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EXPERIMENTAL STUDIES OF THE FORMS AND FUNCTIONS OF PRIVATE SPEECH IN YOUNG ADULTS

By

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A thesis

presented to the University of Waterloo

in fulfillment of the

thesis requirement for the degree of

Doctor of Philosophy

in

Psychology

Waterloo, Ontario, Canada, 1999

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Abstract

This thesis establishes that adults use private speech, challenging Vygotsky's (1934/1987, 1978) claim that this speech form is peculiar to childhood, the equivalent of a developmental stage lasting from about three to seven or eight years of age. Related experimental research on private speech in children is reviewed, as well as the small number of previous studies on private speech in older age groups. Evidence from a series of three studies with samples drawn from an undergraduate university student population strongly supports the view that private speech is used with considerable frequency by adults. In Study 1, self-report questionnaire data indicate that adults report self-verbalizing in a variety of everyday, real-life situations. Study 2 is a microgenetic repeated-measures experiment providing evidence of short-term change in self-directed speech similar to changes reported in research with children, while participants carried out computer data entry tasks and paper-folding tasks during two sessions. Rate of speech decreased and speech preceding action increased with repetition across trials within each session, and psychologically predicative speech increased across sessions. In addition, the rate of speech was higher when participants worked on a difficult computer data entry task than on an easy one, replicating a well-established finding in research with children. In Study 3, a single-session repeated-measures factorial experiment, participants used more private speech

while working on difficult tasks compared to easy tasks, and more while working on verbal tasks (arithmetic word problems and scrambled word tasks) compared to nonverbal tasks (pattern copying using blocks, and paper-folding tasks). These results establish further parallels with research on private speech in children. All participants in the two experiments used self-directed speech, but rates of speech were higher for participants who indicated awareness of self-verbalizing during the sessions when questioned afterward, than for those who denied having done so. Taken together, the findings of this research provide strong evidence that rather than being limited to childhood, private speech is common among adults as well. It is suggested that evidence of a decline in private speech use with age, from research with children, may result less from internalization of this verbal mediation than from increasing awareness of social pressure against talking to oneself, and ideas for further research investigating this suggestion are described.

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Experimental Studies of the Forms and Functions of Private Speech in Adults

Young children can frequently be heard talking out loud to themselves. The claim that speech of this kind is a form of thinking, and indeed an ontogenetic precursor to the development of covert, unvocalized verbal thinking, has gained considerable acceptance in developmental psychology (see, for instance, Berk, 1992). This kind of speech - which is overtly vocalized yet not addressed to anyone other than the speaker himself or herself - has come to be known as 'private speech' (see Kohlberg, Yaeger, & Hjertholm, 1968). While children's private speech has generated research interest in the West for some 30 years, the theoretical underpinnings of this contemporary empirical literature have a much longer history, originating in the 1920s in Russia with L. S. Vygotsky's (1934/1987, 1978) cultural-historical or social-historical psychology. Vygotsky's account holds that children internalize private speech at about eight years of age, after which they carry out verbal thinking covertly and internally, in a form Vygotsky called 'inner speech.' Thus, private speech is commonly regarded as a developmental stage occurring during childhood, a transitional stage in the development of internal, covert verbal mediation. The argument motivating the present thesis is that private speech use is not a developmental stage: this phenomenon is by no means limited to childhood, but is instead a commonplace,

normative occurrence during adulthood as well. Adults talk to themselves with remarkable frequency, at least under certain circumstances, and furthermore, their self-directed speech is very similar in important ways to the phenomenon as it has been documented in children. In this thesis, an initial self-report questionnaire study (Study 1) is followed by two experimental studies (Studies 2 and 3), all with samples of young adult undergraduate university students. Results of these three studies establish unequivocally that adults use private speech, and the view that private speech is a phenomenon peculiar to childhood is mistaken. Although it decisively challenges Vygotsky's specific hypothesis concerning internalization of private speech during childhood, at the same time this research also yields broader support for a fundamental tenet of Vygotsky's more general theory by providing evidence that human cognition is verbally mediated.

Vygotsky's Cultural-Historical Psychology

The research reported in this thesis has strongly theory-based motivation, taking its meaning from the Vygotskian cultural-historical paradigm for psychology, which in turn was based closely on the ontology and epistemology of dialectical materialism. Vygotsky's (1934/1987, 1978) ideas about private speech are a comprehensive microcosm of his general theory of human psychology, and a brief overview of the general theory is useful for understanding these ideas. The cultural-historical approach to human psychology can be summarized efficiently

in terms of three fundamental concepts (see Leontyev, 1981; Wertsch, 1985), all of which reflect basic aspects of the dialectical materialist view of the human condition. These three principal tenets are (1) the primacy of developmental or historical analysis for scientific understanding, (2) the social origins of distinctively human psychological processes, and (3) the mediated structure of human psychological processes.

