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BRIDGING BOUNDARIES VERSUS BREAKING BOUNDARIES: PSYCHOLINGUISTICS IN PERSPECTIVE*

Is psycholinguistics a twice-failed attempt at interdisciplinary science, as suggested by the contributors to this symposium? Blumenthal has drawn an intriguing account of two periods of particular interdisciplinary contact, and attributed the decline of each to imbalances in the relationship: at the turn of the century, he suggests, linguists turned to psychology for inspiration, whereas in the 1960s it was psychologists who turned to the new Chomskian linguistics. Reber has diagnosed the specific forms of imbalance for the more recent period, and takes these factors as more than sufficient cause to let each field go its own way without regret. McCauley agrees that the two "divorces" were inevitable, but also hints at the potential for a more stable relationship between the disciplines when each matures.

In this paper I argue that psycholinguistics, far from being a failure, is alive and well and playing a pioneering role as a model for interdisciplinary contact between psychology and various of the other arts and sciences. The argument has two parts. First, I will sketch a conceptualization of the structure of disciplines within which psychology and linguistics each have a clear place, but show a special form of adjacency that characterizes certain other pairs of disciplines as well. Second, I will describe how this special form of adjacency permits three types of interdisciplinary relations: boundary-maintaining, boundary-breaking, and boundary-bridging relations. *Boundary-maintaining* relations are those in which there is little contact; each discipline goes its own way working on its own tasks. Blumenthal provides a good recent example in his characterization of structuralist linguistics and behaviorist psychology in the mid-twentieth century. Occasionally, however, a position is developed within one discipline which extends across the traditional boundary with another discipline. Though inherently unstable, these episodes of *boundary-breaking* contact often play an important role by giving some needed redirection to the discipline whose territory has been encroached upon and by stimulating interest in interdisciplinary work. This is the kind of relationship that was focused upon by all three contributors to this

symposium, and was prominently featured in the fertile periods of excitement about psycholinguistics at the turn of the century, and again in the 1960s. However, the third type of relationship, *boundary-bridging* contact, also characterized the same two periods, and continues to flourish as the enduring legacy of the 1960s. Boundary-bridging is a quiet, work-a-day kind of interaction which garners less attention than boundary-breaking, but it is the only way of achieving the ongoing contact between psychology and linguistics that is needed if each field is to develop to its full potential. This less visible psycholinguistics plays a special role as a model which betokens opportunities and hazards, now that the boundary-bridging type of contact is being replicated in the relations between psychology and certain other disciplines as well. In making it more visible, I will define psychology, linguistics, and their relationship in a way that varies from Chomsky's own vision, but within which both the short-term and long-term effects of his revolution can be properly understood.

THE STRUCTURE OF DISCIPLINES

The Contrasting Missions of Psychology and Linguistics

One way to approach the structure of disciplines is to first consider the structure of the tasks that disciplines must divide among themselves. At a first order of approximation, it can be said that each discipline takes as its main mission the task of accounting for particular domain(s) of reality, for example, modelling the movement of planets or analyzing the form and meaning of sonnets (cf. Shapere, 1984). *Psychology* is the discipline which attempts to achieve a general account of the mental and behavioral functioning of individual organisms within their physical and social environment – particularly but not exclusively the contemporary, schooled, adult human. (Historically the pendulum swings between an emphasis on the mental versus the behavioral, but this has generated only different schools of thought, not different disciplines. For convenience I will often use the term "behavior" to refer to the more inclusive concept of mental/behavioral functioning.) Psychological research is directed towards the discovery of general principles of perception, learning, cognition, emotion, and so forth. These have usually been thought to operate across the broad variety of domains of behavior (e.g., language,

drawing, friendships and family relations, school performance, and the like). However, a focus on specific domains has sometimes been undertaken as a specialized task carried out by subdisciplines. For example, some psychologists have focused on language as a specialized domain of mental, behavioral, and social functioning. To characterize this subdiscipline as neutrally as possible, I will follow Reber in referring to it as "psychology of language". Psychologists of language view individuals as having knowledge of one or more languages, and activating that knowledge in specific acts of language use (comprehension, production, mental problem-solving, metalinguistic judgments, etc.). The study of this specialized functioning is justified by the conviction that, ultimately, the results should contribute to the overall account of mental and behavioral functioning which is the more general goal.

However, this is not the only perspective that might be taken on language. Language can also be viewed as a cultural product, one of several types of symbolic systems generated within the species. On this view, language is a result or residue of behavior rather than behavior as such – just as paintings, buildings, and proofs of theorems are results of behaviors that endure after the behaviors themselves are completed. As is the case for all major cultural products, there is a discipline which takes as its central task the specialized study of language as a cultural product, namely, the discipline of *linguistics*. In its purest form, linguistics treats language as an abstract object (and some linguists even make the claim that language *is* an abstract object with a Platonic reality apart from any behavior at all; see Katz, 1981). Whatever else linguists do, they will provide descriptions of the structure of specific languages, and perhaps of language in general as well. That is, linguists write grammars, and make attempts towards Universal Grammar. The grammars capture the abstract structure of language, but not the mental, behavioral, and social processes of which language is a result. This is as it should be, and it is fair to say that someone who is not writing, evaluating, comparing, or revising grammars is not engaged in the central task of linguistics. (Such a person, however, might justifiably claim the title "linguist" based on academic background and engagement in less central tasks.)

What degree of cooperation might psychologists and linguists exhibit in carrying out these tasks? Contact does not occur easily, because there is no direct mapping between the constructs of the two dis-

ciplines.—Psychologists (including those who specialize in the psychology of language) will speak of mental representations and rules and how they are applied in real time to produce or comprehend or perform other language behaviors (Clark and Clark, 1977; Fodor, Bever, and Garrett, 1974); or of Mands and Tacts and their dependency on schedules of reinforcement (Skinner, 1957); or of parallel distributed processes and how they produce variations in the production of past tense forms (Rumelhart & McClelland, 1986). The particular constructs depend upon the particular theory, but all are variations on the fundamental concern with functions that are carried out in real time (McNeill, 1975). Linguists, in contrast, identify a system of elements and rules within which any particular linguistic token is given a systematic account which clarifies its relation to larger classes of such tokens. The constructs used might include phone and paradigm (Bloomfield, 1933), or phonological rule, phrase-structure, and transformation (Chomsky, 1965), or sememe and realization (Lamb, 1966); all are means of describing the structure of language as an abstract object.

Yet there is potential for connection. Though the constructs are different, they address the same reality. There is only one universe of objects, states, relations, and events, and the two domains in question (language as behavior and language as a cultural product) are simply different perspectives or levels of regard over the same range of reality. A given bit of reality, for example the uttering of the sentence "Psycholinguistics is alive and well", provides an object of analysis for each discipline, because it partakes of both the domain of behavior and the domain of abstract linguistic objects. It will be viewed as an act of producing an utterance within psychology and as a token embodying linguistic structure within linguistics. Hence, the two disciplines will find themselves in a position of adjacency, able to address the same reality but carrying out different tasks with respect to understanding that reality. Each discipline might carry out its task in isolated boundary-maintaining fashion, but a more complete account can be obtained by incorporating interdisciplinary contact – usually of the boundary-bridging type, but occasionally of the boundary-breaking type as well.

This way of viewing the relation between psychology and linguistics is best appreciated by considering the position of these disciplines within the broader framework of an overall conceptualization of

disciplinary structure. The account that I will offer is based exclusively on the structure of the tasks which have constituted the main mission of each discipline over the last century. Sociological and other factors surely figure in the story of how those tasks have been identified and parceled out among disciplines (see Machlup, 1980, for an account), but it is only the contemporary outcome which need concern us here. The goal is to put the case of psycholinguistics in context, and to identify parallels which might strengthen and inform my analysis of that case.

