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mas. Thus *bachelor* relies on an ICM whereby people reach the age of eligibility, marry promptly, remain monogamously married to the same person, and in which the sole committed sexual relationship is marriage. Problems presented by marginal cases (the pope, or a man in an unformalized relationship) are the result of failure to fit the ICM in some way (e.g., the pope is not expected to marry). Similarly, *lie* operates within an ICM which includes the folk belief that information is normally both true and helpful: hence the hesitation to call an unaccurate utterance a lie if it conceals harmful information (social lies), or to exclude accurate but misleading utterances from the category. [See also Meaning.]

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PSYCHOLINGUISTICS. [This entry is concerned with the psychology of language. It comprises two articles:

An Overview

Approaches to Neurolinguistics

For related topics, see also Acquisition of Language;

Comprehension; Perception of Speech; Processing; and Production of Language.]

An Overview

Psycholinguistics is the study of the mental processes and skills underlying the production and comprehension of language, and of the acquisition of these skills.

1. Production, comprehension, and acquisition.

Psycholinguists consider the skilled human language user as a complex information-processing system. Their aim is to account for the user's acquisition, production and comprehension of language in terms of the various components of this system and their interactions. The PRODUCTION OF LANGUAGE [q.v.] is commonly viewed as involving the following main component processes.

- (a) **CONCEPTUALIZING**: a conscious planning activity in which a communicative intention guides the construction of one or more MESSAGES (conceptual structures that can be formulated in the target language).
- (b) **FORMULATING**: generating natural language representations for messages. This involves two processes. First, GRAMMATICAL ENCODING maps the message onto some grammatical form; this involves retrieving items from the mental lexicon and arranging them in a syntactic frame. Second, PHONOLOGICAL ENCODING transforms this syntactic structure into a phonetic or articulatory plan.
- (c) **ARTICULATING**: executing the articulatory plan as a sequence of ARTICULATORY GESTURES. [See Articulatory Phonetics.] The primary execution modes are the ORAL for spoken languages, and the MANUAL for sign languages. The main secondary mode is WRITING.

Language users are to some extent able to monitor and edit their own linguistic output, either before or after it is overtly articulated. Self-monitoring probably involves the language comprehension system.

Language COMPREHENSION comprises at least the following component processes. [See also Perception of Speech; Processing.]

- (d) **PERCEPTUAL** (auditory or visual) **DECODING**: mapping linguistic input (connected speech, a stream of manual signs, or a string of printed words) onto some code that can be linguistically PARSED. The

nature of these codes in the different linguistic modalities is controversial. PARSING involves segmenting and recognizing words (phonological and morphological decoding, and accessing the mental lexicon), as well as assigning syntactic and semantic structure.

- (e) INTERPRETING: inferring the intended meaning by identifying referents and computing a conceptual representation for the utterance on the basis of the result of parsing, along with prosody and contextual information. Ideally, the producer's intended meaning is derived and integrated in the developing discourse model.

The production and comprehension systems are highly integrated in a skilled language user. In normal conversational dialog, conceptualizing and interpreting are two essential aspects of the same purposeful behavior: the negotiation of meaning between interlocutors. Attentional resources are shared between planning and interpreting utterances. In addition, the MENTAL LEXICON—the repository of a language user's words with their meanings and forms—is largely shared between the production and comprehension systems, as is grammatical and phonological knowledge.

Psycholinguists study the kinds of representations that are computed by the various processing components (in particular, whether these correspond to representations in linguistic theory), and how these computations are executed in real time. It is a matter of much controversy to what degree the component processes are mutually independent; theories range from MODULAR to INTERACTIVE. Less controversial is that skilled language use involves a high degree of automaticity; the user's attention can usually be limited to planning and interpretation. Since the other component processes are largely automatized, they can run in parallel and at high speed. Because the main empirical method in the study of language production and comprehension is experimentation, this part of the discipline is also called EXPERIMENTAL PSYCHOLINGUISTICS.