Developmentalism. The developmental method integral to Vygotsky's psychology follows from the pervasive dialectical materialist emphasis on historical, processual analysis. According to this view, scientific knowledge of a particular object of investigation is gained through knowledge of its origin and its developmental changes. Scientific activity should be directed toward elucidation of the developmental relations and historical conditions which have produced the object, in its present form. Marx and Engels wrote, "'We know only one science - history'" (quoted in Luria, 1987, p. 360). In order to understand an object of investigation, one needs to inquire as to how it got to be the way it is.

Although Vygotsky's psychology is currently becoming known in North America as a theory of child development, Vygotsky himself regarded his work not as child psychology, but as general psychology. His objective of articulating a dialectical materialist paradigm for scientific psychology called for investigation of human beings in the process of their psychological development. It follows that

the Vygotskian cultural-historical paradigm for general psychology is, by definition, a developmental paradigm. Vygotsky "emphasized the study of development because he believed it to be the primary theoretical and methodological means necessary to unravel complex human processes" (John-Steiner & Souberman, 1978, p. 128). This developmental method is implicit in both of the other central principles of Vygotskian psychology, the sociality and mediation of uniquely human psychological functions, and also in Vygotsky's (1934/1987, 1978) ideas about children's private speech.

Vygotsky also applied his ideas about developmental analysis to experimental methodology. Using what he termed the "experimental-developmental" (Vygotsky, 1978, p. 61) method, he tried to elicit theoretically-consistent, predictable processes of microgenetic change which could be observed within the short-term time frame of the experiment. This process-oriented approach to experimental methodology was adopted in designing Study 2.

Sociality. The idea of genetic connection between the individual person's own psychological processes and the social processes in which the person is or has been involved is a fundamental aspect of the dialectical materialist view of human beings. Marx (1888/1959) argued that "the human essence is no abstraction inherent in each single individual. In its reality it is the ensemble of the social relations" (p. 244) within which human activity is realized. From this perspective,

"it is not the consciousness of men [sic] that determines their existence, but their social existence that determines their consciousness" (Marx, 1859/1970, p. 21). For Vygotsky's psychology, this understanding was foundational. The idea of the sociality of human psychological processes was encapsulated by Vygotsky (1960/1981) in what he termed 'the general genetic law of cultural development:'

> Any function in the child's cultural development [development of distinctively human psychological functions - R. M. D.] appears twice, or on two planes. First it appears on the social plane, and then on the psychological plane. First it appears between people as an interpsychological category, and then within the child as an intrapsychological category. (p. 163)

Vygotsky believed this principle was very general in its relevance for scientific human psychology. He claimed, for instance, that "any higher function necessarily goes through an external stage in its development because it is initially a social function" (1960/1981, p. 162), and argued further that "a sign is always originally a means for social purposes, a means of influencing others, and only later becomes a means of influencing oneself" (p. 157). Thus, a fundamental tenet of Vygotsky's psychology is the idea that all distinctively human psychological processes "originate as actual relations between human individuals" (Vygotsky, 1978, p. 57). Vygotsky (1960/1981) argued that as well as having social origins,

human psychological functioning retains a parasocial or "quasi-social" (p. 164) character. For Vygotsky (1989), the "composition, genesis, and function" of human psychological processes, "in a word, their nature - are social" (p. 58). This claim concerning the sociogenetic character of human psychological processes is central to Vygotsky's (1934/1987, 1978) analysis of private speech.

Mediation. Another defining characteristic of uniquely human psychological functions, according to Vygotsky, is their mediation by signs or 'psychological tools,' such as private speech. Vygotsky developed his idea of psychological mediation by way of a carefully drawn analogy with Marx's (1867/1967) analysis of the role of tools in processes of human production or labour. This "analogy between sign and tool rests on the mediating function that characterizes both of them" (Vygotsky, 1978, p. 54). Whereas the tool mediates the individual's contact with the object of his or her labour, the psychological tool or sign mediates both interpersonal relations and higher psychological processes. This difference in orientation is the fundamental distinction, for Vygotsky, between mediation by tools and mediation by signs.

The tool facilitates human productive processes: using tools, people act on objects and transform them, in accordance with particular human needs. "The essence of intelligence," according to Vygotsky (1989), "lies in tools" (p. 55), which enable humans to transform, control, and 'master' many aspects of their

objective environment. Psychological tools, on the other hand, function as means of influencing and understanding the actions of others, and as means of mastering, or gaining conscious volitional control over, one's own actions and psychological processes. Vygotsky suggested that incorporation of semiotic media into psychological processes brings about a transformation from what he referred to as 'natural' psychological processes to cultural or 'higher,' distinctively human processes. In this transformation, natural functions are "culturally reconstituted" (Vygotsky, 1978, p. 57). Vygotsky's concept of psychological tools was very inclusive. He listed numerous examples, including: "language; various systems for counting; mnemonic techniques; algebraic symbol systems; works of art; writing; schemes, diagrams, maps, and mechanical drawings; all sorts of conventional signs; etc." (Vygotsky, 1930/1981, p. 137). The most important psychological tool is speech.