Disciplinary Division as Levels in a Specialization Hierarchy

In most academic institutions, the various disciplines are grouped into divisions which suggest an implied structure of reality. There is some variation in where the boundaries are drawn and why, but certain distinctions recur persistently. In Figure 1, I have sketched one such structure. It displays the domains of reality which the primary academic disciplines claim as their objects of analysis, and highlights their grouping into four major vertical divisions (levels), with one of these divisions further partitioned into three horizontal divisions. In Figure 2, a parallel structure shows which discipline has accepted the task of accounting for certain of these domains of reality as its main mission, and labels show the disciplinary division which corresponds to each division of reality. Both figures also use arrows to highlight the particular relation of adjacency which characterizes successive levels. This form of adjacency is the focus of the analysis presented in this paper.

   The vertical organization in Figures 1 and 2 captures three of the major disciplinary divisions typically found in college catalogues, and the task of analysis which each division has adopted as its main mission: (1) accounting for the physical world (the *physical sciences*); (2) accounting for the organic part of the physical world (the *biological sciences*); and (3) accounting for the mental and behavioral aspects of the functioning of organisms (the *behavioral sciences*). At the fourth level, the task is to account for the enduring products of the mental and behavioral functioning of (human) organisms; so unlike are these various cultural products that disciplinary divisions of major consequence have emerged in accord with the nature of the product. The internal structure of the fourth level has a degree of complexity that is
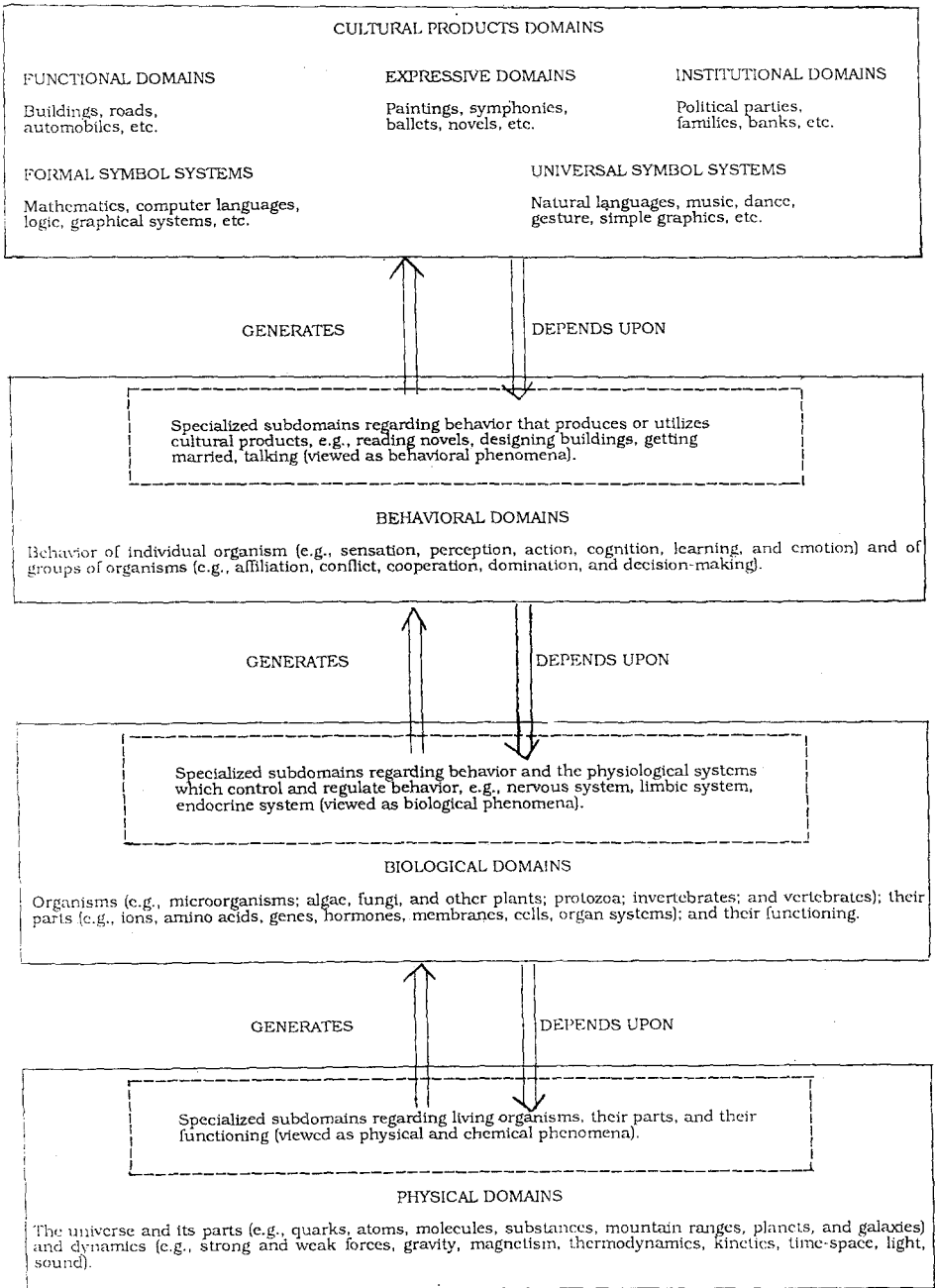
CULTURAL PRODUCTS DOMAINS

FUNCTIONAL DOMAINS

Buildings, roads,
automobiles, etc.

EXPRESSIVE DOMAINS

Paintings, symphonies,
ballets, novels, etc.

INSTITUTIONAL DOMAINS

Political parties,
families, banks, etc.

FORMAL SYMBOL SYSTEMS

Mathematics, computer languages,
logic, graphical systems, etc.

UNIVERSAL SYMBOL SYSTEMS

Natural languages, music, dance,
gesture, simple graphics, etc.

GENERATES   DEPENDS UPON

Specialized subdomains regarding behavior that produces or utilizes
cultural products, e.g., reading novels, designing buildings, getting
married, talking (viewed as behavioral phenomena).

BEHAVIORAL DOMAINS

Behavior of individual organism (e.g., sensation, perception, action, cognition, learning, and emotion) and of
groups of organisms (e.g., affiliation, conflict, cooperation, domination, and decision-making).

GENERATES   DEPENDS UPON

Specialized subdomains regarding behavior and the physiological systems
which control and regulate behavior, e.g., nervous system, limbic system,
endocrine system (viewed as biological phenomena).

BIOLOGICAL DOMAINS

Organisms (e.g., microorganisms; algae, fungi, and other plants; protozoa; invertebrates; and vertebrates); their
parts (e.g., ions, amino acids, genes, hormones, membranes, cells, organ systems); and their functioning.

GENERATES   DEPENDS UPON

Specialized subdomains regarding living organisms, their parts, and their
functioning (viewed as physical and chemical phenomena).

PHYSICAL DOMAINS

The universe and its parts (e.g., quarks, atoms, molecules, substances, mountain ranges, planets, and galaxies)
and dynamics (e.g., strong and weak forces, gravity, magnetism, thermodynamics, kinetics, time-space, light,
sound).

Fig. 1.   The specialization hierarchy for domains of reality.

CULTURAL PRODUCTS ARTS AND SCIENCES

MATHEMATICS AND ENGINEERING SCIENCES	HUMANITIES	SOCIAL SCIENCES
Study of the complex products: Engineering, architecture, computer science, etc.	Study of the complex products: Visual arts, music, dance, literature, etc.	Study of the complex products: Political science, economics, sociology, etc.
Study of the symbol systems: Mathematics, computer languages, logic, graphics, etc.	Study of the symbol systems: Visual arts, music, dance, linguistics, semiotics, etc.	Study of the symbol systems: Linguistics, semiotics, etc. (usually placed in humanities).

Obtain specialized description

Obtain explanation and evidence

Upward-specialized subdisciplines including psychology of music, psychology of aesthetics, human factors, psychology of architecture parts of social psychology, psychology of computation, psychology of reasoning, psycholinguistics, sociolinguistics, etc.

BEHAVIORAL SCIENCES

Psychology (including subdisciplines of experimental psychology, physiological psychology, comparative psychology, humanistic psychology, social psychology, psychodynamics, etc.); Behavioral (rather than institutional) perspectives within sociology, anthropology, and other social sciences.

