of the thalamus, however, are unknown.
There are also more direct lines of evidence that the limbic system is crucial to higher forms of cognition, in the deficits present when different limbic areas are cut off from the cortex. I mentioned above that people who lose connections from the cingulate gyrus to the motor cortex are able to plan behaviors, such as getting out of bed in the morning, but are unable to carry them out. H.M.'s loss of the hippocampus and amygdala limited his experience of the immediate past to the minute or so that his short-term memory lasts (Yeterian, 1985: 13). Relatively little is known about the exact functions of the limbic system in action and cognition; however, it is clear that no aspect of sensory or motor function is ever totally separate from limbic influence.

What is interesting is that these limbic structures seemingly so crucial to higher cognitive processes are also those which coordinate most of the organism's behaviors for survival, such as feeding, reproduction and excretion. These "survival functions" were traditionally considered far removed from abstract thought and consciousness (c.f. MacLean above). This implies that higher cognitive activity has evolved not as independent processes, but as extensions and elaborations of "lower" functions. Higher cognitive processes exist as systems which maintain interdependency with their evolutionary origins. Limbic influence in the neocortex also implies that survival and self-maintenance priorities lie behind much of what goes on in higher cognitive processes, in selecting significant information, in adding emotional and motivational tone to experience, and in remembering experiences for future action. This is not to say that everything we do is explicitly for survival. The evolution of the neocortex in humans (and the capacity for social interaction which it allows) allows actions as rich in complexity and as indirectly removed from immediate concerns for survival as we observe in our own lives. Keep in mind, however, that Mead considered the act as a process of adjustment by which the organism maintains itself in a changing environment. This similarity will be considered further in the next chapter.

As the organism adjusts to increasingly complex situations, and human beings deal with the most complex situations, it seems that the intensity of interaction between sensory input and motor output must also be more complex. It is out of this complexity, however, that our highest capacities for organizing reality are possible. These capacities are realized furthest by our creation of and interdependence with a social world. After half a century of research in neurophysiology and neuroanatomy, we can still retain Mead's belief that symbolic interactionist social psychology and neural systems are not incompatible, but complementary. In the next chapters I will explore to what extent both perspectives support a more unified understanding of action and human conduct.
Figure 8. Summary diagram showing the "limbic diamond," a representation of increasing reciprocal connectivity between frontal association cortex, sensory association cortices, and limbic cortices.
Chapter 3: Theoretical Consistencies between Symbolic Interactionism and Neurophysiology

Though the presentations of symbolic interaction and neurophysiology may have seemed to touch upon some similar points, the reader may have found the two realms of description to be quite unrelated. The thesis of this paper is to show that the neurophysiological description of human action, and that of symbolic interactionism are more than distinct specialties, but instead hold consistent perspectives of the nature of reality and of the human being's active relationship to that reality. This can be shown without reducing one level of analysis to the other. Both positions describe a common topic, the action of human beings. Drawing from both the realm of human group life and social psychology and also upon recent findings in neuropsychology, we propose that Mead's symbolic interactionist position of action is consistent with the structure and functions of the central nervous system.

This chapter will present the "meta-theory" by which we find these two descriptions linked. In chapter four, I will speculate upon several specific similarities between the two perspectives through an integrated analysis of Mead's act. In this chapter I will consider the following theoretical consistancies between symbolic interactionist and neurophysiological conceptions of action: (1) The neurophysiological and the symbolic interactionism position view reality as a process, and the relationship of a living organism to reality as one of adjustment. (2) The organism deals with emergent reality through a process of interpretation in which both the action and the environment of the organism is built up in a co-determinant process. (3) Both perspectives support similar rejections of dualistic conceptions of mind and body, subjectivity and objectivity, and the organism and environment. (4) Both perspectives describe this adjustive relationship as an active process as opposed to the passive model of action proposed by the stimulus-response approach. (5) Both also reject the mechanistic and deterministic dimensions of the stimulus-response model of action. (6) The alternatives these perspectives propose are also similar in that action is viewed as a co-determinant and formative process which involves both serial and parallel processes occurring simultaneously. These two processes are interdependent, and consistent with a common dynamics principle, that of action as a process of adjustment to an emergent reality.

I will start with the theoretical and rather cosmic assumptions of the nature of reality as applicable to both the individual organism and its central nervous system. Both facets of the living system hold two common assumptions. The first assumption is that all that exists is in process. This is the accepted assumption that the universe is fundamentally dynamic in nature, and there is nothing truly static. No element of human activity, therefore, can be described as a static processes, but must fit a dynamic conception of reality (Morrione, 1988). The second assumption is that reality is emergent. Emergence describes the fundamental indeterminacy in the relationships of matter and energy through time. At any moment, everything in the universe has an essentially novel relationship with everything else, since no two isolated moments can be numerically identical and all that exists is in a process of change. Because of the changing relationships and the increasing
complexity of relationships if we consider conglomerates of particles, we cannot assume that matter and energy change as determined cause and effect; rather there is a basic indeterminacy in the direction of change. Heisenberg's principle of non-linearity confirms this position. Thus emergence expresses the indeterminate process of changing relationships characteristic of all that exists, including living organisms.

Though all is in emergent process, there is also structure in the universe, which can be described by theories of system dynamics. Physics describes various forces which bind particles, or restrain their motions within probabilistic parameters; and system theories, such as thermodynamics describe how various dynamic structures of matter and energy persist over time. A piece of iron persists by the coherency of its bonds and the proximity of its surrounding particles. The law of thermodynamics would describe the rock to be at equilibrium in relationship to its surroundings. At equilibrium, the amount of entropy, or random unusable energy, has gathered in the given system which dampens its kinetic state. Heat the iron, and its kinetic state changes, until the bar begins to melt. Remove the heat, and the iron eventually returns to equilibrium with its surroundings.

Living systems operate by the laws of thermodynamics as well, but maintain a more complex dynamic relationship to their surroundings than do most non-living things. Herbert Blumer and George Herbert Mead use the term "adjustment" to describe the dynamic relationship characteristic of living systems. Adjustment is the process by which a living system actively reorganizes its own past conditions in the present to confirm emergent, or novel occurrences.

In order to persist, living systems maintain a dynamic state which is far from equilibrium, and they do so by actively importing energy and exporting entropy which builds in their system. If entropy accumulates in the system, its kinetic state slows down as it approaches equilibrium and the living system dies. The living system, therefore, must be constantly active through both change and persistence in order to survive and maintain its dynamic state far from equilibrium. The adjusting system handles emergent occurrences differently than non-living systems. The equilibrium system responds passively to change, such as the iron bar which is heated externally. The adjusting system, however, actively confronts emerging reality. The adjusting system persists by maintaining a dynamic balance between two processes, novelty and confirmation. Novelty is emerging reality, and confirmation is the adjusting process by which novel occurrences are handled. If there are more emergent or novel occurrences than the system can handle, the system is destroyed by a state of chaos. On the other hand, if the organism adjusts completely to all emergent conditions entropy would build up bringing the system to equilibrium, or death. By constantly importing novelty as energy and matter, and exporting entropy or unusable confirmed energy, the living system persists. Thus an adjusting system requires both change and persistence to survive. As Mead puts it, the living system is always "living in the future" because present conditions are inadequate to sustain life once confirmed and therefore the present must constantly be reorganized (Miller, 1973: 30).