Fundamental to the dialectical materialist principles of the sociality and mediation of distinctively human psychological processes is the concept of internalization or interiorization. Vygotsky (1978) defined internalization simply as "the internal reconstruction of an external operation" (p. 56). Internalization is the active transformation of the mediated structure of external (and hence social) activity into internal or 'inner,' mediated psychological processes. For Vygotsky, the most important aspects of internalization involve increasingly complex

psychological reflection of semiotic media and their semantic properties. Internalization is not simply a reduction of external processes or a movement from external to internal functioning, but is instead the process in which distinctively human psyche is produced. The internalization process, as Davydov, Zinchenko, and Talyzina (1982) explain, "does not consist in the shift of external activity to the internal plane ... that precedes it, but in the very formation of this plane" (p. 34). Vygotsky (1934/1987, 1978) argued that those psychological processes which are distinctively human are formed through internalization of sociogenetic sign systems, the most important of which is speech.

Speech-For-Oneself

For Vygotskian theory, a fundamental issue in scientific human psychology concerns relations between speech and thinking. Vygotsky (e. g., 1934/1987, 1978) regarded speech as the most important mediational system in human psychological functioning. In the human neonate and infant, he suggested, verbalization is noncognitive and largely affective, while cognitive processes are 'natural' or biologically-given functions, unmediated by language; speech and thinking are, so to speak, independent of one another. According to Vygotsky, "the intersecting of these paths of development" (1934/1987, p. 119) is "the most important moment in the course of intellectual development" (1978, p. 24). During the preschool and early school years, he argued, the child's cognitive

processes are restructured into verbally-mediated cultural forms, whereas the child's speech becomes intellectualized.

Vygotsky's interest in the mediation of human thinking by properties of speech led him to a concern with the phenomenon of inner speech. Vygotsky's discussion of inner speech - found mainly in the final chapter of his book, Thinking and Speech (1934/1987) - is rather cryptic and ambiguous in some ways, as well as decidedly incomplete. These shortcomings probably reflect in part the curtailing of Vygotsky's work on this problem by his untimely death. Vygotsky thought of inner speech as an interiorized system of psychological tools, an internal psychological means of verbal mediation - as Ushakova (1986) suggests, "a mediator language" (p. 13) - which is centrally involved in distinctively human psychological processes. Vygotsky (1934/1987) described a complex, multileveled set of relations between speech, thinking and, ultimately, motivation; in this relational system, inner speech functions in a crucial mediational role. For purposes of the present work, it is sufficient to define 'inner speech' as verbal thinking, a form of internal verbal mediation formed through interiorization of properties of private speech, which is characterized by what Vygotsky called 'psychological predication.'

Vygotsky (1934/1987) distinguished between the psychological and grammatical subject and predicate of an utterance. The psychological subject and

predicate are not determined, as are the grammatical categories, by the formal structure of the sentence or utterance in question. Instead, Vygotsky's psychological categories are determined by the particular objective, goal-related context in which the utterance is produced. Vygotsky exemplified this distinction using the sentence, "The clock fell" (see p. 252). In this sentence, the grammatical subject is 'clock,' and the predicate is 'fell.' In both interpersonal speech and inner speech, though, the psychological subject and predicate may or may not correspond with the grammatical categories. If this sentence is uttered as a response to the question, "What happened to the clock?," the psychological subject and predicate correspond to the grammatical subject and predicate; if the sentence is uttered in response to the question, "What fell?," then the psychological and grammatical categories are not in correspondence.

In interpersonal speech, psychological predication occurs to the extent that the participants in a given utterance (that is, speaker and listener) have a shared understanding of the situation and of particular goals inherent in it. That is, psychological predication in social speech depends on the degree of intersubjectivity. Inner speech, Vygotsky (1934/1987) argued, "consists entirely of psychological predicates" (p. 273). The subject of verbally-mediated thinking is implicitly known to the thinker; for this reason, Vygotsky argued, it is not necessary for this psychological subject to actually be semiotically instantiated, as

it were, in the concrete process of cognition. "The subject of an inner judgment," as Ushakova (1987) explains, need not be included in the inner speech process because it "is always present in thought and hence is always implicitly understood" (p. 65).

Vygotsky's (1934/1987) distinction between psychological subject and predicate parallels the distinction in recent linguistic theory between 'given information' and 'new information' in human communicative processes (see Wertsch, 1985). 'Given information' is information which a speaker assumes an interlocutor already has in conscious awareness, at the time of a particular communicative utterance; 'new information,' on the other hand, is information which the speaker assumes he or she is introducing (or reintroducing) into the conscious awareness of the listener, by means of the utterance. If the sentence, "The clock fell," was spoken in response to the question, "What happened to the clock?," the given information in the sentence would be 'the clock,' while the new information would be 'fell;' conversely, if the speaker was responding to the question, "What fell?," then 'fell' would be given information and 'the clock' would be new.