DEVELOPMENTAL PSYCHOLINGUISTICS studies the ACQUISITION OF LANGUAGE [*q.v.*], be it the mother tongue or a second language. Its methods are both observational—using, in particular, the analysis of longitudinal corpora—and experimental. The aim is to account for the acquisition of natural language skills on the basis of the learner's initial state of knowledge, the nature of the

input, and the learner's inductive abilities (cf. Gleitman et al. 1988).

Psycholinguists have a vested interest in disorders of language, in particular APHASIA and DYSLEXIA [*qq.v.*]. This is because malfunctions can reveal much about the architecture of the language processing system, and about the neurological implementation of natural language skills. A classic text on psycholinguistics is Clark & Clark 1977; see also Carroll 1985.

2. History. The term 'psycholinguistics' came into vogue during the 1950s—initially through an influential interdisciplinary Seminar on Psycholinguistics in 1953 (Osgood & Sebeok 1954), and later through the inspiring cooperation between George Miller and Noam Chomsky. The resulting upsurge of interest in this field has led to the widespread but serious misunderstanding that psycholinguistics originated during that period. In fact, the production, comprehension, and acquisition of language have been studied since the beginnings of scientific psychology; the traditional cover term is PSYCHOLOGY OF LANGUAGE. During the second half of the 19th century, a primary aim of linguistics was to explain the origins of language. Language was considered to be a 'spontaneous' product of nature, rather than an invented device for communication, as the 18th-century rationalists had proposed. The psychology of language was invented by Heymann Steinthal, Moritz Lazarus, and Hermann Paul to provide the explanations; psychology at the time was the study of conscious experience. Wundt 1900 approached the problem with the following suggestions:

- (a) A primitive gestural language could have arisen as a set of expressive movements that mimicked the ideas they expressed, or were overt symptoms of affects.
- (b) These expressive movements may have come under voluntary control, allowing for diverging developments in different societies.
- (c) Expressive linguistic movements, such as words and sentences, are generated time and again in the act of speaking by apperceptively partitioning a total idea (*Gesamtvorstellung*) into its constituent parts.

Language was seen as existing only in this creative act of mind, i.e. as an expression of conscious experience (see Knoblauch 1988). The concern with language genesis also stimulated empirical studies of first-lan-

guage acquisition by Charles Darwin, August Schleicher, Moritz Lazarus, and in particular Wilhelm Preyer.

The first half of the 20th century saw an uninterrupted research tradition in developmental psycholinguistics, with major European and American works on lexical, syntactic, and phonetic development in a large variety of languages (see Leopold 1972 for bibliography).

In spite of Wundt's denial that the experimental study of language was feasible, experimental psycholinguistics developed in the 20th century as the systematic introspection of linguistic judgment and as the study of analogical formation and association, of verbal memory, and of reading. This era also saw the beginning of speech error research.

Two major paradigm shifts took place in the psychology of language at the beginning of the 20th century. In Europe, Karl Bühler led the revolt against Wundt. In his functional approach, language is an instrument or ORGANON, and linguistic signs perform three functions: they are symptoms of the mental states of the speaker; they are signals which appeal to the addressee; and they are symbols which represent states of affairs. Wundt had only considered the symptom function, but speech acts cannot be accounted for without a hearer and a referential domain. Bühler was the first to develop a theory of deixis and indexicals. He dominated an only moderately experimental but mentalistic psycholinguistics on the continent until he took refuge in America in 1938 (see Innis 1982).

In America, behaviorism replaced the Wundtian psychology of conscious experience. Leonard Bloomfield, a Wundtian in 1914, became converted to a behaviorist psychology in 1933. Jacob Kantor and M. F. Washburn introduced the behaviorist notion that words are conditioned responses, while sentences are stimulus-response chains. Despite Bloomfield's work, structural linguistics was largely ignored by psychologists of language; experimental studies of verbal learning dominated the field. Not until the 1950s was a rapprochement sought among psychologists, linguists, anthropologists, philosophers, and information theorists—though without challenging the behaviorist premises (see Miller 1951).