Obtain specialized description

Obtain explanation and evidence

Upward-specialized subdisciplines including neurophysiology, endocrinology, behavioral biology, etc.

BIOLOGICAL SCIENCES

Biology (including subdisciplines of microbiology, molecular biology, botany, zoology, genetics, anatomy, physiology, etc.).

Obtain specialized description

Obtain explanation and evidence

Upward-specialization subdisciplines including biophysics, biochemistry, etc.

PHYSICAL SCIENCES

Physics (including subdisciplines of atomic physics, kinetics, mechanics, optics, acoustics, etc.); chemistry (including subdisciplines of physical, inorganic and organic chemistry, chemical analysis, etc.); geology; meteorology; astronomy.

Fig. 2.   The specialization hierarchy for disciplines.

only hinted at in Figures 1 and 2; the complexity arises from the fact that humans utilize a variety of symbol systems to fashion such complex creations as skyscrapers, political parties, operas, and novels. Universal symbol systems such as natural language, gesture, and music give rise to expressive products (which are the subject domain of the arts and humanities), as well as social systems and institutions (which are the subject domain of the social sciences). Especially in contemporary times, formalized symbol systems such as mathematics and logic, computer languages, and certain graphical representations are used to create functional products such as buildings and machines (which are the subject domain of the engineering sciences).

The symbol systems are themselves cultural products, and the most prominent systems have their own disciplines; for example, natural languages are studied within the discipline of linguistics, and mathematical systems are studied within the discipline of mathematics. However, these symbolic sciences are generally not grouped together within academic institutions. Rather, each symbol system is grouped with the cultural products that are fashioned from it (Figure 1), and the symbolic sciences are likewise divided among two or three different disciplinary divisions (Figure 2). Hence, the products and corresponding disciplinary divisions of the fourth level are: (4a) functional products and the formalized symbol systems that are used to produce them (the *mathematical and engineering sciences*); (4b) expressive products and (usually) the universal symbol systems that are used to produce them (the *arts and humanities*); (4c) social systems and institutions and (sometimes) the universal symbol systems that are used to produce them (the *social sciences*). These domains of the fourth level are disparate, but all involve products of human mentation and activity which are informed by the larger culture and leave a residue which in turn becomes part of that culture for the next generation. This collective characteristic is often overlooked, but forms the rationale for grouping them together as cultural products at the fourth level.

What is noteworthy about the four disciplinary levels is that their structure is one of hierarchic specialization rather than of simple partitioning. That is, the domains of reality which they address are nested, not mutually exclusive; they involve different levels of analysis of the same reality. What produces the nesting is that each higher domain is generated from the lower one; entities and processes in the

lower domain tend towards increasing complexity, and organized systems emerge for which specialized concepts and explanations appear necessary. Disciplinary divisions mirror this nested structure, with each division in turn telescoping away from its parent division towards a more specialized account.

The relationship of hierarchic specialization entails that a segment of reality that participates in a domain at one of the higher levels of the hierarchy necessarily participates in domains at all of the levels below it as well, but a segment that participates in a lower-level domain does *not* necessarily participate in the more specialized domains above it. When a higher-level discipline does apply, it provides analysis which is tailored to the most specialized properties and network of relationships exhibited by a segment of reality; however, the applicability of lower-level disciplines is not lost. For example, physiological systems are analyzed primarily within the relatively specialized biological division (specifically, by the discipline of physiology), but at root these systems are just particular ways of organizing the physical world and therefore can be analyzed as well from the less specialized perspective of the physical sciences. As shown in Figure 1, the physical level generates the biological level, and inversely the biological level depends upon or has its foundation in the physical level. In general, the set of specialized systems which constitutes a domain at the higher level (e.g., the domain of physiology) is regarded as a special case or sub-domain at the lower level (e.g., physiological systems as a special case of physical systems). In Figure 1 this is illustrated by having the biological division (a solid rectangle at the higher level) linked to a sub-domain of the physical division (a broken rectangle within the larger solid rectangle at the lower level). The corresponding adjacency relation between disciplinary divisions is illustrated by the same means in Figure 2. The adjacency relationship between any such pair of disciplines holds the potential for mutually advantageous interchange (represented by the curved arrows in Figure 2), as will be discussed in detail in the next section.

Hence, at the lowest level a fundamental distinction is made between living and nonliving entities; the task of specialized study of living organisms has been delegated to the biological sciences, while study of the physical underpinnings of organic processes is retained within the physical sciences as a special case that is addressed by subdisciplines such as biophysics. This scheme for division of labor

applies recursively.[1] At the level of living entities, a distinction is made between the physiological systems that are most directly involved in controlling behavior, and those that are not. The task of specialized study of behavior, especially human behavior, has for the most part been delegated to the behavioral sciences, while study of the physiological underpinnings is retained as a task of the biological sciences. Finally, a distinction is made at the level of behavior between behavior that produces or participates in cultural products such as language, paintings, and buildings, and behavior that does not. The task of specialized study of cultural products has been delegated to product-specific disciplines such as linguistics and political science; the more general study of the behavioral underpinnings is retained as a task of the behavioral sciences. In all cases, however specialized and narrowly focused the study at a lower level of the underpinnings of a higher-level system (e.g., psychology of language as a study of the behavioral underpinnings of linguistic structure), the ultimate goal is to contribute to the general discipline at its own level (e.g., psychology), not to the specialized discipline at the higher level (e.g., linguistics).

This scheme by no means provides a complete conceptualization of the structure of disciplines. To point out just the most obvious exclusions, first it should be noted that the lowest level of the specialization hierarchy (the physical sciences) has a highly-differentiated internal structure based in part on an embedded part-whole hierarchy. Different physical sciences address different levels of that internal hierarchy, from particle physics through intermediate steps such as chemistry and meteorology to galactic astronomy at the top of the hierarchy. (Some of these are listed in Figure 2, though the part-whole hierarchy itself is not displayed graphically.) Note that living organisms, insofar as they are studied within the physical sciences, are treated as falling within this same hierarchy, though as a special case. Insofar as they are studied within the biological sciences instead, a specifically biological part-whole hierarchy can be identified (i.e., from amino acids to genes to cells to organ systems to organisms), which is one of several determinants of the internal structure of the biological level.

Second, even finer-grained structure is generated at each level by additional distinctions, such as a focus on diachronic versus synchronic processes, on atypical or pathological cases versus typical

cases, on different cultures versus the investigator's own culture, on application or performance versus theory, and so forth. Conceptual and methodological considerations also play a role (Shapere, 1984). Figures 1 and 2 do not go to this level of detail, since it is not crucial for the case which is at hand, but adding these distinctions generates such major disciplines as history, anthropology, and medicine as well as sub-disciplines such as developmental psychology, cross-cultural psychology, art history, and studio art.

Third, even the addition of other distinctions would not provide a neat place in the structure for the discipline of philosophy, due in part to the foundational and metatheoretic roles which it plays. Certain parts of philosophy (as well as religion) possibly could be incorporated by adding a division for beliefs, spirituality, and morality to the cultural products level. Other elaborations no doubt are needed as well to achieve a complete account. However, Figures 1 and 2 are adequate for the present purpose of showing that the relation between the target disciplines of this paper (linguistics and psychology) is best understood in terms of a larger, nested series of disciplinary divisions generated by a recursive operation of specialization.