Adjustment describes a dynamic principle common to all living things. The concept therefore applies directly to Mead's description of the acting individual and to the central nervous system, both of which are composed of countless adjusting systems. The significant point of this concept to our analysis of action is that no living thing can exist by a passive relationship to its environment, therefore no adequate model of action can presuppose passive relationships. Both the neurophysiological and the interactionist

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1 The description of life processes as far-from-equilibrium systems is taken from a relatively recent paradigm in system sciences, the "self-organization" paradigm. Erich Jantsch (1980) in his book "The Self-organizing universe" gives a comprehensive study of the paradigm and the system dynamics characteristic of living systems. Though Mead's writings predate the empirical study of far-from-equilibrium systems, his concepts are very consistent with this current theory of system dynamics. The similarities between Mead's concepts and the self-organization paradigm deserve further study.
positions describe active adjustment relationships between the organism and emergent reality. Symbolic interactionists, Mead and Blumer especially, have constructed their theories according to this principle, and the neurophysiological position also follows the dynamics of adjustment. I will describe a sample in which adjustment dynamics apply to both perspectives.

As mentioned in chapter one, Mead's act is an expression of the adjustment processes as a basic unit of activity. The countless component processes of the act, however, are themselves adjustment processes, which include the activities of the CNS. The impulse serves as an example of adjustment dynamics which embodies the processes of self-organization and interpretation as elements of activity. In Mead's view, the impulse rather than the stimuli is the primary organizing factor in the act. "We cannot interpret the act in terms of stimuli. If we do, we miss its significance. Rather, an impulse or a tendency to act is present, and it makes use of stimuli or selects stimuli to act, and this is characteristic of all life forms. Stimuli are the means, but the tendency, the impulse, is essential for anything to be a stimulus" (1927: 109). By tendency, Mead seems to refer to the dynamic flow of adjustment and emergence described above. The impulse occurs with the fluctuation in this flow, the emergent event which the organism must handle to maintain itself. The impulse, then, begins the process of confirming novel or emergent occurrences in a given situation. The novel occurrence may be the block in one's line of action which occurs with the problematic situation, such as the discovery that one's car has stalled in traffic; or the impulse may be "internal," such as the lack of glucose in the cell. Mead seems to include even the cellular components of organisms as dealing with impulses of their own.

At the impulse, the organism selects from its surroundings what it needs to sustain itself. There is therefore a goal or direction present with the impulse. "The act reduces to energy ready to express itself, but along lines determined by the character of the structure of the body" (1927: 114). The adjustive system "knows," in effect, what it needs to maintain itself. The cell knows it requires less carbon dioxide and more glucose, knowledge which is expressed in the active exchange of these materials. The hungry dog knows its needs food, which manifests in the act of eating. Mead calls this self-organizing process "intelligence." "Intelligence is the selection by the organism of stimuli that will set free and maintain life and aid in rebuilding the form." (1927: 109). This is not the same as reflective intelligence or conscious knowledge (though both involve these selective processes), but is common to all living systems. In acquiring what it needs to sustain itself, the system expends energy, but only when it actually processes something. "Food does not exist as an object till there is an animal that can select and react to carbons and proteins. For something to be food, it must be in relationship with an organism" (1927: 115). Thus a stimulus is only relevant to action if it is selected. "Stimuli are the means, but the tendency, the impulse, is essential for anything to be an impulse." For the stimulus to be related to action, therefore, it must be incorporated into the ongoing activity of the organism. Novel events are incorporated through the interpretive process.

From Mead's description of the impulse can be derived how organisms act on the basis of an interpretive process rather than by the causal force of stimuli themselves. In other words, organisms act on the basis of the meaning of things, and not on the basis of stimuli alone. Action is built up through a selective process of adjustment to the impulse. The adjusting system organizes with each emerging impulse the criteria for selecting the

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1 The adjustive process as I have described it, however, is not often acknowledged by interactionists, and it is probable that many have not understood the system dynamics which Mead and Blumer had in mind. Likewise, I have discovered only a small amount of literature that refers to adjustive, self-organizing processes in the CNS (c.f. Janisch, 1980). I am therefore extrapolating Mead's dynamic perspective to the neurophysiological level. I consider this a valid extrapolation because Mead's perspective is meant to apply to all living systems. It is not certain, however, that adjustive dynamics apply uniformly to every system in the CNS.
stimuli needed for its maintenance. The hungry dog's impulse begins to organize the act of getting food. The neuron's lack of a neurotransmitter sets the criteria for its selection through the cell membrane. The stimuli emerge in an environment which is both within and outside of the organism. The stimuli may be energy, matter, or information, such as the significant symbol (which reduces to both energy and matter). The emergent stimuli release the energy of the impulse in the sense that they meet or confirm the prior organization which selects them. The impulse, however, does not determine the course of action in this process, since the tendency to act does not predict exactly what stimuli it will receive. Thus the neuron which is prepared to receive acetylcholine, a transmitter substance may take in curare, a poison which mimics acetylcholine. The hungry dog may find that the plastic toy steak it chews does not satisfy its hunger. Action therefore is indeterminate. The organism prepares for the future but the future it receives is never exactly as predicted. Actions, however, emerge from the interaction of both the prior organization and whatever stimuli it is able to select. This is the interpretive process of action. For human beings, meaning as an organization of future action is part of this interpretive process.

Through this interpretive process the organism builds up both the actions it carries out, and the environment it experiences. Its environment is constructed continually of the interaction between the organization it brings to experience and what it receives as emergent stimuli. "Thus every form maps out its own environment, its line of influence and so gives rise to other objects existing in relationship to the form itself. The environment emerges, and forms create environment, be they nests or homes" (1927: 115). Thus, the organism selects the stimuli which sustain it, and and in turn recreates the environment. Action, therefore, involves a codetermination of the organism and its environment. In simpler organisms the environment is merely the dynamic chemical exchange of the organism and that which it selects, such as the amoeba in relation to its food. With human beings, the environment, as such, includes conscious objects which can be physical, social, and abstract, including others and the self.

To summarize the interactionist conception of reality, the relation between living and non-living systems is one of active adjustment. The adjustment process describes an organism as a self-organizing system which confronts emergent reality by actively selecting what it needs to maintain itself. In doing so, the act is built up as emergent reality is interpreted. This is an indeterminate process since both the criteria of selection and the stimuli received are emergent in that neither predetermine the course of action. The interpretive process organizes both the form of response and the environment which the organism experiences. In other words, the interpretive process of adjustment organizes the meaning of things. Organisms act then, not on the basis of stimuli alone, but on the basis of the meaning of things.

This rather abstract discussion of the interactionist conception of reality is relevant to our discussion because it is consistent with the neurophysiological model of information processing described in chapter two. The brain processes information through an interpretive, adjustive process and action, insofar as it is mediated by the CNS, is built up by the brain's interpretive processes. Indirect evidence for this claim comes from the fact that the brain consumes a great deal of energy and thus maintains a far-from-equlibrium state. The brain, for example, comprises only two percent of the body weight, but consumes twenty percent of the available oxygen (Carlson, 1986: 116). This implies that the brain is actively maintaining a far-from-equilibrium state through adjustive, self-organizing processes. This assumption is supported, however, by evidence that stimuli which reach the primary sensory areas are not passively linked to a response, but are actively selected by other areas. This is evident in the connectivity of the primary sensory and motor cortices to the association cortices and limbic system. The primary sensory areas have no direct connections to motor output areas. Data must first go through areas in the "limbic diamond" where interconnections and, thus, the complexity of processing is most intense among limbic and association cortices. It is in the limbic diamond areas where
information is elaborated, related to past and anticipated future conditions, and where some sort of response is organized. It is also where the success of these responses is monitored and modified continuously.