Chomsky's 1959 attack on B. F. Skinner precipitated the return to a mentalist psychology of language. The early 1960s saw the creation of a new kind of experimental psycholinguistics by George Miller and his colleagues at Harvard—where, simultaneously, Roger Brown and his co-workers were laying the foundations of a new developmental psycholinguistics. Miller's school ex-

plored whether the parser incorporated a transformational grammar. The CODING HYPOTHESIS proposed that parsing a sentence consisted of 'undoing' its transformational structure, so that the sentence's deep structure would be recovered and coded in memory. According to the D[ERIVATIONAL] T[HEORY] OF C[OMPLEXITY], the parsing load for sentences should then covary with their transformational complexity. Though empirical support was initially better for the coding hypothesis than for DTC (Fodor et al. 1974), both were eventually given up (Levelt 1974). [See Processing, *article on Mental Lexicon.*] However, Miller's basic idea of incorporating a grammar into the parser survived. During the 1980s, the notion was intensively and more successfully explored, but with grammars more sophisticated than the transformational grammar of the 1960s (see Dowty et al. 1985).

3. Recent work. During the 1970s, the ties of experimental psycholinguistics to generative grammar loosened, while the subject matter broadened. First, there was a major shift of interest from syntax to meaning and interpretation. Herbert Clark and his colleagues studied how subjects verify sentences; how they derive literal and non-literal meanings of idioms; how they integrate given and new information in understanding sentences; how they infer the illocutionary force of sentences; and how they infer relations among sentences in short texts. Text and story understanding became a research field of its own. [See Text Understanding.] The meaning of texts was represented as a propositional network in influential models by John Anderson and Gordon Bower, and by Walter Kintsch and Teun van Dijk. During the 1980s, the notion of discourse models was adopted from discourse semantics, and was fruitfully applied to studies of text interpretation (Tony Sanford and Simon Garrod). Miller & Johnson-Laird 1976 turned to PSYCHOLEXICOLOGY, the psychology of word meaning. They developed a procedural semantics for perception-related words, such as color terms, terms for temporal and spatial relations, and verbs of motion.

LEXICAL ACCESS became a second major theme during the 1970s. The dominant models of word recognition were John Morton's LOGOGEN MODEL, Kenneth Forster's BIN MODEL, and William Marslen-Wilson's COHORT MODEL. The former two were largely used in studies of visual word recognition, while the latter was designed exclusively to account for spoken word recognition.

A third new theme was the real-time course of language understanding. [See Comprehension.] The introduction of 'on-line' experimental methods, such as pho-

neme- and word-monitoring, enabled psycholinguists to study the course of semantic and syntactic integration from moment to moment as the speech signal develops. Marslen-Wilson and his colleagues demonstrated that all sources of relevant information—phonological, syntactic, semantic, and pragmatic—are simultaneously and rapidly accessed to interpret the incoming signal. A range of studies on the time course of ambiguity resolution, of anaphora interpretation, and of contextual effects on lexical access followed the initial findings, and continued into the 1980s. In the area of reading research, a similar development took place when George McConkie and Keith Rayner developed the technique of making the visual stimulus—word, sentence, or text—dependent on where the reader fixates (cf. Rayner & Pollatsek 1989).

A fourth main development occurred in the theory of the PRODUCTION OF LANGUAGE [*q.v.*]. Charles Osgood and Kathryn Bock pioneered the experimental study of sentence production, investigating how salient or topical entities were encoded in spontaneously produced sentences. Frieda Goldman-Eisler, Brian Butterworth, and others analyzed pause patterns in speech, to study the speaker's planning processes. Anthony Cohen, Victoria Fromkin, and others reactivated research on speech errors. Particularly influential in this connection was Merrill Garrett's model of formulation according to which a speaker first constructs for his message a FUNCTIONAL STRUCTURE—in which the major grammatical relations among open-class lexical items are specified—and then a POSITIONAL STRUCTURE, an ordered representation of open- and closed-class elements in terms of their phonological properties. These two stages of formulation, grammatical and phonological encoding, were supposed to be computationally independent but temporally overlapping. Apart from a continuation of these approaches, the 1980s saw the appearance of sophisticated models of phonological encoding (Stephanie Shattuck-Hufnagel, Gary Dell), as well as new approaches to the speaker's planning of requests and of referential expressions (H. Clark, Theo Herrmann). See Levelt 1989 for a review of production research, and Butterworth 1980–83 for collections of papers.