RELATIONS BETWEEN ADJACENT DISCIPLINES IN THE SPECIALIZATION HIERARCHY: HORIZONTAL VERSUS VERTICAL ALLEGIANCES

With the framework of disciplinary structure in place, the question of the relation between disciplines at adjacent levels of the specialization hierarchy can be addressed. As drawn in Figures 1 and 2, the picture is a neat one and features boundaries that appear clear and inviolate. But in fact, the type of adjacency produced by hierarchic specialization produces situations of ambiguity and/or territorial conflict. Each higher-level discipline includes certain sub-disciplines which have a close interface with the specialized portion of the next-lower discipline, and it is often unclear who should be carrying out what tasks. For example, physiological psychologists and neurophysiologists sometimes carry out investigations that appear indistinguishable. Either group might seek to determine the role of the lateral geniculate nucleus in visual perception, as one instance, and could carry out identical studies to this end. The results of such work might be

presented at the annual meeting of the Association for Research in Vision and Opthalmology, which attracts participation from disciplines at both levels of the hierarchy. Vertical contacts across disciplinary boundaries often seem to such investigators to offer the royal road to understanding the part of nature with which they are both concerned. A beneficial flow of ideas and techniques might be expected, based on the psychologists' expertise in behavioral measurement and experimental design, combined with the biologists' broader understanding of the organic properties of the visual system.

Yet disciplines are aptly named, for they exert discipline on those who work at the boundaries to turn their gaze horizontally, and attend to the distinctive goals of their own discipline. Physiological psychologists are daily reminded that the overall goal of psychology is the achievement of a general account of the mental and behavioral functioning of individual organisms within their environment. Their own interdisciplinary interest in the connection of behavior with its physiological underpinnings is peripheral to the discipline, not central, and they will find themselves attending presentations and examining students on topics from cognitive psychology, social psychology, personality theory, and so forth. Ultimately, their own value as *psychologists* will be judged by their contribution to the goal of a general account of mental and behavioral functioning. Likewise, neurophysiologists in their daily contacts will be reminded that physiology's overall goal is to understand how physiological systems function, including renal, cardiac, and other systems which play little role in the control of behavior. Neurophysiologists will attend presentations and examine students on the functioning of such systems, on the general principles of cellular development and function, and so forth. Few investigators are so immune from such influences that they can adopt a purely vertical focus on the narrow part of reality that is their specialized concern. It is often decried that the pressures to make horizontal rather than vertical connections are too powerful, and work to the detriment of understanding these parts of reality. However, the utility of being able to make connections in *two* directions – horizontal as well as vertical – suggests that the abandonment of disciplines would be too extreme a response to the over-emphasis on horizontal connections which disciplines enforce.

One advantage of bidirectionality is that a larger pool of techniques, perspectives, and conceptual anchorings is made available than

otherwise. This is especially apparent in the subdisciplines which lie near the periphery of their respective disciplines. For example, chemistry could offer the technique of x-ray diffraction to solving the biological puzzle of the structure of DNA. However, the use of chemical techniques to serve the ends of biology brings a dilemma: are those who carry out such work chemists or biologists? In fact, departments of biochemistry are placed with chemistry and other physical sciences in some institutions, and in the biological sciences in other institutions. Some biologists doing such work have chosen to call themselves "molecular biologists" rather than biochemists, in part to emphasize their identity as biologists, but the distinction is not a sharp one. In Figure 2 I have recognized the ambiguity by placing this work at both levels, somewhat arbitrarily using the term "biochemistry" at the physical level and "molecular biology" at the biological level. Again, it is the larger goals and issues to which an investigator relates the work that are the primary determinants of level, rather than specific characteristics of the work itself.

A second example is provided by the case of behavioral biology. The delegation of behavioral studies to the behavioral sciences has been incomplete, in that some biologists have retained the task of studying *animal* behavior and social organization. Different methods for approaching the same task of behavioral study have been developed within biology (e.g., the ethological approach) versus psychology (e.g., the Skinnerian approach), making for a particularly interesting case of task assignment and interdisciplinary relations (see, for example, the chapter on cognitive animal ethology in Bechtel, 1986, for an analysis). In contrast to the biochemistry case, behavioral studies by biologists and psychologists have been carried out in parallel, with relatively little collaboration or even contact being sought. The most prominent attempts at making vertical connections have been imperialistic rather than cooperative in character: notably, Wilson's (1975) *Sociobiology* insists that the social behavior of humans as well as animals can be analyzed and explained entirely in terms of its service towards biological ends such as gene replication and survival. In recognition of the incompleteness of the delegation of behavioral studies to the higher level, the specialized part of the biological sciences in Figure 2 includes behavioral biology in addition to physiological subdisciplines.

These are only a few of the numerous cases in which one can

observe what actually happens at the boundaries between disciplines: how the tasks are divided, and how investigators from different disciplines interact when they find themselves in a position of adjacency. By considering such cases, I have identified three general types of relationship that occur at the boundaries of the specialization hierarchy. This relatively empirical approach provides a rather different account of interdisciplinary relations than has usually been offered on more purely theoretical grounds. Notably, the unity of science stance that was developed within the positivist tradition emphasizes the potential for discovery of bridge laws which in some sense reduce every discipline to physics. It is not my task here to enter into this old debate; see Bechtel (1986) and McCauley (1981) for explicit criticism of the unity of science position and for a sketch of an alternative framework, within which the present analysis lies.

I will describe the three types of relationship with respect to the boundary between psychology and linguistics, which is the particular focus of this paper. This boundary exemplifies the more general boundary between the behavioral sciences and the various cultural products disciplines, and hence the analysis has implications which extend well beyond the particular case.

THREE TYPES OF RELATION BETWEEN ADJACENT DISCIPLINES: THE CASE OF PSYCHOLOGY AND LINGUISTICS

Since natural languages are positioned at the top level of the hierarchy in Figure 1, segments of reality that are linguistic in nature can be analyzed at all four levels of the hierarchy of disciplines in Figure 2. At the cultural products level, abstract analyses of language are carried out primarily within linguistics, but also within certain subdisciplines such as anthropological linguistics. At the behavioral level, work on language is carried out within subdisciplines such as psychology of language and sociolinguistics. At the biological level, the subdiscipline of neurolinguistics carries out specifically linguistic studies, but foundational work on the anatomy and physiology of the ear and auditory system is important as well. Finally, even at the physical level, there is foundational work on sound and the auditory system. The multiple levels at which language can be analyzed are illustrated in Figure 3, which shows some of the ways that the act of perceiving the word "alive" can be construed at each level, as well as the ways that

LINGUISTICS: Phonology

Provide an abstract account of the phonemic structure
and phonological rules which characterize the word alive,
embedded within the broader phonological theory. This
is carried out without regard to any embodied usage
of the structure, and therefore is indifferent to
the distinction between perception and production.

Obtain a phonological description
of experimental stimuli, including
a characterization of the phonemes,
distinctive features, and
phonological rules applied for each
utterance used as a stimulus.

Obtain partial explanation for universal
characteristics of phonological systems,
based on the limits and characteristics
of human speech perception; obtain evidence
for the "psychological reality" of the
linguistic account.

PSYCHOLOGY: Psycholinguistics (field of speech perception)

Provide a behavioral-level account that specifies the
functional units of speech perception (e.g., distinctive
features, syllables, and words) and the processes by which
identification of the stimulus "alive" as a token of the
word-type alive is accomplished. To do this, make inferences
from experimental data, for example, data on the degree to
which various speech sounds are perceptually distinguishable.
This is carried out with little regard to localization of
the perceptual processes within the ear and nervous system.

Obtain a description of speech
perception at the behavioral level,
e.g., data on which speech sounds
are perceptually most distinguishable
and data on the temporal
characteristics of speech perception.
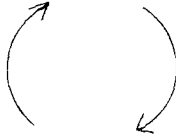
Obtain a partial explanation for the
behavioral phenomena of speech perception,
in terms of underlying physiological
mechanisms and constraints; obtain
evidence for the "neurophysiological
reality" of the behavioral account.

BIOLOGY: Anatomy and physiology of the ear and auditory system

Provide a biological-level account that characterizes the
transmission of the speech waveform through the outer,
middle, and inner ear; transduction into a pattern of neural
firing in the auditory neuron; and further processing in the
auditory receiving area and Wernicke's area by which the
pattern is identified as a token of the word alive.

Obtain a description of the higher-
order properties of speech waveforms,
so that the waveform is characterized
in terms of frequency bands
(fundamental and formant frequencies),
formant transitions, etc.

Obtain an understanding of the
limitations imposed by the physics
of sound and the auditory system
in the evolution and functioning of
that system.