This highly interactive form of information processing is essentially an adjustive process of the same sort essential to Mead's position. From among the total spectrum of sensory experiences reaching the primary areas, the limbic diamond areas select the information which is relevant to the situation at hand. Various areas and systems within the brain deal with only the information relevant to their own functions. Visual areas deal with visual information and auditory areas with auditory information. It is not known exactly how the information is selected or exactly how it is processed; however, we can assume that with the intensity of bi-directional connections in these areas there is opportunity for the sorts of processes Mead has assumed to occur. Even routine acts, such as looking for a snack in the refrigerator, involve highly interactive processing in the brain. Limbic influences contribute processes such as emotional experience, motivation of action, and also select those experiences which are preserved as memory. The act begins with the impulse such as the pang of hunger which mobilizes the action of finding food; therefore, the impulse as the energy or tendency to act corresponds with the evidence that the limbic system is a source of motivation. The limbic system also has access to both sensory and motor cortices, and the multimodal forms of memory, including motor memory, and thus may be instrumental to organizing the direction of action. One remembers what sort of food may be found in the refrigerator, such as leftover cake. Motor response may also be sequenced in this highly interactive process; thus an environment of objects is built up, as well as related forms of response. The various items in the refrigerator are meaningful in terms of being good snacks. This manipulation, when released, is monitored by sensory areas, which allows the act to be continuously modified. One does not find the cake, but takes fruit instead. Through these complex processes, information flows simultaneously through millions of pathways flowing in different directions, and the brain deals with countless stimuli simultaneously. It is clear, therefore, that action does not follow a linear path from stimulus to response. The brain adjusts to the information it processes, and action is emergent and indeterminate.

We have seen that both the interactionist and neurophysiological perspectives share a common dynamic principle that action in living systems is a result of an interpretive, adjustive process. From this approach, both Mead's and the neurophysiological perspectives are able to account for the physical processes of psychical phenomena, such as subjective experience, consciousness, mind, and self. Models which do not acknowledge the interpretive, adjustive processes of action cannot be applied adequately to living organisms, and therefore, cannot adequately describe psychological processes. I will describe briefly how the stimulus-response model of action fails in this regard. The S-R model can be shown to be a passive, dualistic, mechanistic, and deterministic model of action. Focusing upon these arguments will reveal further similarities between the interactionist and neurophysiological models of action.

Any model of action which applies adequately to living systems must describe an active rather than passive relationship between the organism and emergent reality; thus the stimulus-response model of action can be rejected, because it holds that action is a passive response to the stimuli which strike us. There is no prior organization to receive stimuli; the stimuli themselves organize the form of response, setting off some conditioned reflexive sequence. The passive system is otherwise at equilibrium until it receives some stimulus from the environment. Given the necessity of a living thing to maintain an active adjustment relationship to its surroundings, it is clear that action cannot occur in living systems.

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1 Multimodal areas, however, process information from several sensory modes. It is unknown exactly what each system and area selects; we can only assume that systems are selecting information of some sort.
systems through the causal force of the stimulus alone. Therefore, any description of action driven by stimulus or by some other linear, causal chain, should be rejected.

The construction of action through the interpretive process and the codetermination of the organism and its environment are the criteria Mead uses for rejecting dualistic concepts, particularly the split between mind and body, subjectivity and objectivity, and the stimulus and response. Mead rejects the mind/body dualism by showing that mind is a physical process rather than a separate "substance" transcending the material world. Consciousness arises from a certain form of the adjustive process in which the human being indicates the meaning of objects with significant gestures or symbols in interaction with oneself or others. Consciousness, then, is not a static property but an active process emerging from a certain dynamic relationship with emergent reality in the course of adjusting to situations. This rejection of Cartesian-type dualism also serves to bridge the gap between subjective and objective experience. This form of dualism is imposed by those who assume primary qualities to be the causal source of secondary qualities such as color, shape, and sound (c.f. ch. 1). Without a concept of the selective process of interpretation there is no means by which objective occurrences can become subjective experience. In the interactionist position subjectivity and objectivity are always linked, since the organism is actively creating its environment while being created by it. The organism brings to the primary qualities of the physical world the conditions for selection, and subjective experience is one result of the physical processes of interpretation. In this functional description, the distinction between objectivity and subjectivity blurs. Likewise, in the neocortex there is the "raw" experience of primary qualities registering in the primary ares of the cortex, including the experience of contact resistance. This basic experience as sensation is not significant for forming action until it is processed and elaborated further, and it is from this complex elaboration that subjective experience arises, in whatever forms it may take.

In addition to rejecting these traditional philosophical dualistic concepts, both interactionist and neurophysiological approaches reject dualistic analyses of action. These forms of analysis are held by those who consider action to result from chains of cause and effect, the worst offenders, again, being the S-R model. In the S-R model, the stimuli come from the environment—generally from outside the organism and cause a response through a relation of processes inside the organism. Even if one assumes that some stimuli have an internal source, such as the stimuli for hunger, there is still a dualistic assumption being made. The stimulus is separate and distinct from the response because it is the causal source of the response.

The causal relationship between stimulus and response is mechanistic rather than interpretive, and therefore is not a process characteristic of living systems. In a mechanistic process, the stimulus X causes some change in the system which links X to response Y, which is the output. A soda machine, for example, receives a quarter which initiates the sequence by which it releases the soda. The interpretive process, in contrast, is not one of cause and effect. The selection of stimuli on the basis of self-organized criteria comes prior to the stimulus, intervening between cause and effect, and adding a degree of complexity in which such direct causality is lost. The activity of the organism and the CNS, therefore, does not occur through passive mechanistic processes, but through interpretive, adjustive processes. The soda machine does not maintain itself as it receives quarters and releases beverages, while the person drinking the soda is quenching his or her thirst. By failing to account for the adjustive relationship between the organism and emergent reality, those who use S-R models cannot adequately describe psychological processes and purposes for action in physical terms.

1 This information has already been "translated" twice, in the sense organs, and in the synapse of the thalamus. There are also several other subcortical paths which sensory information may take.
The stimulus-response model is also flawed in that it assumes a *determinant sequential path of action* from a specific stimulus to a specific response. The interactionist model, in contrast, allows active modification of the act as it occurs, and thus is more consistent with the connectivity of the brain. As described above, action is built up as the organism anticipates future conditions in organizing present conditions. This process is indeterminate because the organism continuously interacts with the novel conditions of the present. The act, therefore, is not simply the release of a response but is instead an ongoing process of modification. We modify immediately how much strength we use to lift a tea kettle as we discover how heavy it is. The course of action does not follow a predetermined path but fluctuates with emergent reality and can be redirected. Openness to modification also gives the act flexibility, where the response to stimuli is largely inflexible and determinant in the S-R model. It is not clear, for example, how the same stimuli can have different meaning in different situations, whereas in the interpretive model the meaning can be built up fairly independently from the specific nature of the stimuli. When one is hungry, the box of breakfast cereal is a source of food. When one has just eaten, the box is something to put back in the cupboard. Though the box itself looks the same in both instances, its meaning depends upon what we are going to do with the object. In the brain, different sources of sensation, limbic involvement, and memory are organized differently in both actions.