Vygotsky (1934/1987, 1978) was interested in empirical investigation of private speech as a means of trying to study inner speech experimentally, in an objective manner. Furthermore, Vygotsky saw in the phenomenon of private

speech a way of studying inner speech over the course of its ontogenetic development, an approach consistent with the dialectical materialist emphasis on historical, genetic analysis. Vygotsky (1934/1987) suggested that inner speech and private speech share a common psychological function, both serving as 'speech-for-oneself.' This intrapsychological function of speech has its origins in interpsychological, social speech. Older, more capable people introduce communicative speech to the child and begin to influence and regulate the young child's actions, using speech. The child gradually appropriates this capacity in speech for verbal regulation and control of action, and a functional differentiation develops in the child's speech: from the original communicative function, Vygotsky argued, a second cognitive, self-regulatory function emerges and is gradually internalized by the child.

Thus, speech-for-oneself develops from social speech and interpsychological processes, and is gradually internalized, during early school age, as an instrument of thinking, problem-solving, and self-regulation. Summarizing the various functions of speech-for-oneself, Vygotsky (1978) noted that it "enables children to provide for auxiliary tools in the solution of difficult tasks, to overcome impulsive action, to plan a solution to a problem prior to its execution, and to master their own behavior" (p. 28). Furthermore, speech-for-oneself "facilitates intellectual orientation, conscious awareness, the overcoming of difficulties and impediments,

and imagination and thinking" (Vygotsky, 1934/1987, p. 259), semiotically instantiating "the attempt to make sense of the situation in words, to find a solution to a problem or plan the next action" (p. 70). Another function of self-directed speech which Vygotsky mentioned is affect expression or "discharge" (p. 70).

Vygotsky and Piaget. Vygotsky's (1934/1987, 1978) interest in children's self-directed speech was stimulated in part by Piaget's (1923/1959) ideas about 'egocentric speech,' of which Vygotsky (1934/1987; see especially Chapter 2) was very critical. Piaget viewed egocentric speech as presocial, precommunicative speech which is not adapted to the perspective of the listener. The preoperational child is unable to decenter and take his or her listener's perspective, resulting in confusion and a failure to integrate perspectives. Unlike Vygotsky, Piaget did not see egocentric speech as playing an important role in psychological development. Instead, he regarded it as epiphenomenal, a mere surface manifestation of the child's underlying cognitive egocentrism. As the child's cognitive egocentrism declines with the development of reversibility and the ability to decenter, he or she becomes able to adapt his or her speech to the listener's perspective, and egocentric speech is displaced by socialized, adapted, communicative speech.

Vygotsky (1934/1987) challenged Piaget's (1923/1959) account of egocentric speech as presocial and unsocialized. (In contemporary English-language

literature, the non-Piagetian term 'private speech' is used to refer to this phenomenon; Vygotsky, however, used Piaget's term 'egocentric speech,' as well as the non-Piagetian term 'speech-for-oneself.') Vygotsky argued that far from being presocial, the very young child's speech is necessarily inextricably embedded within social-contextual relations. Rather than 'socialization,' the developmental changes occurring in this speech form are more accurately described as 'individualization' (see Vygotsky, 1989), involving movement from sociogenetic origins toward individual cognitive functioning. Private speech originates in social relations and, following the broad ontogenetic pattern described by Vygotsky (1960/1981) in his 'general genetic law of cultural development,' is transformed into an individualized system of psychological mediation.

Vygotsky (1934/1987) also challenged Piaget's (1923/1959) view that egocentric speech disappears as it is displaced by socially adapted speech. He argued that rather than either disappearing or being replaced by socialized speech, the child's self-directed speech instead undergoes a transformational process of internalization as it "'goes underground'" (Vygotsky, 1934/1986, p. 33), constituting the basis for the development of inner speech. Vygotsky (1934/1987) reinterpreted data reported by Piaget (1923/1959) as being equally supportive of his own position. Piaget observed age differences in children's use of egocentric

speech: whereas often more than half of five-year-olds' speech was egocentric, by eight years this speech form had virtually disappeared. Piaget interpreted this finding as a surface reflection of the child's declining cognitive egocentrism. Vygotsky (1934/1987), on the other hand, interpreted these data as evidence of internalization, rather than socialization, of egocentric speech. He argued that this particular period of ontogeny identified by Piaget is the period when speech-for-oneself is internalized. What is reflected in the reduction in the child's use of nonsocial speech, then, is not the advent of decentration but the advent of internal verbal thinking.

Like Piaget (1923/1959), Vygotsky (1934/1987) assumed that the use of egocentric speech was limited to the age range of approximately three to eight years, at which time, according to Vygotsky, egocentric speech is internalized and becomes covert rather than overt. He described egocentric speech as "a specific stage in the development of child speech" (Vygotsky & Luria, 1929/1974, p. 464), "a transitional stage in the development of speech from external to internal" (Vygotsky, 1934/1987, p. 71).