PHYSICS: Physics of sound and the auditory system

Provide a physical-level account of the waveform in terms of
amplitude and frequency over time; characterize the lower-level
physical characteristics of the components of the auditory
system (e.g., characterize the eardrum as a special case of
membranes in general).

Fig. 3.   Levels of analysis of the language domain.

boundary-bridging contact can benefit the separate works of analysis.

The benefits of interdisciplinary cooperation are apparent in this figure, but boundaries can be ignored or challenged as well. In what follows, each of the three types of interdisciplinary relation is described in turn, with a particular focus on the relation between linguistics, at the top level of the hierarchy, and psychology, at the immediately adjacent level below linguistics.

Boundary-maintaining relations

This relationship (or lack of relationship) is exemplified whenever psychologists and linguists carry out their work in relative isolation. Within linguistics, this has been the most frequent mode of operation; one example would be Katz's (1972) semantic analysis. Within psychology, it is much harder to find examples; for reasons that will become apparent in the next section, isolation from linguistics occurs primarily when the subdomain of language itself is being ignored. Once language behavior comes up for serious scrutiny, some use of linguistics almost always follows. The most notable exception is Skinner's (1957) analysis of verbal behavior, which took a purely behavioral perspective. Typically, though, psychologists must initiate some bridging of the boundary with linguistics, as next described.

Boundary-bridging relations

Linguists analyze language as a cultural product, a result of mental, behavioral, cultural and social processes which can be viewed abstractly apart from those processes. Psychologists of language also focus on language, but concern themselves with the processes rather than the product. The two tasks – analyzing language as a cultural product and analyzing language as behavior – yield two different kinds of accounts. When some attempt is made to coordinate these accounts, interdisciplinary work of the boundary-bridging type can be observed. I will refer to those who carry out the coordination as *psycholinguists*.

It is important to recognize that this work does not occur on some neutral, in-between territory which might itself aspire to disciplinary status. Boundary-bridging contact will always occur to satisfy goals of

one discipline by using results from the other discipline. This is illustrated by the deliberate use of two oppositely-directed arrows in Figure 2, rather than one bidirectional arrow or even a separate little box. As the labels on those arrows indicate, psychologists do psycholinguistics by making use of linguistic description and theory as one tool in building models of the mental representation of language, and linguists do psycholinguistics by looking to psychology when questions of confirmation and explanation arise. This relationship is not idiosyncratic to these particular disciplines, but rather derives from their positioning in the specialization hierarchy. The same relationship holds for any pair of vertically-adjacent disciplines. For example, neurophysiologists make use of behavioral description as one tool in diagnosing and constructing accounts of neural functioning, and psychologists can look to neurophysiology when questions arise concerning explanation and confirmation of psychological models. In general, the less specialized discipline reaches upward to obtain a description and other domain-specific analysis from the more specialized discipline, and the more specialized discipline sometimes reaches downward to obtain sources of explanation and confirmation in the less specialized discipline. (This is not intended to suggest that there are no sources of explanation within a level as well; for example, evolutionary theory functions within the biological sciences as an explanatory framework for a variety of biological phenomena. A complete explanation, however, will incorporate lower-level sources as well, e.g., the chemistry of DNA.)

Uses of linguistic results by psychologists. In the case of psycholinguistics, it is the psychologists who have gained the most in recent years from this relationship. Most psychologists who specialize in language are regular "customers" in the shop of linguistic research. Some description of the linguistic facts is prerequisite to investigation of how those facts are represented or honored in mental/behavioral activity. Usually the linguist has done a thorough enough job of description that the psychologist need not attempt his or her own description from scratch. Even the undergraduate researcher who divides a list of word stimuli for a memory experiment into nouns and verbs is making use of linguistic analysis, though the analysis is so basic and was learned so long ago that this may not seem an obvious case of interdisciplinary contact. Typically, though, explicit selection or integration of more complex linguistic analyses is required. The

psychologist will need to reformat the linguistic facts into a form appropriate for functional, behavioral, or mental modeling, and to discard the aspects of the linguistic analysis that do not pertain. Therefore, every psychologist in training to do psycholinguistics should be taught how to make intelligent use of linguistic analyses.

Deliberate selection and reformatting of linguistic analyses can be observed in a number of psycholinguistic research programs. A particularly fine example is provided by the work of Herbert and Eve Clark (a psychologist and linguist, respectively). Beginning in the 1960s, they have used linguistic analyses of negation, comparatives, and other syntactic, semantic and pragmatic phenomena as a starting point for psycholinguistic investigation. In each case, the linguistic facts have been applied in conjunction with general cognitive principles to arrive at a proposed mental representation (in process-ready format) and a set of mental or developmental processes which operated on that representation. Error patterns, processing latencies, and ages of acquisition by children have been well-fit by these models. Their attitude towards linguistic analysis is appropriate for boundary-bridging contact: linguistic descriptions are taken seriously, but are selected and reformatted to serve the goal of modeling mental representations and processes.

All linguistic analysis is potentially of use to the psycholinguist, but some analyses require more reformatting than others. The linguist has no inherent reason to strive for a description that is in process-ready format; rather, the description that gives the most elegant account of the linguistic facts will usually be preferred. Chomsky's Standard Theory is a prime example of a linguistic account that is not well-formatted for real-time processing, as computational linguists were to discover in the 1960s. Hence, in the 1970s many.psychologists chose to obtain their linguistic descriptions from Augmented Transition Network (ATN) grammars. With little modification, these could be applied as models of the mental representation of syntax, leaving the psychologists free to focus on the processing part of the model. It is very nice to have someone do the linguistic work in a way that (deliberately or not) is suited to the psychologist's goals, but in general this should not be expected. ATN grammars were developed by investigators who had computational interests, rather than those who were working at the center of the field of linguistics. (*Language*, the premier general journal of linguistics, only infrequently publishes work

in the subdiscipline of computational linguistics; specialized journals are the more usual outlet.) Few if any linguists have chosen to do mainstream linguistic description using computational models such as ATN, because they are quite unwieldy for such linguistic tasks as investigating historical change in the form of the passive. Hence, the choice of model will depend upon one's goals. Strictly linguistic goals have generally led to the choice of Standard Theory or one of its successors; psychological goals have required reformatting of Standard Theory type grammars, or initial choice of a process-ready grammar such as ATN.

More recently, one of the psychologists involved in the early application of ATN grammars, Ronald Kaplan, has formed a fruitful collaboration with linguist John Bresnan. Their work on lexical-functional grammar (LFG) is one of the best current examples of how the two disciplines can function cooperatively, with each participant willing to consider the goals of the other as a constraint on work within the primary discipline. Other successful research teams jointly headed by a linguist and a behavioral scientist include the work on American Sign Language by Ursula Bellugi and Ed Klima (e.g., Klima and Bellugi, 1979) and the foundational studies of linguistic capacities by Lila Gleitman and Henry Gleitman (e.g., Gleitman and Gleitman, 1970). For all three of these research teams, the psychological studies benefit from ongoing involvement by linguists who are willing to consider psychological goals in addition to their own native goals as linguists. When these linguists carry out their work of linguistic description, they must satisfy two sets of constraints simultaneously, producing descriptions that can be easily applied in behavioral research as well as satisfy criteria of linguistic adequacy. The linguists do not carry out this work solely for selfless reasons of academic charity to psychology. They too stand to gain, by gaining immediate access to psychological results that can satisfy interdisciplinary goals of their own.

Uses of psychological results by linguists. Linguists do not particularly require the use of results from psychology to carry out their central task of linguistic description, so contact is somewhat more optional for the linguist than it is for the psychologist of language. Nonetheless, psychology can be of use when linguists turn their attention to certain questions that are bound to pique the curiosity of any scholar who has devoted a lifetime to the study of language.