Perhaps the most significant link between the neurophysiological and interactionist concepts of action is that both account for the simultaneous occurrence of both sequential and parallel forms of information processing. This link makes possible the integrated model of action which is the primary thesis of this paper. For action to be anticipated yet monitored and modified simultaneously, both parallel and sequential forms of information processing are necessary. Purely sequential models of action, such as the stimulus-response model, cannot account for the parallel processing which is readily observable in behavior. Typing is an example of sequential and parallel processes operating simultaneously. We type a given sequence of words from left to right, but at the same time monitor what we type, such that mistakes stand out as objects which we indicate. Mead describes the act as requiring parallel and sequential processes. The four phases of the act often follow a sequential pattern from impulse to consummation; however, as described in chapter one, each phase is present in some form throughout the act. The impulse, for example, calls out both sensory and motor images which anticipate both what one perceives and what one may do in the future. Manipulation and perception also occur simultaneously as we monitor what we do. Likewise, the symbol calls out the result of the act before it occurs allowing us to consciously guide our line of activity. All of these capacities require parallel processing of information in order that they can occur simultaneously as well as sequentially.

The ability to handle parallel and sequential processes simultaneously is reflected in the anatomical and functional organization of the neocortex, especially with the reciprocal flow at the peak areas of the limbic diamond. As described in chapter two, in addition to sequential connections between sensory and motor areas of the cortex, there are also connections flowing from motor areas in the frontal lobe back to sensory areas. There are also parallel, reciprocal connections between the limbic system and both sensory and motor areas. Other nuclei, such as certain thalamic nuclei, have reciprocal connections with only a specific area of the brain, such as a specific motor area. These feedback loops could modify, inhibit, or intensify communication among different brain areas. For example, cortical connections with the limbic system allow a two-way flow of information from both sensory and motor areas. Thus the limbic system can influence and be influenced by both sensory and motor areas. These connections operate in parallel because they have separate axonal pathways in the brain, and they can operate simultaneously since separate groups of neurons can fire at the same time. This is seen in metabolic scans of cortical activity. These scans show entire regions of the cortex to be more active than others depending upon the task. When subjects are asked to imagine walking down a street, for instance, the
prefrontal areas and the visual association areas become more active, though other areas of the brain are also active.

The presence of parallel and sequential processes in both neurophysiological and behavioral facets of action calls for a new model for describing human conduct. A model of action for both humans and other animals must acknowledge holistic, interpretive, and adjutive processes involving non-determinant, bi-directional flow of activity from which action emerges. A purely sequential model of action would not make sense given such connectivity. This is especially true for models which presuppose that information flows in one direction only, from sensory input to motor output.1 An arrow from sensory to motor areas in the frontal lobe might represent the flow of sensory stimuli to motor response. However, an accurate model would also have to show arrows flowing back from motor to sensory, or from limbic and subcortical areas, and the arrows themselves would be modified through various reciprocal feedback loops. Thus any one area of the brain could have millions of arrows of connectivity and could potentially be influenced by most other areas in the brain either directly or indirectly. Any attempt to find strict sequential relations between stimulus and response in such a system is futile. The model of action which can account for such connectivity cannot do so by imposing causal sequential relations among the organism and its environment.2

Serial and parallel processes are evident both in action and in the structure and functions of the neocortex. The necessity of both processes in action, however, show that both symbolic interactionism and neurophysiology support a consistent perspective of the nature of reality. Both parallel and sequential processes are necessary and interdependent in a model of action as adjustment between a living system and its surroundings. Activity is handled in and modified by an interpretive process by which the organism deals with novel events in its surroundings. The organism, in order to maintain itself, requires both an emergent structure and an openness to novel events. Acts are built up in this co-determinant process. The emergent structuring that confirms novel events is accomplished largely by sequential processes. The organism confirms novel events by sequencing a line of activity which both anticipates future occurrences and handles immediate occurrences. The organism also must be open to novelty, such that ongoing action can be modified. This requires a simultaneous monitoring of activity while it occurs, which is possible through parallel processing of information. The organism maintains itself by keeping a balance between novelty and confirmation at a dynamic level which is far from equilibrium. Shifts in this balance are, generally speaking, the impulses which organize further activity, the fuel which keeps activity going. The combination of parallel and sequential processes, therefore, is characteristic of the common dynamics by which all living things persist, the

1 The idea that information flows primarily from sensory to motor areas is still a fairly predominant view in the neurosciences, even though most grant that information may follow parallel pathways to the frontal cortex and other areas. Relatively little attention in the study of behavior has been given to the function of reafference from motor areas, though interest in these connections seems to be increasing lately.

2 I have used the stimulus-response model as a running example of the sort of passive, dualistic, mechanistic, and deterministic model of action which both symbolic interactionism and neurophysiology reject. The S-R model has been the scapegoat here, as it often is in Mead and Blumer's writings. The flaws of the S-R model, however, may apply to any model of action of living organisms, human or otherwise, which presupposes a causal or sequential chain of action, a dualistic distinction between the organism and its environment, or which fails to account for interpretive, adjutive relationship between the organism and its surroundings. Such models of action are found in most fields of the social and biological sciences. Some sociobiologists, for example, attempt to reduce social action to genetic determinants. Some sociologists often propose social forces which determine behavior, and some psychologists look for "attitudes" which determine behavior. The alternative model proposed here has many implications for comparative studies with other theories, as well as methodological issues; however, such discussions are not within the scope of an introductory theoretical paper.
process of adjustment. Thus the most intriguing link between symbolic interactionism and neurophysiology is that both hold a consistent view of reality as an adjustive process. Furthermore, there seems to be several elements of action where Mead seems to have anticipated both the connectivity and function of the CNS as well as its evolution, despite over half a century of new research in neuroscience. We have explored the major theoretical similarities in this chapter. In the chapter four I will suggest how serial and parallel processes and limbic diamond interaction in the brain can be integrated with Mead’s description of the act.
Chapter 4: An Integrated Analysis of the Act

Since this paper serves as a research proposal rather than a compendium of research in its own right, the theoretical similarities between the neurophysiological and symbolic interactionist perspectives is perhaps more relevant at this stage than extensive specific examples of neurophysiological components of social psychological processes. A theoretical framework can guide future study of both perspectives, especially since so few attempts have been made to integrate these approaches to the study of human action. In this light, the final chapter of this proposal will serve as a sample of the wealth of insights possible through an integration of symbolic interaction and the neurosciences. In this chapter I will discuss several specific similarities between Mead's description of the act, and the neurophysiological model presented in Chapter two. I will focus particularly upon the role of reciprocal connectivity and interaction in the "limbic diamond" area of the neocortex, and more specifically upon the role of the limbic system in the act.

The impulse

The limbic diamond connectivity and the limbic system is implied throughout Mead's description of the act. I will introduce the relation of limbic diamond influence to the act with a discussion of the impulse, and will note other possible roles for this connectivity in the other four phases of the act. The impulse relates to the limbic diamond connectivity along two general aspects introduced in chapter one; the origin of impulses in the ongoing process of adjustment, and the role of the impulse in sensitizing all phases of the act. For the first aspect, it is speculated that, at the cortical level, the impulse arises from the complex interaction of the limbic system and limbic diamond areas, rather than from the stimuli received in the primary sensory areas. Second, Mead's description of the impulse implies several aspects of limbic output. An impulse with a limbic source could sensitize both motor and sensory cortices, and be instrumental to projecting future lines of activity. The act which begins with the limbic diamond interaction differs from serial information processing or S-R type models, which would propose that the act begins with sensory information reaching primary cortices. Our physiological model, though speculative, would support Mead's concept of action is an interpretive process of adjustment rather than a passive model of stimulus and response.