Vygotsky's empirical research. Working with collaborators including Levina (see Levina, 1981), Luria (see Luria, 1979), and others, Vygotsky carried out a sizable programme of empirical research investigating the involvement of children's private speech in problem-solving and regulation of action. He

investigated, for instance, the relations between children's use of private speech and the cognitive and practical demands of the experimental task. Piaget's (1923/1959) measure, the coefficient of egocentrism, was used in this research. This coefficient is the ratio of the quantity of egocentric speech produced by a child to the total quantity of his or her speech (both egocentric and social), or in other words, the proportion or percentage of the child's speech which is private. Vygotsky (1934/1987, 1978; see also Levina, 1981) summarized results of experiments in which children worked on tasks which had specific obstacles and difficulties deliberately incorporated into them, by the researchers. When children reached these points of particular difficulty in the tasks, their coefficients of egocentrism "almost doubled" (Vygotsky, 1934/1986, p. 30), both in comparison with baseline control data, and in comparison with data reported by Piaget (1923/1959). Children in these experiments "showed an increase in average levels of egocentric speech in any situation where some difficulty was encountered" (Vygotsky, 1934/1987, p. 70). This form of speech "always appeared very frequently when the child was confronted with a difficult situation" (Vygotsky & Luria, 1929/1974, p. 465). In general, Vygotsky (1978) reported, "the relative amount of egocentric speech, as measured by Piaget's methods, increases in relation to the difficulty of the child's task" (p. 27).

Vygotsky (1934/1987, 1978; see also Levina, 1981) also observed a change

in the positioning or location of children's private speech in relation to their actions. "Initially," Vygotsky (1978) wrote, "speech follows actions, is provoked by and dominated by activity" (p. 28). However, experimental research revealed a "crucial change" (p. 27) in the relation between private speech and action:

> At an early stage speech accompanies the child's actions and reflects the vicissitudes of problem solving in a disrupted and chaotic form. At a later stage speech moves more and more toward the starting point of the process, so that it comes to precede action. It functions then as an aid to a plan that has been conceived but not yet realized in behavior. (pp. 27-28)

Elsewhere, Vygotsky (1934/1986) described this emergence of planfulness in private speech as follows:

> We observed how egocentric speech at first marked the end result or a turning point in an activity, then was gradually shifted toward the middle and finally to the beginning of the activity, taking on a directing, planning function and raising the child's acts to the level of purposeful behavior. (p. 31)

With this change, speech-for-oneself comes to function "as a mediator in purposive activity and in planning complex actions" (p. 39). Vygotsky (1978) claimed that this relationship between speech and action can change quickly: "The

structural relation can shift even during an experiment" (p. 27).

Furthermore, according to Levina (1981), "through his analysis of egocentric speech under conditions in which the difficulty of the task was increased, Vygotsky noted that its frequency increased just before a child's action" (pp. 281-282). This finding suggests that the planning function of speech-for-oneself becomes especially important under challenging conditions, as reflected in the increased frequency of speech preceding action; it also parallels the relationship between task difficulty and the basic overall quantity of speech-for-oneself.

Summary. Vygotsky (1934/1987, 1978) argued that private speech is an increasingly predicative, transitional speech form, developed by the child on the basis of linguistic mediation occurring in joint action with older, more capable people. The transformation from social speech to speech-for-onself is an instance of Vygotsky's (1960/1981) 'general genetic law of cultural development,' the broad ontogenetic pattern of movement from interpsychological to intrapsychological functioning. Vygotsky's (1934/1987, 1978) account of children's private speech was supported empirically by evidence of an association between private speech production and task difficulty, and evidence of the emergence of planning in private speech.

Contemporary Western Research on Private Speech

A number of aspects of the contemporary empirical literature on private speech are relevant for this thesis documenting the use of this speech form by adults. The two experiments reported in this thesis (Studies 2 and 3) demonstrate that the use of private speech by adults is affected in a manner analogous to that of children by experimental manipulation of the type of task the participant is engaged in, and in a manner identical to that of children by manipulation of the difficulty of the task. Other questions investigated in research with children which are addressed in these two experiments with adults include issues involving the methods used to categorize private speech according to functional, structural, and phonological characteristics (including methods used for analyzing psychological predication and other features of private speech), and relationships between private speech production and task performance measures. Finally, evidence concerning ontogenetic change in private speech will be considered, and the small number of previous studies on private speech and related phenomena in older age groups are reviewed.

Task Type

A variety of different kinds of tasks and activities have been used as means of eliciting or contexts for observing private speech in research involving children. The most commonly used tasks in experimental research have been

jigsaw puzzles (Behrend, Rosengren, & Perlmutter, 1989; Deutsch & Stein, 1972; Diaz & Lowe, 1987; Frauenglass & Diaz, 1985; Gaskill & Diaz, 1991; Goodman, 1981, 1984; Goudena, 1987, 1992; Kohlberg et al., 1968, Study 4; Pellegrini, 1980, 1981). Other experimental tasks reported in this literature include construction tasks using blocks (Azmitia, 1992; Berk & Spuhl, 1995; Kohlberg et al., 1968, Study 4), sequencing (Beaudichon, 1973; Diaz & Lowe, 1987; Duncan & Pratt, 1997; Frauenglass & Diaz, 1985) or classifying (Frauenglass & Diaz, 1985; Diaz & Lowe, 1987) picture cards, paper-folding tasks (Duncan & Pratt, 1997), delayed matching-to-sample tasks (Murray, 1979), and a board game (Feigenbaum, 1992).