First, psychology offers a source of explanation; within behavior and mentation there are underpinnings to be found for linguistic facts which can play an explanatory role. Explanation is broadly construed here as including several ways of understanding the underpinnings of a higher-level phenomenon. Specifically:

(1)   Mechanistic explanation provides a detailed account of the lower-level mechanism by which a higher-level system is instantiated. Most psycholinguistic processing models (such as those of Herbert and Eve Clark) can be viewed in this way, although computer simulations of natural language processing provide the best example (e.g., Shank, 1972).

(2)   Foundational explanation involves meta-theoretical exploration of the foundations of the higher-level system. Examples of this type are less numerous, but prominent among them would be the work of Baron (1977) and Bickerton (1977), both of whom have considered onto-genetic data as relevant in explaining language change.

(3)   Constraint-specifying explanation identifies constraints on the higher-level system that are imposed by the properties of the lower-level domain in which that system is seated. For example, language was not free to evolve in a way that emphasized center-embedded or even left-branching structures, since the properties of human memory result in a high degree of difficulty and error in producing such structures (Yngve, 1960). Right-branching structures are consistent with the properties of human memory, and therefore predominate.

The extent to which linguists have shown interest in psychology as a source of explanation has varied over the years; as Blumenthal has described, the turn of the century was a period of particularly high interest, and in the contemporary period interest has been more sporadic.

In addition to providing a source of explanation, psychology can also be used in the service of linguistic goals by providing converging evidence for the correctness of linguistic analyses. There is an entire experimental literature focused on the "psychological reality" of transformational grammar (see Fodor, Bever, and Garrett, 1974, for a review), but this work was primarily carried out by psychologists and

had minimal impact on theory evaluation within linguistics. Whether or not evidence of psychological reality should serve as an obligatory criterion in evaluating grammars is a matter of some controversy, not made easier by the fact that linguists and psychologists generally disagree on what counts as evidence. Even Chomsky, who claimed psychological status for his linguistic accounts, has rarely given weight to the particular evidence gathered by psychologists. However, the occasional adventuresome linguist has initiated a search for evidence of the type psychologists favor; Fromkin's (1973) interpretation of speech errors stands as an excellent example.

Finally, linguists can make use of psychology when they desire an interdisciplinary perspective on certain issues that cut across disciplines, notably, the unending issue of nativism versus empiricism. A good deal of data has been gathered by psychologists for the express purpose of evaluating the roles of heredity and environmental input in the development of individuals. The data has not been conclusive enough to end controversy within psychology, but has yielded surprisingly specific, complex accounts for certain subdomains and organisms. Particular interpretations of the psychological data have particular implications for the issue of nativism within linguistics, and should therefore be of some interest within that discipline.

Boundary-bridging relations in the case of kin term analysis. To make the foregoing discussion more concrete, consider the case of kin term analysis, which shows a complex history of intradisciplinary as well as interdisciplinary analysis at both levels. Abrahamsen (in preparation) outlines that history as follows.

First, anthropological linguists developed the method of *componential analysis*, in which abstract analysis of the semantic dimensions (components) underlying kin terms was successfully applied to the linguistic goal of classifying the kin systems of various cultures (e.g., Wallace and Atkins, 1960). At about the same time, the developmental psychologist Piaget (1924/1959) studied kin terms as one cognitive domain which exhibits the relation of reciprocity (that is, the relation that holds between *left/right, mother/daughter, uncle/nephew,* and so forth). Eventually, anthropological linguists Romney and D'Andrade (1964) proposed a version of componential analysis which not only satisfied linguistic goals, but also satisfied the psychological goal of incorporating the reciprocity relation into the analysis (although they apparently were not aware of the connection to

Piaget's work at the time). Specifically, they posited sex, generation, lineality, and reciprocity as semantic components that organize the semantic field of kin terms. With explicitly interdisciplinary goals in mind, they sought evidence for the "psychological reality" of their analysis, and carried out the necessary psychological studies themselves. They found that their analysis provided a better model of the mental representation of kin terms than did competing analyses. However, they did not address the question of the relative processing difficulty of the various terms.

Linguist Eve Clark and her student Susan Haviland (Haviland and Clark, 1974) raised the issue of processing difficulty, and argued that a different type of linguistic analysis provided a better basis for prediction. In *relational analysis*, each term is provided a definition in process-ready relational format. For example, in their adaptation of the relational analysis by linguist Bierwisch (1970), *aunt* is defined as [X CHILD-OF A] [A PARENT-OF B] [B PARENT-OF Y] [FEMALE X]. Taking these definitions as models of the mental representation of kin terms, Haviland and Clark surmised that multi-relation representations would be more difficult to process than single-relation representations, and that terms that mixed the CHILD-OF and PARENT-OF relations would be more difficult than terms that did not. If so, *mother* should be acquired before *grandmother*, which should be acquired before *aunt*. They carried out an acquisition study, which provided the evidence which they sought for the psychological reality of this analysis.

However, there were aspects of Haviland and Clark's results that were not predicted by their analysis. Landau and Abrahamsen (1977) proposed a different relational analysis, which lacked the parsimony one would want from a purely linguistic perspective, but provided an almost perfect fit to new acquisition data they obtained as well as previous sets of data. In their analysis, *aunt*, for example, is represented as [C HAS-PARENT P] [P HAS-SIBLING A] [FEMALE A] and *daughter* is represented as [P HAS-CHILD C]. Landau and Abrahamsen noticed that their assumptions about what aspects of relational representations would make for processing difficulty dovetailed precisely with Romney and D'Andrade's semantic components (as well as some more recent work by D'Andrade in which a method of weighting the dimensions was utilized to permit ordering predictions). In particular, degree of recursion corresponded to generation; same-relation

versus mixed-relations corresponded to lineality, and direction of relation (child-initial versus adult-initial) corresponded to reciprocity.

Hence, the particular relational analysis developed by Landau and Abrahamsen was just a different way of formatting the componential analysis developed by Romney and D'Andrade. The relational format was most convenient for psychological modeling, but was useful only if the equivalent of a componential analysis on the relations was also carried out. The componential format alone was most convenient for linguistic applications, but a relational-type analysis is always involved as a first step in carrying out componential analysis. Hence, the two approaches can be integrated to provide a superior framework for carrying out both linguistic and psychological investigations, with the format to be used at any one time determined by the immediate task at hand. There need be no fight between proponents of componential analysis (primarily anthropological linguists) and proponents of relational analysis (primarily psychologists and others who focus on the "psychological reality" of the account).

Other examples of cooperative boundary-bridging. The case of kin terms, in which certain linguists working at the fourth level of the specialization hierarchy showed an interest in interdisciplinary connections with psychology at the third level, is regrettably unusual. Reviewing the contemporary psycholinguistic literature, one can see that psychologists' use of linguistic description is the one boundary-bridging activity that is being done consistently and well. Linguists are making relatively little use of the results of psychology, and there are only a few ongoing collaborations between psychologists and linguists in which there is give and take in both directions. A better-developed example of bi-directional contact can be found in the relation between neurophysiology and psychology. After a long period of relative neglect, psychologists are once again interested in the constraints on psychological models to be found in the results of neurophysiology, and more generally in the "neurological reality" of behavioral descriptions. With the development of an interdisciplinary cluster of neuroscience, the contributions of psychology in providing a behavioral level of description for neural functions have also had increased visibility. One can continue down the hierarchy and find good examples of cooperation between the biological and physical sciences as well. An historical example would be the work on physiological processes such as fermentation that was carried out by

Buchner and other chemists at the turn of the century (see Holmes, 1986, in Bechtel (ed.), for an account). A more recent example is the discovery of the chemical structure of DNA (Watson and Crick, 1953), which was accomplished when a biologist primarily interested in genetics (Watson) acquainted himself with results obtained by chemists using the X-ray diffraction technique (notably Rosalind Franklin).