The impulse as an adjustive process is a tendency to reorganize, to various degrees, lines of activity which confirm novel events. Since novel events take many forms, from headaches to street riots, the organism must have an ongoing capacity for some form of active adjustment to all changes in its world if the organism is to survive. Therefore, for adjustment to take place, a complex representation of the world must be maintained to meet and handle novel events. It is possible that interaction in the limbic diamond area is where the most complex processes of adjustment to changing situations takes place, insofar as cortical activity is involved. Further, the impulses which begin the act may arise primarily

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1Many acts and processes of adjustment, such as autonomic functions, maintaining posture, or repetitive actions such as walking, may rely largely on subcortical interaction. Subcortical interaction can certainly
from limbic diamond interaction. There are several factors supporting the position that limbic diamond interaction begins the act. First, the limbic diamond area constructs the most complex representation of ongoing activity such that it is able to adjust to novel events reaching any sensory area, as well as internally generated events. Primary areas do not have this capacity for adjustment on their own. Emergent events must be made relevant to the entire organism if the entire organism is to adjust to them. Information reaches primary areas in its least elaborate form and in the form distinct for the particular sensory mode. Only visual information reaches visual primary areas, only auditory information reaches auditory primary areas. For information to be useful, it must undergo elaboration in association areas, where information from different sensory modalities is mixed with information from the limbic areas and frontal association areas. The limbic diamond areas, therefore, are where the most complex processing of novel stimuli occurs at the cortical level. With complex reciprocal connectivity in these areas, all major cortical and subcortical functions can be "represented." Sensory information is available as multimodal gestalts of the external sensory world and as sensory imagery, such as visual imagery of imagined objects. Symbolic information, such as auditory or written words, is also processed in the limbic diamond area. Subcortical information such as hunger or sleepiness, and emotional information may also be present in the ongoing representation of the world in the limbic diamond area.

Limbic diamond interaction also carries past experience into the present, and thus orients the organism to new stimuli. Binding the past to the future to organize present experience is the essence of the adjustive process. Binding one moment to the next includes the reconstruction of distant past experiences, or long-term memories: however, it is the short-term memories of the immediate past, perhaps, which maintain the ongoing orientation toward situations over time. The immediate past is always oriented toward the future as a projected line of activity one constructs continually to meet situations. For example, the perception of distant objects involves projecting a future contact relationship on the immediate sensory experience. The individual anticipates a future hypothetical relationship with the object on the basis of which novel information is organized. As mentioned, the adjustive process is the essential dynamic of living organisms, and is therefore a continuous process. The adjustive process, then, involves monitoring or interpreting incoming information according to the internal representation of the world which is constructed continually. At the neocortical level, this process occurs between the limbic diamond areas adjusting to unelaborated information from the primary areas and subcortical areas.

It is from the interaction between the complex, ongoing representation of the world and the emergent conditions or novel stimuli that impulses arise. The impulse arises out of fluctuations in this ongoing adjustive process. These fluctuations are possible where interaction is highest, where the sensory and internal world has its most complex representation, and where the past is bound to a future line of activity. Emergence of the impulse is a capacity essential for the organism's self maintenance, since an impulse is necessary for changing one's line of activity to meet emerging situations. The more complex the representation of the situation, the more likely and more discriminating the fluctuations may be, making impulses more likely to occur. The organism can adjust to these discrepancies with more complex and finely organized action. The complex limbic interaction in human beings, therefore, is adaptive for acting in a more complex social world, and also allows the social world itself to evolve. Thus out of the highest complexity influence activity at the neocortical level, and therefore carries on some of the functions to which I ascribe to the limbic diamond area. I will mention some aspects of subcortical interaction below; however, I will focus discussion on neocortical and limbic system adjustive processes and leave implicit that subcortical systems, in fact the entire organism, are involved in adjustment as well.
of interaction comes the most order, through the more adaptive interpretation of emerging conditions.

The impulse itself seems to have its source, for the most part, in the limbic system. Though the impulse arises out of the interaction of the limbic diamond and the rest of the CNS, impulses have effects similar to limbic influences on activity and information processing described in chapter two. This suggestion gives Mead's concept of impulse a significant link to neuroanatomy and physiology. Mead's concept of impulse has two similarities to limbic influence on interaction. First, if impulses originate largely through limbic processes, it can be seen how the impulse can mobilize action and sensitize all parts of the act in building a new line of action. Second, the limbic system's general functions in survival processes are similar to Mead's concept of the impulse as geared toward self-maintenance.

According to Mead, impulses reorganize the organism's line of action by sensitizing all phases of the act—perception, manipulation, and consummation. He suggested that the tendency to act calls out "imagery," both motor and sensory imagery, which orients the organism toward selecting certain stimuli, and simultaneously begins to organize the form of manipulation, both processes referring to the goal or consummation of the given act (Baldwin, 1986: 56). The limbic system is a likely source of the impulse in this respect, since it has heavy reciprocal connections to both sensory and motor areas. The limbic system receives information from cortical and subcortical areas in building up the "inner world" which can serve as source of the impulse; but it is, perhaps, in the outflow of limbic influence that the previous line of action is reorganized and the new act begins. For the impulse to sensitize all parts of the act, it must interact with both motor and sensory activity. The limbic system has access to both motor cortex and sensory cortex simultaneously through parallel pathways. Both the hippocampal and olfactory trends of connectivity branch out to all sensory areas, especially association areas where elaboration of information occurs; they also send two-way connections to motor cortices, especially the supplementary and prefrontal cortices where planning and sequencing of behaviors occurs. Thus an impulse of hunger, arising primarily from the hypothalamus and reaching the cortex via the limbic system, can branch out to prime sensory areas for the selection of stimuli relevant to the act of eating. The hunger impulse can simultaneously prime the motor areas to begin sequencing lines of response. For human beings (if they should decide to act on the impulse), objects related to finding food become meaningful toward this goal, including objects emerging from memory. Complex motor sequences for attaining the food can be formulated simultaneously. Though it is not known exactly how such "imagery" from the limbic system interacts with neocortical areas, it seems that Mead had correctly assumed the connectivity involved in this process.

Mead's description of the impulse is also similar to limbic system's functions in the self-maintenance of the organism. I argued in chapters two and three that the whole of the organism, and the CNS especially, is involved in the process of self-maintenance. As the brain evolved, later stages developed mainly as elaborations of the self-maintaining processes. This is not to say that the complexity of activity, especially human activity, reduces to survival behaviors alone, but rather, self-maintenance expresses the dynamic exchange of confirmation and novelty characteristic of the self-organizing adaptive process. Mead implies that similar processes of self-maintenance lie behind the

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1 The evolutionary trend toward more complex adjustment processes may be one reason why the primary cortices emerged most recently and are subjected the least amount of limbic influence. The primary sensory areas add the luxury of more precise sensory information that would make discrepancies between the anticipated and actual sensory experiences more likely. With these fluctuations, impulses arise which can mobilize action around small changes in one's surroundings. This would be very useful for manipulating physical objects, and corresponds to the primary motor areas which allow precise movements.