Comparisons of children's private speech on tasks of different kinds have been made in three experiments. Kohlberg et al. (1968, Study 4) compared the private speech of preschoolers carrying out 'sensorimotor' tasks (stringing beads and building a structure with blocks) and 'cognitive' tasks (two jigsaw puzzles). Results indicated that rates of private speech were higher while participants carried out the cognitive tasks, compared with the sensorimotor tasks.

Taking a somewhat different approach, Frauenglass and Diaz (1985) observed preschoolers working on two 'perceptual' tasks (puzzles and block design matching) and two 'semantic' tasks (classification and picture sequencing), and found that private speech production was greater on the semantic tasks than

on the perceptual tasks, presumably because the semantic tasks required cognitive processing of a kind more closely related to speech than the perceptual tasks (see also Diaz, 1986).

This seemingly straightforward finding was not replicated, however, by Duncan and Pratt (1997), who observed preschoolers carrying out paper-folding tasks (tasks of a visual-spatial nature, comparable to Frauenglass & Diaz's [1985] 'perceptual' tasks) and story-sequencing tasks (comparable to Frauenglass & Diaz's 'semantic' tasks). Duncan and Pratt (1997) found that the percentage of speech classified as 'private' was greater on paper-folding than on story-sequencing, in contrast with the pattern reported by Frauenglass and Diaz (1985). Duncan and Pratt (1997) suggest that this unexpected result may have arisen from differential motivational properties of the two tasks: participants were highly enthusiastic about the paper-folding activities, and they were permitted to take their paper objects with them at the end of each of the three experimental sessions, enhancing motivation for these tasks even further, in a manner not paralleled with the story-sequencing tasks. Thus, the design of this study does not permit a clear comparison of self-verbalization on the two different tasks, although it does indicate that differences between experimental tasks are complex rather than simple, and can reflect extraneous motivational and procedural features, rather than properties of the tasks themselves.

Children's private speech has also been investigated in naturalistic observational studies, in preschool (Daugherty, 1993; Daugherty, White, & Manning, 1994; Manning, White, & Daugherty, 1994; Quay & Blaney, 1992; White & Manning, 1994; Winsler & Diaz, 1995) and elementary school (Berk, 1986; Berk & Garvin, 1984; Bivens & Berk, 1990; Manning & White, 1990) classrooms. Whereas in experimental studies it has been common for as many as half the children in a given sample to produce no private speech at all while being observed (Berk, 1992; Frauenglass & Diaz, 1985; Fuson, 1979), numerous classroom studies have documented private speech use by all participants (Berk, 1992).

Experimental studies comparing children's private speech on tasks of different kinds have shown that tasks differ in terms of their tendency to elicit this speech form (Duncan & Pratt, 1997; Frauenglass & Diaz, 1985; Kohlberg et al., 1968), although the precise nature of this relationship requires further clarification. Observational studies have found that in naturalistic classroom contexts - in contrast with experimental settings - private speech production is typically documented for every child in a given sample (see Berk, 1992). In the research reported in this thesis, experimental comparisons are made of young adults' private speech while working on tasks of several different kinds.

Task Difficulty

Vygotsky's (1934/1987) observation that children's private speech production increases during moments of difficulty while carrying out a task has typically been investigated in contemporary experimental research using within-subjects manipulations of task difficulty, permitting comparisons of private speech while working on easier tasks and more difficult tasks. This approach has provided a considerable amount of evidence corroborating Vygotsky's claims.

The first contemporary study examining the effect of task difficulty on children's private speech was reported by Kohlberg et al. (1968, Study 4). The two sensorimotor tasks used in this study (bead stringing and construction with blocks) were treated as easier than the two jigsaw puzzles (the cognitive tasks), and one puzzle (consisting of 11 pieces) was treated as easier than the other (22 pieces). This design was validated by comparing the number of requests for help made by children while doing each task: there were more requests for help with the easy puzzle than the sensorimotor tasks, and more on the difficult puzzle than the easy puzzle (p. 727). Self-directed speech followed this same pattern, with higher rates of speech on the difficult puzzle than on the easy one, and higher rates on the easy puzzle than on the sensorimotor tasks. While the comparison between puzzles and sensorimotor tasks was confounded with type of task, the comparison between the two puzzles supports Vygotsky's (1934/1987) position. This was the first of a number of replications of this task difficulty effect in the contemporary

literature.

In the only experiment manipulating task difficulty as a between-subjects (rather than within-subjects) variable, Beaudichon (1973) compared private speech use by five-year-olds and seven-year-olds carrying out either easy or difficult picture-card sequencing tasks. Beaudichon found that among the five-year-olds but not the seven-year-olds, those who worked on the difficult tasks used more private speech than those who worked on the easy tasks. This finding of a task difficulty effect at five years but not at seven years supports the view that this age range is one during which private speech undergoes critical development, with external verbal mediation functioning more prevalently in the challenging situation at the younger age only.