What is uniquely important about the case of psychology and linguistics, though, is that it is the first well-developed effort at the highest levels of the hierarchy, that is, an effort to make connections between our understanding of particular cultural products and our understanding of the behavior that produces cultural products. It can serve as a model for other interdisciplinary efforts that are just beginning to emerge as psychology enters a period of interest in domain-specific behavior (see Gardner, 1983). Modest beginnings have been made towards a psychology of musical behavior, of drawing, of architecture, and so forth. Linguistic behavior no longer seems as complex as it once did, by comparison, and obtaining psychological accounts of increasingly complex domains should begin to yield some cross-domain generalizations. Only experience will tell how much of the burden of analysis can be carried by these generalizations, and how much must remain domain specific – a result that will be important for the shape that psychological theory takes in the future.[2] Meanwhile, some very original contributions have been made within specific interdisciplinary areas. To mention just one example of how psychologists can help to determine the behavioral foundations of cultural-product phenomena, Colin Martindale ('Art follows Art', 1985) has identified periodicity in the history of the arts and provided some evidence that it is due more to internal factors in the development of each art than to the effect on artists of the general cultural environment or external events.

Boundary-breaking relations

In the preceding section, I have tried to characterize the kind of stable, ongoing contact that is possible between adjacent disciplines, if an effort is made from at least one direction. These boundary-bridging relations, however, are not the only kind of interdisciplinary contact. Particularly when one discipline is in a weak position with respect to an adjacent discipline, boundary-breaking contact can occur instead,

and usually will garner a good deal of attention when it does. A vertical boundary is broken when an investigator in one discipline seeks to bring part of the traditional territory of an adjacent discipline under his or her own umbrella, rather than using existing work from that discipline in boundary-bridging fashion. Though an encroachment on territory is involved, sinister intent or effect need not be imputed; the receiving field is often revitalized and provided with some needed redirection during the relatively brief period of intense contact. Chomskian linguistics and the psychological work on language which it inpsired prominently featured this kind of contact, and it is the demise of the boundary-breaking that is the subject of the obituaries and divorce decrees of the papers in this symposium. There are several kinds of boundary-breaking contact that characterized the relation between linguistics and psychology in the 1960s, and I will begin by describing and illustrating some of them.

First, a weaker discipline might adopt work from an adjacent discipline whole-cloth, because it lacks the means of adequately adapting the work to its own goals. Psychology in the early 1960s was weak relative to linguistics, at least in its inability to give an account of language and other complex systems of behavior. Into this vacuum came an exciting, still quite controversial theory from linguistics (Chomsky's transformational grammar). The product of this contact was the Derivational Theory of Complexity (DTC), in which an abstract, formal device within linguistics (the grammatical transformation) was directly imported into psychology, with each transformation taken to correspond to an operation in the mental processing of sentences. This is exactly what should have been done at the time, and inspired a fertile period of research. Later, however, it was recognized that in the initial excitement, not enough distance had been maintained between the two disciplines; the DTC conflated linguistic description with behavioral description. The extent to which the relevant material from linguistic analysis would need to be reformatted and selected by psychologists became appreciated when it was found that, although some transformations from the 1957 version of Chomsky's theory did seem to correspond roughly to psychological operations, or at least predicted psychological complexity (Miller, 1962), others did not. And of course when the linguistic theory was revised, that played havoc with the DTC. It was then concluded that the relation of grammars to psychological processing was "abstract"

(Fodor and Garrett, 1966), but this leaves things too mysterious. I prefer to say that the psychologist should be prepared to take any linguistic analysis and adapt the substance of the analysis to the mental model by means of selection and reformatting. When this is done, there is no violation of boundaries.

Nonetheless, the DTC stirred up excitement in psychology and got the ball rolling; some of the work was done brilliantly, and it was a stage we needed to go through. The DTC marked a transitory, boundary-breaking phase which was later replaced by more highly-differentiated cooperation, and was of considerable value in that role.

At the same time that psychologists were taking (but not reformatting) linguistic descriptions from Chomsky, Chomsky himself was breaking through the boundary by doing some of his own psychology. First, there is the issue of nativism versus empiricism which concerns psychology (to the extent that it pertains to the development of mind and behavior), as well as biology (to the extent that it pertains to the development of organisms more generally) and philosophy. For linguists, it is an issue of interdisciplinary concern but not centrally an issue of linguistics as such. Nonetheless, Chomsky made a strong argument for nativism – not due to weakness in psychology in the sense of having no coherent position of its own to offer, but rather because he found psychology's empiricism distasteful. His own goals could not be met by what contemporary psychology had to offer, so he crossed the boundary and did the psychology himself. This was boundary-breaking, rather than boundary-bridging, because Chomsky generated his own psychological account rather than using the existing accounts available within psychology.

A second way in which Chomsky crossed the boundary between psychology and linguistics involves his distinction between competence and performance. For Chomsky, grammatical models were not just descriptions of the cultural product of language, but were mental models as well; grammars were viewed as models of the idealized speaker/hearer's tacit linguistic knowledge ("competence"). Only linguistic methods were endorsed by him for uncovering competence, however, leaving psychologists to investigate merely how the limitations of memory and other human functions yielded the untidiness of language behavior ("performance") as the observable product of a pristine but rather inaccessible competence. Psychologists were caught flatfooted here, with no strong alternative of their own worked

out, so Chomsky's distinction did end up governing the way they viewed their work for some time. In the short term, this boundary-breaking was beneficial in providing some much-needed stimulation within psychology. In the longer term, however, the effects were negative. Many psychologists, frustrated with a distinction that did not find a natural fit within their own meta-theory, concluded that a "performance" theory was all the theory that one needed; essentially, they decided that there need be no distinction between linguistic and psychological perspectives.

If my analysis is correct, this is an unfortunate conclusion. Linguists will continue to find abstract models of language structure to be most appropriate for their own central task of describing language as a cultural product. Psychologists will continue to need those analyses; they have enough psychology to do without doing linguistics as well. It should be clearly recognized that Chomsky was stepping beyond the boundaries of linguistics in developing these essentially psychological concepts, and that psychologists who chose them in preference to their own home-grown empiricism were cooperating in the boundary-breaking. There is nothing inherently wrong in this; innovative thinkers often wear multiple hats and make contributions to more than one discipline. The primary danger is that observers may not notice the hat-switching, and therefore think a psychological claim a linguistic one because it is made by a linguist. Chomsky the linguist worked out an approach to linguistic description, based on the concept of a generative grammar, which has had an enduring influence within linguistics and a derivative usefulness to psychologists. Chomsky the psychologist made challenging explanatory claims about the acquisition and mental reality of grammars which softened psychology's empiricism, but ultimately failed to replace it for reasons that were well-captured by Reber.

There are also examples of psychologists and other behavioral scientists doing their own linguistics. Sometimes this is a bad idea, but in cases where linguists have not done the work needed by the investigator, some hat-switching may be the only way to get the job done. As one instance, Osgood, Suci, and Tannenbaum's (1957) work on the semantic differential incorporated a psychological method (factor analysis) for obtaining a description of connotative meaning, in the absence of suitable linguistic methods or results. Second, some psychologists (e.g., Rumelhart, 1975) have developed "story gram-

mars" to be applied in research on discourse processing, again in the absence of appropriate descriptions within linguistics. Third, other psychologists have proposed their own models of metaphor for use in processing models (e.g., Ortony, 1979). Fourth, some members of the artificial intelligence community have also not been shy about doing their own linguistics, in preference to reformatting existing grammars (e.g., Schank, 1972); however, this involves a vertical boundary only to the extent that the computer work is viewed as a simulation of behavior.

SOME OTHER TYPES OF INTERDISCIPLINARY CONTACT

The boundary-bridging and boundary-breaking types of contact across the vertical boundaries of the specialization hierarchy do not exhaust the possibilities for interdisciplinary contact. Another major form of contact derives from the internal (horizontal) structure within each level of the specialization hierarchy. For example, within the biological level there is a part-whole relation between genes and chromosomes which, once appreciated, allowed for the emergence of the chromosome theory of Mendelian heredity. This is one of two cases presented by Darden and Maull (1977) as exemplifying their notion of "interfield theory", which is defined broadly enough to include connections within the same level as well as across levels. Another example of a horizontal interfield theory within the biological level is the synthetic theory of evolution (analyzed in papers by Darden and Beatty in Bechtel, 1986).