A fifth development, gaining momentum during the 1970s and vastly expanding during the 1980s in both America and Europe, was the psycholinguistics of SIGN LANGUAGE [*q.v.*]. Its focal center was the Salk Institute's team (Ursula Bellugi, Edward Klima, Howard Poizner, and colleagues), who worked mainly on American Sign

Language. Sign languages have proved to be natural languages on structural, neurological, processing, and developmental grounds (cf. Poizner et al. 1987).

Chomsky's attack on behaviorism also deeply affected developmental psycholinguistics. [See Acquisition of Language.] Explanations of acquisition in terms of 'association', 'reinforcement', and 'generalization' were replaced by the notion of a L[ANGUAGE] A[CQUISITION] D[EVICE] which would infer a grammar on the basis of a finite set of input sentences; an innate UNIVERSAL GRAMMAR, delineating the class of potential grammars; and an EVALUATION PROCEDURE that selects an optimal grammar from among descriptively adequate grammars. A set of heuristic procedures could speed up this inference process. Chomsky and Miller's logical analysis of the acquisition problem led to LEARNABILITY theory [*q.v.*], a branch of mathematical linguistics which studies the learnability of grammars under various conditions on the input to LADs and on hypothesis space (Levelt 1974). Wexler & Culicover 1980 applied the theory to transformational grammar, and Pinker 1984 to Lexical-Functional Grammar [*q.v.*]. During the 1980s, a theory of PARAMETER SETTING was developed, according to which children infer a grammar by setting a finite set of parameters in their innate universal grammar (Roeper & Williams 1987).

The notion of LAD, a purely syntactic device, also released a flood of empirical research in syntactic development. Researchers began writing phrase structure and transformational grammars for samples of early child language. But the enterprise failed when it turned out that, in the initial stages, children show no evidence of mastering the corresponding grammatical concepts of 'subject', 'predicate', 'direct object', etc. Rather, word order seemed to depend on semantic roles such as 'agent', 'action', and 'possessor'; children differed in how they assigned word order to roles. The early 1970s was the period of such 'rich' or semantic grammars (Brown, Lois Bloom, Melissa Bowerman).

The character of the child's input became another major theme. MOTHERESE turned out to be simplified input in several respects (Catherine Snow). Still, serious doubts remained about whether this would help the child in inferring the grammar (Elissa Newport, Lila Gleitman, Marilyn Shatz). For a review of these issues, see Gleitman et al. 1988.

Other major themes taken up during the 1970s included the acquisition of word meaning (Eve Clark, Susan Carey), of pragmatic and conversational skills

(Elizabeth Bates, Jerome Bruner), and of phonological development (Charles Ferguson, Lise Menn, Natalie Waterson).

The single most ambitious enterprise beginning in the 1970s was Slobin's crosslinguistic project (published 1985). Languages differ deeply in how they grammaticize semantic and pragmatic features, and in which features they encode at all; hence the child must have predispositions, called OPERATING PRINCIPLES, to sort out how these grammatical encodings are organized in the mother tongue. Slobin's project studied the universality of the proposed operating principles by comparing early acquisition in a large variety of languages. A similar large-scale crosslinguistic project on untutored second language acquisition was carried out during the 1980s under the auspices of the European Science Foundation (see Perdue 1984).

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Approaches to Neurolinguistics

The primary goal of the field of neurolinguistics is to understand and explicate the neurological bases of language and speech, and to characterize the mechanisms and processes involved in language use. The study of neurolinguistics is broad-based; it includes language and speech impairments in the adult aphasias and in children, as well as reading disabilities and the lateralization of function as it relates to language and speech processing.

Psycholinguistic approaches to neurolinguistics provide a theoretical, as well as methodological, basis for the study of language and the brain. The field of psycholinguistics uses behavioral measures of normal adults and children to infer the nature of the processes and mechanisms used in language and speech. Applied to neurolinguistics, it provides a method of exploring how