2 C.f. chapter 3
act. "We assume that there are impulses, the tendency of the organism to act in a certain way due to the sensitizing of the organism or to the organization of action that will set free the tendency to act and to replace the energy expended in the act. 'This is intelligence' (Mead, 1927: 112). Mead speaks here of the intelligent selection of matter, energy and information for self-maintenance. The limbic system and other subcortical areas such as the hypothalamus handle many of these self-maintaining processes, such as feeding, excretion, blood pressure, and reproduction. The limbic system is also a "driver," to use MacLean's term, of the subcortical autonomic functions (Isaacson, 1982: 240). In addition to regulating subcortical survival functions, the limbic system may also give self-maintenance "priorities" to information processing in the neocortex. The limbic cortices, for example, influence the act with emotional tone, and relay feelings from subcortical areas such as pain, hunger, and sleepiness. Human beings can choose to ignore such feelings as hunger, but will generally act upon the messages from limbic areas which alert the organism to what it needs to maintain itself. Similarly, Mead describes the impulse in terms of feelings. "[Acts] start with the impulses seeking expression, impulses manifested as feelings such as hunger" (Mead, 1927: 108).

According to Mead, the impulse reduces to energy ready to express itself as the organism adjusts to emerging stimuli (Mead, 1927: 112). This suggests that the impulse as energy is similar to the limbic system's function of "energizing" various systems in the neocortex (Yeterian and Pandya, 1988). This relationship is another aspect of the limbic system as impulse sensitizing the entire act. The impulse as "energy" may drive such processes as memory association and creative association that are crucial to the selection of stimuli. In the motor areas, the impulse energizes the process by which behaviors are organized and future ines of action are projected. Limbic influence also extends to subcortical areas that are also crucial in reorganizing the current line of activity with the impulse. The impulse as energy is seen in both the inhibitory and excitatory interaction among the limbic system and other areas.

Mead described the impulse orienting the selection of relevant stimuli. The selection process will be discussed further in the context of perception. The energy of the impulse from the limbic interactions (or possibly from other subcortical areas) may drive processes of memory association and also the creative association of ideas. This emergent property of the association process may account in part for the indeterminacy in the formation of action. Memories may take the form of imagery, including visual imagery and auditory imagery such as spoken words or music. Ideas or thoughts may also involve imagery or symbols which are reorganized creatively. Both memories and ideas, however, are similar in that they are constructed in the present. It is the process by which they are constructed or called out that may be relevant to the energy of the impulse. Memories and ideas tend to emerge in relation to the situation at hand; however, they do not arise in a causal linear fashion such that the causal source of a particular idea is obvious to us. Think of a word at random, and there is no way to determine why you associated that thought rather than another. Similarly, we often get ideas or flashes of memory completely unrelated to the situation at hand. This suggests that memory and creative association emerge in a non-linear fashion; they may follow the general parameters of the situation at hand, but also have a random, indeterminate element which makes it impossible to predict exactly what thoughts may emerge in any situation. The non-linearity in the process by which thoughts arise suggests that the memory association areas are "driven" by other areas which energize the non-linear organization of memory images. This process applies to motor association as well, and the emergent organization of motor sequences. The source of this energy may be the limbic system or other subcortical systems, and most likely several systems are involved. The cingulate gyrus, for instance, energizes activity in the supplementary frontal cortex, but also has connections to the sensory association cortices (Yeterian and Pandya, 1988). The exact mechanism of the association process is unknown. The relevant point here, however, is that since association is driven in a non-linear fashion, there is always an element of indeterminacy in the process of using past
experiences to interpret present situations and project future lines of action. Thus the non-linearity of the interaction among limbic diamond and other areas adds to our previous arguments that acts are formative, and are built up as an emergent, indeterminate process.

The energy of the impulse, in addition to driving association processes, relates to the motivation of the sequencing process by which future lines of activity are projected. The cingulate gyrus, for example, is seen as motivating the sequencing of plans taking place in the prefrontal areas such that responses can be carried out (Yeterian and Pandya, 1988). The cingulate gyrus does not actively plan motor sequences on its own, but may give a direction or tendency to these plans of action in relation to the holistic representation of the situation in the limbic diamond interaction. Limbic influence, therefore, may contribute to the process whereby future lines of action are projected and carried out.

The impulse as expressed by limbic influence is a crucial part of the process by which activity is organized at the cortical level. The limbic system, however, also influences subcortical systems. The reorganization of the line of activity at the subcortical level is crucial for changing and modifying one's line of activity. The limbic system can have various inhibitory and excitatory influences on subcortical areas, and in this way can drive subcortical elements of action on the basis of the representation of the situation maintained by interaction in the limbic diamond areas. The basal ganglia, for instance, must receive a signal from the limbic system to inhibit the current direction of motion. A break in connectivity between the basal ganglia and higher cortical regions results in obstinate progression in which the animal cannot avoid walking into obstacles it clearly perceives.

Mead's concept of the impulse seems, in many ways, similar to the functions of the limbic system in organizing behavior. Mead may also have implied a reason why the limbic system is so heavily interconnected with the neocortex. The limbic system has access to cortical and subcortical information concerning the activity of the entire organism, and thus could signal problems in adjustment occurring at both the cortical and subcortical level. The limbic system's general role in survival functions supports this hypothesis. Further, the limbic system can reorganize the course of activity at subcortical and cortical levels through its outflowing connections to these areas. At the cortical level the limbic system could sensitize all parts of the act, in giving direction to the selection of stimuli, driving memory association and projecting future forms of manipulation in the frontal lobes. A limbic impulse could reorganize all of these areas simultaneously, thus allowing immediate response to problematic situations. A serial model which begins the act with the stimulus in the primary areas would require the relevant stimuli to be perceived and elaborated before being acted upon by motor areas. With the limbic impulse as the beginning of the act, the prefrontal areas could be sensitized such that the line of action could be planned out before relevant stimuli are discovered and perceived. The neuroanatomical and physiological model of action, therefore, suggests significant parallels with Mead's concept of the impulse.

Perception

Mead's concept of perception shows two aspects of the influence of the limbic system and the reciprocal connectivity of the limbic diamond; in the selection of stimuli, and in the construction of an environment of objects. These two processes are important for relating sensory stimuli to the line of activity one constructs to handle situations. I will discuss here the neurophysiological aspects of the selection process and the process by which perception leads to the construction of meaningful objects.

Mead describes the selection and interpretation of stimuli as essential for the process of perception. The process of selective interpretation is plausible from neurophysiological perspective, although the mechanisms of this process are not well understood. The impulse, as expressed by limbic influence, was described above as sensitizing sensory areas to certain stimuli by calling out sensory imagery related to the
resultant of the act at hand. This orientation to stimuli is necessary for the selection process. Even with unexpected events, the organism must be prepared in some way to receive and interpret the stimuli. "In the instance of a firecracker exploded behind the chair, the stimulus is largely from the outside, but it depends on the organism itself as well. The more complex the organism, the more definite the stimulus must be" (Mead, 1927: 113). Though the interpretation of stimuli is only possible by the interaction of stimuli with the orientation brought to it by the organism, the mechanisms in the association cortices which make this possible are not understood. One clue may be the patterns of connectivity to the six cell layers of the neocortex described in chapter two. One layer of cells receives information coming from the outside world through the primary cortices. Other layers receive information flowing out of the limbic and association areas toward the primary areas (c.f. Figure 6). Thus in the association cortices, information from both the external sensory field and "internal" representation of the world maintained in the limbic diamond interaction are superimposed (Yeterian, 1985). The interaction of these layers, however, is not understood, but these patterns of connectivity show that internal and external information flow in close proximity, and thus some sort of selection mechanism may be in operation.