Finally, there are some other forms of interdisciplinary contact which can occur between disciplines without regard to vertical or horizontal adjacency; the boundary is not particularly at issue. Usually these interchanges are carried out without acrimony, due to the lack of potential for territorial threats. Some of them are as follows.

First, one can obtain a useful metaphor from another discipline. For example, many psychologists have adopted the computational metaphor for cognition from computer science, and one psychologist (Pribram, 1969) has reached all the way to the physical sciences to obtain the holographic metaphor for memory.

Second, one might obtain an actual method of analysis from another discipline that will work in one's own discipline. A psychologist might

benefit from a resource allocation model within economics, for example, by applying it to "resource allocation" within cognition.

Third, one can obtain evidence for a theory by finding traces that may be left in a remote domain. For example, following a chain of inference from the outcome of Carbon 14 dating on a shard might provide one with strong support for a particular account of prehistory or even for an interpretation of a written record from the period.

The fourth type is particularly interesting. Entities from different domains interact, and the results of another discipline are often needed to handle the interaction. For example, auditory processing involves responsivity to patterned acoustic input. Some description of the input is needed to model the processing. At one time these were limited to time-frequency-amplitude descriptions, but more complex levels of organization have more recently been captured in Fourier analyses of complex waveforms and the like. In any event, a stable relation between psychologists and physical scientists has undergirded the work in psychology. This use of descriptions of environmental input is actually similar in kind to the use of descriptions of cultural products, except that it is not limited to the culturally-conditioned environment. Incidentally, psychologists have not always been content with what the physical scientists offered in the way of description; J. J. Gibson (1966) stands as the prime example of a psychologist who decided to do his own description of the environment, in order to get it right for his own goals.

<div align="center">REFLECTIONS</div>

In this paper I have attempted to outline a way of viewing the relations between disciplines within which certain pairs of disciplines – those that are adjacent within a specialization hierarchy – have the potential to participate in very particular forms of asymmetric relationship. Some of these forms are stable, boundary-bridging contacts; others are volatile, boundary-breaking contacts. All, however, are rooted in the goals of one or the other discipline. Among those whom we call psycholinguists, there are psychologists who make use of linguistics, and linguists who make use of psychology, but there are no psychologist-linguists, nor should there be. Successful interdisciplinary contact does not usually give rise to a new discipline;[3] what it does is

satisfy certain goals of one discipline that by their very nature require the use of results from the adjacent discipline.

By this criterion, there is a continuing, successful psycholinguistics which has gotten beyond most of the boundary-breaking contact and settled into boundary-bridging – although primarily in the direction of psychologists making use of linguistics. This difference is due not to some special virtue on the part of psychologists, but rather to the fact psychologists of language need linguistic analyses in order to perform their central task. It would certainly be desirable for linguists to give some priority to the interdisciplinary enterprise of obtaining down-wards-based explanations for linguistic phenomena. However, this is not a *central* task of linguistics, and therefore cannot be expected to occur with the same regularity as psychologists' use of linguistics.

It should also be clear from the discussion of boundary-breaking contact that what is done and who does it must *both* be considered. A proposal made by a linguist is not necessarily a linguistic proposal; the linguist may be doing psychology. And sometimes psychologists will do their own linguistics. These boundary-breaking pieces of work need to be understood for what they are – e.g., psychology done by a linguist using essentially linguistic methods for linguistic goals, or linguistics done by a psychologist using essentially linguistic methods for psychological goals, and so forth. There are even situations in which an individual who is a linguist by training becomes interested enough in the psychological perspective that he or she switches perspectives, adopting psychological goals, methods and research problems and using the results of linguistics in the instrumental fashion of a psychologist. Yet the person may continue to consider herself or himself a linguist. The change of perspective less often occurs in reverse (a psychologist switching to a linguistic perspective). Career changes in either direction can result in some very well-done inter-disciplinary work and are good for both disciplines; however, it is important that others not let the initial identity of the investigator lead to confusion as to what is linguistics and what is psychology.

This same scheme of analysis yields a pair of descriptions that can be used to identify boundary-bridging work: (1) psychology done by a psychologist using essentially psychological methods but incorporating linguistic results for psychological goals; and (2) the use of psy-chological results by a linguist for linguistic goals. Other profiles

represent the breaking of a boundary or a career change, as discussed above.

One advantage to the adjacency relation in the specialization hierarchy is that it makes available a broader pool of ideas for the understanding of a domain. The two perspectives are different, but can aid one another in a variety of ways. As discussed by Blumenthal in this symposium, when one discipline has become stuck, the infusion of new ideas through boundary-breaking contact can play an important role in unsticking it. When both disciplines are performing satisfactorily, the coordination of their results provides a better overall account than can either discipline alone, as illustrated above for the case of kin term analysis.

It is only recently that the adjacency relation between psychology and other cultural-product disciplines has begun to be similarly exploited, forming such subdisciplines as psychology of music, of math, of architecture, and so forth. If a prominent psycholinguistics had not developed over the last 20 years, it is unlikely that these newer contacts would have been initiated as early nor carried out as well. Other behavioral sciences have also benefited from the example, as seen in the formation of subdisciplines such as sociolinguistics (a currently recognized subdiscipline of sociology with its own journal) and socioliterature (a potential subdiscipline of sociology which does not yet actually exist, but which is predicted by this analysis).

A complication here is that sociology itself covers a good deal of territory; primarily it examines institutions (a type of cultural product) such as the family and the organization, but it is also the closest discipline in place to study the behaviors that underlie these institutions. Sociolinguistics tends to be carried out by investigators taking a behavioral perspective within sociology, but has also attracted the efforts of some social psychologists and linguists. Conceivably, sociology and some other disciplines (such as political science and economics) will eventually not have to perform double duty, if new behavioral sciences develop to take up the task of accounting for the behavior which generates institutional and organizational cultural products. Sociolinguistics would then have its home within the new behavioral sociology. Alternatively, Gardner (1985) expects that much of contemporary cognitive psychology will be absorbed, along with artificial intelligence, into a unified cognitive science, which

would have specialized subdisciplines for domains such as language, music, and architecture. Both his proposal and mine would involve a good deal of departmental restructuring, and an interesting mixture of fragmentation and unification of approach. However, Gardner seems to leave open the possibility that these new subdisciplines would largely absorb the existing cultural products disciplines such as linguistics, music theory, and sociology. The result would be the loss of major portions of the fourth disciplinary level. I would regard any such outcome as both highly improbable and highly undesirable.

Another development has been the forming of trinary relationships. For example, neurolinguistics involves an interdisciplinary connection among psychology, linguistics, and that part of neurophysiology which is concerned with language. Trinary relationships can also be created by combining two disciplines horizontally with one more specialized discipline, obtaining cooperative enterprises such as psychosociolinguistics.

In conclusion, it appears that there is an ongoing psycholinguistics which has an enduring role to play, and that it can function as a model for other contacts between the behavioral sciences and the cultural-product disciplines. The behavioral sciences comprise the youngest of the four levels in the hierarchy of Figure 2, so we are really at the beginning of learning how to make contacts between the behavioral sciences and the adjacent levels. Episodes of boundary breaking will continue to occur from time to time, often to the benefit of both fields, but should not be permitted to distract attention from the stable boundary-bridging contact that we have learned to carry out.

NOTES

[1] Of course, this sequence of delegations must be understood as abstract, not historical. In particular, psychology arose as a separate discipline later than many of the cultural-products disciplines, and in that sense there was never an act or process of delegation. Rather, behavior emerged as an object of study in its own right, which has gradually led to an understanding of its role as a mediator between biological phenomena and cultural products.

[2] At this point the MIT school, as represented by Fodor's (1983) claims on modularity,

would keep accounts domain-specific; but most psychologists, including the emerging connectionists (Rumelhart & McClelland, in press), would prefer to find at least *some* fundamental generalizations about how mental/behavioral systems are formed that would apply across domains.

[3] There are exceptions, such as the rise of biochemistry to address a previously-ignored domain.

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