Manipulating task difficulty within-subjects, Duncan and Pratt (1997) found that five-year-olds produced a greater percentage of private speech on difficult paper-folding tasks and story-sequencing tasks, compared to easy versions of these same tasks. This experiment also extended empirical documentation of the task difficulty effect, by demonstrating an analogous effect of task novelty. The design included a series of three sessions with each participant; during the second and third sessions, participants worked on familiar items (presented repeatedly, during all three sessions) and novel items (which had not been presented before). On both kinds of tasks, percentages of private speech

were higher when participants worked on the novel tasks than on the familiar, repeated tasks. By introducing a microgenetic component into the design of this study, Duncan and Pratt were also able to document cross-session declines in private speech on both tasks, when children worked on the increasingly familiar repeated items.

Murray (1979) studied the private speech of five- and six-year-olds performing delayed matching-to-sample tasks. The duration of the delay interval was varied in order to create three levels of task difficulty (2 second, 10 second, and 30 second delays). Murray found that as the duration of the delay was increased, private speech production increased while task performance decreased. Also using a design with three levels of task difficulty, Behrend et al. (1989) analyzed preschoolers' private speech production while they carried out jigsaw puzzles. Unlike the pattern reported by Murray (1979), the relationship found by Behrend et al. (1989) between private speech and difficulty was nonlinear, with speech use being greater on puzzles of moderate difficulty than on either easy puzzles or very difficult puzzles.

Taking a different approach, Deutsch and Stein (1972) and Goodman (1981) manipulated preschoolers' perceptions of the difficulty of jigsaw puzzles by interrupting participants on some trials, telling them they had run out of time for the task, with the implication that they had been working too slowly. This

manipulation brought about the expected increase in private speech use in the Deutsch and Stein (1972) study but not in the Goodman (1981) study.

Vygotsky's (1934/1987) observations concerning relations between task difficulty and private speech have been replicated (Beaudichon, 1973; Duncan & Pratt, 1997; Kohlberg et al., 1968, Study 4; Murray, 1979; Roberts, 1979) and extended (Behrend et al., 1989; Deutsch & Stein, 1972; Duncan & Pratt, 1997) in contemporary research. This task difficulty effect is one of the most widely replicated findings in research on children's private speech. The research reported in this thesis extends this central finding to the young adult age group, with a number of different kinds of experimental tasks.

Systems of Functional, Structural, and Phonological Categories of Private Speech

In order to evaluate Vygotsky's (1934/1987) claims about the emergence of verbal planning and other characteristics of children's private speech, researchers have developed a variety of sets of criteria for classifying units of private speech into categories on the basis of function, structure, or phonological characteristics. The first such private speech classification system was introduced by Kohlberg et al. (1968). This particular typology has had considerable influence on the methodology of subsequent research.

Application of the Kohlberg et al. (1968) classification system involves first categorizing utterances as either private speech or nonprivate (social or

interpersonal) speech, then classifying private utterances into one of the following six categories:

Category 1: Word play and repetition;

Category 2: Remarks addressed to nonhuman objects;

Category 3: Describing own activity;

Category 4: Questions answered by the self;

Category 5: Self-guiding comments;

Category 6: Inaudible muttering.

Kohlberg et al. took an eclectic approach in formulating this set of categories, incorporating ideas from Piaget (1923/1959) and Mead (1934) as well as Vygotsky (1934/1962). Categories 1 and 2 were based on Piaget's ideas about egocentric speech; Category 4 was derived from Mead's concept of the social self; and Categories 3, 5, and 6 were based on Vygotsky's claims about the development of verbal planning and self-regulation, and about internalization of verbal mediation. Kohlberg et al. (1968) argued that this set of six categories forms an ontogenetic sequence, with individual children initially using playful, non-task-related forms of private speech (Categories 1 and 2), then task-related forms which gradually become self-regulatory (Categories 3, 4, and 5), followed by increasingly incomprehensible muttering and whispering (Category 6) when the final internalization process is occurring.

The 'describing own activity' and 'self-guiding comments' categories (Categories 3 and 5) appear to provide for a test of Vygotsky's (1934/1987) claims about the emergence of verbal planning and the concurrent reorganization of the temporal relation between speech and action. Utterances classified as 'describing own activity' are not directly goal-related, have "no task-solving relevance or planning function" (p. 708), and accompany or follow the speaker's actions; 'self-guiding comments,' in contrast, are goal-directed and analytical, and precede the speaker's actions. A Vygotskian prediction, then, would call for an ontogenetic decrease in the frequency of Category 3, paralleled by an increase in Category 5, with the development of the planning function of private speech. In a cross-sectional study comparing five-, six-, eight-, and nine-year-olds, Kohlberg et al. (1968, Study 3) found a decrease across age groups in the percentage of private speech classified as describing own activity (Category 3), but no systematic age differences in self-guiding comments (Category 5). Kohlberg et al. also found an increase across age groups in inaudible muttering (Category 6), consistent with the hypothesis that this is a late-developing private speech form and an immediate antecedent to complete internalization. Approximately half of the nine-year-olds' private speech in this study was classifed in this category (about twice the proportion observed among the five-year-olds).

Neither this eclectic classification system introduced by Kohlberg et al.