From this selection process, an environment of objects is built up. The perceptual environment one experiences combines what is "out there" in the form of sensory information reaching the primary areas with what the organism adds to this raw sensory information in the interpretive process of selection. The neurophysiological model suggests that perception does not occur in sensory areas alone, in isolation from the rest of the CNS. Limbic and frontal association also play a role in perception; and this is consistent with Mead's description of the object. It is not possible to conclude here exactly what the neural representation of objects may be, both physical objects and especially social objects. Mead's description would suggest, however, that the limbic system and frontal areas are involved in the construction of objects.

We can assume that limbic influence is involved in perception simply from the degree of connectivity one finds in sensory association areas. I described the possible role of limbic influence "driving" the processes of memory and creative association and sensory imagery that meet and interpret incoming sensory stimuli. The limbic system may also convey information about the general tendency or direction of the given act as expressed by the impulse; for example, an impulse of fear may direct perception toward objects related to a path of escape. Similarly, the limbic influence may add emotional tone to our perception of objects, not necessarily as a distinct sensory experience, such as "seeing red" when one is angry, but in terms of how we interpret stimuli in terms of future action. Affective information, then, may also contribute to selecting relevant stimuli and constructing objects. Depending, to an extent, on one's mood, a rainy day can be refreshing, or miserable.

Information processing within the sensory areas is also an increasingly interactive process in which the specific modalities such as sight, hearing, and odor may blend into various multimodal representations of the world. This occurs primarily in the multimodal association areas in the sensory association regions which receive connections from several modalities. Such a blending of sensory information would occur in parallel to our experience of distinct modalities. Sensory information, then, becomes increasingly interactive with limbic and multimodal information. Sensory information also interacts with motor information.

The motor areas, especially prefrontal association areas, interact with sensory areas via reciprocal long connections, and are increasingly interconnected approaching the limbic areas (Yeterian and Pandya, 1988). Since the impulses from the limbic system can sensitize motor as well as sensory areas to the general direction of the act, the form of manipulation may be organized at the same time that sensory information is received. Through these two-way interactions, sensory information becomes increasingly interactive with the anticipated manipulation one will have with the object. Thus, in the limbic
diamond area, what is experienced is related to what one will do with an object in the future. This is essentially what Mead has termed the meaning of an object, a combination of both the sensory experience of a thing and its relationship to future action. With perception of the distant object, the addition of future manipulative or contact information to it gives the relevance of the distant object to future action. This future quality, as mentioned, is the hypothetical nature of the distant experience which guides the developing act.

This physiological model of perception seems quite consistent with Mead's description. It also offers an alternative to serial models which propose that sensory information flows in one direction, from perception in the sensory areas to further processing in the limbic areas and output as behavior in motor areas. If perception took place exclusively in the sensory association areas, it is difficult to see how meaning could be so thoroughly mixed with what we perceive. Models which do not consider the relevancy of reciprocal interaction among frontal, limbic, and sensory association areas, then, are left essentially with the stimulus-response model of action.

**Manipulation**

Similarly to perception, manipulation at the cortical level is not limited to the activity of the frontal motor areas. Manipulation involves both sensory and motor cortices as well as limbic and subcortical structures. Mead shares the idea that manipulation has both sensory and motor components. Manipulation involves not only the behaviors which accomplish an act, but the monitoring of those behaviors through the contact experience. As described in chapter one, contact confirms the hypothetical nature of the distant object. The capacity of manipulation to confirm the distant experience is seen in the connectivity between motor and somatosensory areas. Heavy reciprocal interconnections are seen between motor areas and somatosensory areas including primary, secondary, and association areas; for example, the primary motor areas which control each muscle in the body correspond to the receptors for somatosensory information from those same areas. The hands have among the greatest cortical representations in both the somatosensory and motor areas (Kolb and Whishaw, 1985: 176).

Such heavy interconnection is necessary because movement requires simultaneous somatosensory feedback to modify the amount of force applied by the muscles. One may anticipate how heavy a coffee cup may be, for example, but the muscles adjust to the actual weight upon contact. Direct somatosensory feedback is also necessary for motor sequences such as walking or drumming one's fingers on the table. The resistance of the table tells the motor areas when to start lifting the fingers. Contact experience of resistance, therefore, can have an immediate influence on the form and force of manipulation being applied.

Contact experience, however, can reach beyond the motor and somatosensory areas. Both areas are either directly or indirectly interconnected with other sensory and motor association areas and the limbic system. With such feedback the entire line of action can be modified by contact experience. Similarly, the hypothetical nature of the line of action based on perception of distant objects can be confirmed and modified by contact experience feeding from the somatosensory and motor areas. Thus the cortical areas involved in manipulation are able to confirm the hypothetical nature of the distant experience, which, in Mead's terms, gives the reality of the physical thing.

Mead took a different approach to describing sensory and motor functions when it was common during his time to keep motor and sensory functions separate, with sensory lobes handling perception alone, and frontal lobes handling all aspects of behavior. In Mead's analysis, both perception and manipulation have motor and sensory aspects. Motor aspects of perception include the active orientation of the body to stimuli and also the implications of future lines of activity involved in giving contact qualities to distant objects. Manipulation has a sensory aspect in somatosensory feedback, and also in the influence of
perceptual information in guiding the form of manipulation. Mead did not divide the world into sensory input and motor output, but into contact experience and distant experience. In doing so, Mead predicted very closely Sanides' (1972) model of neocortical evolution.

Mead's description of sensory and motor functions as contact and distant experiences closely parallels the evolutionary development of the neocortex. In chapter two I described the two trends in the limbic system from which the neocortex evolved, the hippocampal and olfactory moieties. Both trends evolved into motor and sensory areas; however, each trend specialized for handling either distant or contact objects. The hippocampal trend leads to areas which deal with manipulation of the trunk and limbs and somatosensory experience had by that manipulation. From the olfactory trend evolved areas such as central vision and audition which handle distant sensory objects, and also the motor and somatosensory functions serving the head, neck, and face. The implications of these relationships between contact and distant experiences and the evolutionary patterns of the brain have yet to be worked out. There are, however, many tantalizing implications which warrant further investigation. For example, the olfactory trend which handles distant experiences also include Broca's area in the ventral prefrontal lobe and Wernicke's areas in the temporal lobe, both of which have a role in language.

Given the consistencies between Mead's description and neurophysiological data, the analysis of human action in terms of distance experience and contact experience rather than separate sensory and motor functions may be fruitful approaches for both symbolic interactionism and the neurosciences. In fact, in the neurosciences there has been much attention given in recent years to the problems of distinguishing sensory and motor functions in the CNS and in behavior. ¹ Mead's description of the act may suggests an alternative line of inquiry for the analysis of motor and sensory processes of action.

Consummation

Where Mead's descriptions of perception and manipulation relate fairly clearly to neurophysiological processes, the physiological elements of consummation are less clear, even in terms of speculation. Nevertheless, I will discuss here the relationship of the limbic system to Mead's concept of consummation. Limbic influence seems to be involved in giving the "value" of the act, as Mead described it, and also in coding significant experiences into long term memory for future use. The limbic system may also be involved in relating the complex interaction of emerging stimuli and various elements of the act into a more global experience of a situation.

Mead describes consummation as defining the value of an act (Mead, 1938: 445-453). He suggests that there is an experienced emotional dimension to consummation, such as satisfaction. "Consummation is satisfaction and, if you like, happiness..." (Mead, 1938: 136). The implications of an affective dimension to consummation suggest the involvement of the limbic system. Mead's view would make sense in light of suggestions that impulses arise partly from fluctuations in the limbic system's interaction with limbic diamond areas. When the discrepancy of the fluctuation is resolved, the limbic system may inform the rest of the brain with some sort of affective signal. The existence of such affective signals is certainly speculative, but corresponds somewhat with our introspective experience of the feelings which accompany the completion of an act. Even if an act does not always result in a feeling of satisfaction, there seems to be a perceived shift as one changes from one act to another, or one train of thought to another.

A cue from the limbic system which signals the end of a given act, however, would also be adaptive in organizing increasingly complex actions. If the neocortex operates by the rapid and abstract association of memories, ideas, and multimodal sensory and motor information, there may be need for a less rapid, global cue which signals when the given

act is complete and when attention should shift elsewhere. The limbic system is a likely candidate for this function since it has full access to cortical and subcortical information, but seems to operate less rapidly than information flowing at the cortical level. Moods and emotional states, for example, tend to shift less rapidly than ideas and memory images.

There are two implications for such limbic influence in consummation; first, that consumption may be related to the coding of long-term memories; and second, that the limbic system may help the organism develop and maintain a global experience of situations. If consumption gives the value of an act it may also give the act's value for use in future action. In other words, the consummation of an act may label what experiences in the act are significant for memory. Recall from chapter two that the coding of long term memory occurs in the limbic system, primarily in the hippocampus and amygdala. Though it is not certain that the coding of all memories is driven by the consummation of acts, this may hint at why memories are often value-laden. Past experiences are not just flashes of imagery but are good, bad, successful, pleasurable, and so forth. These value-laden qualities of past experiences are useful for anticipating future lines of activity and defining the meaning of objects. Mead gives a similar description of the use of value-laden memories. "In terms of these values we can analyze the act" (Mead, 1938: 452).

The limbic system's involvement in consummation implies that limbic influence may help to bind the complex interaction of memories, ideas, and changing sensory information into a more global experience of a situation. There are three factors supporting this conclusion. First, I have suggested that impulses sensitize all phases of the act, and that the limbic system is a major source of these impulses affecting both neocortical and subcortical areas. Also, impulses continue throughout the act adjusting to emergent conditions; thus, limbic influence is also present throughout the act. Second, since it seems that information in the limbic system is processed more slowly and shifts more gradually than the rapid interchange of information in the neocortex, limbic influence may regulate the flow of neocortical information. The limbic system may dampen minor fluctuations in the rapidly changing sensory information, ideas, and memory associations which may conflict with each other and disrupt the line of activity at hand. The difference in processing speeds may therefore coordinate the different phases and sub-components of activity around a globally organized goal or purpose of the act. This relation between limbic and neocortical information flow, then, may contribute to our awareness of reality as situations rather than random streams of events. A third factor in this argument, however, is that limbic and neocortical interaction is still open to any major fluctuations which warrant a change in the organism's line of activity. Such fluctuations result in the impulse for a new act. The dynamic thresholds which dampen impulses fluctuate as well. One may be more sensitive to sudden noises in a dark house than during the day. Impulses for new acts then may arise with some major fluctuation such as a problematic situation, or may arise as previous acts are consummated and give a limbic signal that the act is through and that attention may shift. In either case, activity is continuous as the organism handles a continual stream of new situations.

The limbic system seems to be involved in maintaining the impulse of adjustment throughout the act, dampening minor fluctuations in cortical activity and reorganizing action to handle major fluctuations. Through these processes the limbic system plays a major part in organizing the individual's reality into situations rather than unrelated streams of acts and stimuli. Neurophysiology, therefore, may offer one explanation of how we experience action as situated.

Summary
In this chapter I have added to the general theoretical links described in chapter three some specific links between Mead's description of the act and the neurophysiological model of action. I have focussed primarily upon the role of the limbic system and the reciprocal interaction among the limbic diamond areas which include frontal association and
sensory association areas and the limbic cortices. For the impulse, I suggested that the limbic system is involved in monitoring the ongoing interactions with the world represented at the cortical and subcortical levels, and also in initiating impulses directed toward resolving fluctuations in the adjustment process. The limbic source of the impulse can reorganize activity in both sensory and motor areas and thus sensitize all phases of the act. Links to neurophysiology in the process of perception include the relation of impulses to the selection and interpretation of stimuli. Limbic diamond interaction in general was related to the process of constructing and environment of meaningful objects. The discussion of manipulation suggested how contact experiences can confirm hypothetical distant experiences, and how the description of sensory and motor functions as distance experience and contact experience correspond to the evolution of the neocortex. Finally, I speculated upon the roles of the limbic system in consummating the act, in terms of signaling the completion of an act, and adding value qualities to experiences relevant to memory. I also suggested the limbic system’s general role in organizing experiences and action into situations.

There are many more possible links between neurophysiology and the interactionist perspective of action which were not discussed here. They include such issues as indication, symbolic interaction, mind, thinking, role-taking, the self, and social coordination. There are many specific issues in neurophysiology and symbolic interaction which would warrant further research. Further integration of interactionist concepts in the neurosciences would suggest the following lines of research:

1) The development of models of action and information processing which take into account the bi-directional flow of information among the frontal association, sensory association, and limbic cortices. Models which proposes a serial and sequential flow of information from sensory input to motor output should be reevaluated.

2) Further exploration of the relation of contact experience and distance experience to sensory and motor functions in neurophysiology and behavior, especially from an evolutionary perspective.

3) The study of reafference, or the reciprocal connections from the frontal lobe to sensory areas, and their relation to thinking and symbolic interaction.

4) The general study of the limbic system and its relation to higher brain functions and behavior.

Researchers continuing the integration of neuroscience with the interactionist perspective might explore the following issues:

1) George Herbert Mead’s perspective of neurophysiology, evolution, and the system dynamics of the act, especially adjustment and the impulse.

2) The process of indication and its relation to mind, self, and symbolic interaction.

3) The implications of the limbic system’s role in behavior and its relation to human group life, including such issues as emotions, motivation, and the management of behavior in social situations.

4) Child development and the relation of symbolic interaction in children to the development of the brain.

Finally, both perspectives may benefit from continuing the evolutionary approach in the study of brain, human conduct and group life, and the system dynamics of adjustment common to all living things.

Even a cursory study of these topics would be inexhaustible; also, it is difficult and perhaps fallacious to pin these social processes to specific functions of the central nervous system since these are as much products of symbolic interaction as they are physiological processes. Further, the processes of symbolic interaction and of the central nervous system hold many unanswered, perhaps unanswerable, questions which may limit our efforts to integrate the two fields. I hope to have shown, however, that the similarities between the symbolic interactionist model of action and that of neurophysiology make the effort of developing a unifying theory worthwhile.
References