(1968), nor the variants of it reported in more recent work, are entirely appropriate for testing Vygotsky's (1934/1987) claims concerning the emergence of verbal planning in private speech, for two reasons. One of these involves classification of private speech into multiple categories. Only two of the six categories in the Kohlberg et al. (1968) system (describing own activity and self-guiding comments) are related to Vygotsky's hypothesis, and utterances classified in the other four categories (word play, remarks to nonhuman objects, self-answered questions, and inaudible muttering) are excluded from classification in terms of possible self-guiding or planning characteristics. No use is made of these data in the hypothesis test, although an utterance such as, for instance, a remark addressed to a nonhuman object may in some cases have self-guiding or self-regulatory characteristics (for example if a child were to say to a troublesome jigsaw puzzle piece, "Get in there," a moment before putting it in place). The use of a multiple-category classification system is unconvincing because of the possibility that the data are divided into too many small, irrelevant categories to allow for an adequate test. Such an approach does not use the available data exhaustively in testing this central hypothesis.

The second shortcoming of the Kohlberg et al. (1968) classification system for testing Vygotsky's (1934/1987) hypothesis about verbal planning is related to the first. Coding using this system is constrained by reliance on semantic

characteristics which are clearly discernable to an observer, and therefore all utterances without interpretable semantic content are classified as inaudible muttering. This constraint is problematic because while muttering or whispering may not have obvious meaning to an observer, such speech may certainly be meaningful - potentially, quite richly meaningful - to a speaker producing it. There is no reason to assume that the self-guiding or planning functions of whispered or muttered private speech are less important than those of speech which is clearly understandable to another person. Reliance on semantic content for utterance classification and the resulting exclusion of incomprehensible speech from the hypothesis test, and the more general problem of dividing the data into multiple categories, are shortcomings which undermine the usefulness of the Kohlberg et al. (1968) classification approach for investigating Vygotskian hypotheses about private speech.

The attribution by Kohlberg et al. (1968) to Vygotsky of the idea that private speech passes through a phase of increasingly quiet muttering and whispering prior to full internalization is erroneous. In fact, Vygotsky (1934/1987) specifically argued against this view, which he attributed to John Watson (1924). Watson asserted that human thinking is soundless speech, and that the only important difference between speech and thinking is one of vocalization. The transition from external speech to internalized speech, then, involves the reduction

of auditory features, during which process there occurs an intermediate phase when vocalization is progressively reduced, and thinking responses are whispered rather than spoken aloud. Vygotsky (1934/1987), on the other hand, was more interested in qualitative change and structural reduction involving psychological predication, than he was in quantitative, mechanistic reduction in the loudness of speech. In Vygotsky's words,

> There is no good basis for the assumption that the development of inner speech is a purely mechanical process, that is, a process that consists of a gradual reduction in speech volume. To state the problem more directly, there is no evidence that the transition from external overt speech to inner covert speech moves through the whisper. It is simply not the case that the child gradually begins to speak more and more softly, ultimately achieving soundless speech. (p. 112)

While it is perhaps possible to argue that the hypothesis of auditory reduction is not specifically contradictory to Vygotsky's general position, plainly it was not his hypothesis. Vygotsky's focus was on structural transformation of private speech with the development of psychological predication.

Much of the subsequent research on children's private speech has been influenced in terms of methodology by the classification system introduced by

Kohlberg et al. (1968). Some researchers have used the Kohlberg et al. taxonomy in its original form, without alterations (Rubin, Hultsch, & Peters, 1971; Deutsch & Stein, 1973); others have borrowed categories from the Kohlberg et al. (1968) system, including them along with other categories in their own coding systems (Frauenglass & Diaz, 1985; Furrow, 1984, 1992; Gaskill & Diaz, 1991; Murray, 1979); still others have used the basic Kohlberg et al. (1968) system with substantial modifications (Berk, 1986; Berk & Garvin, 1984; Berk & Spuhl, 1995; Bivens & Berk, 1990; Goodman, 1981, 1984).

Studies reported by Berk and colleagues (Berk, 1986; Berk & Garvin, 1984; Berk & Spuhl, 1995; Bivens & Berk, 1990) using a modification of Kohlberg et al.'s (1968) classification system have produced evidence consistent with some of the assumptions inherent in the Kohlberg et al. view of private speech development. This modification involved collapsing the six Kohlberg et al. categories into three broad ontogenetic levels as well as adding several supplementary subcategories. As described by Berk (1986), the resulting classification system is as follows:

Level 1: Task-irrelevant private speech, consisting of the Kohlberg et al. (1968) Categories 1 (Word play and repetition) and 2 (Remarks addressed to nonhuman objects), and task-irrelevant affect expression;

Level 2: Task-relevant private speech, consisting of the Kohlberg et al.

Categories 3 (Describing own activity), 4 (Questions answered by the self), and 5 (Self-guiding comments), and task-relevant affect expression;

Level 3: External manifestations of inner speech, including Kohlberg et al. Category 6 (Inaudible muttering), and silent lip and tongue movements.

Like the original Kohlberg et al. system, this modified version is based on the assumption of an ontogenetic pattern in which children's private speech becomes more task-related, then becomes less clearly articulated, before eventually being completely internalized. Initially, private speech is ineffective from a self-regulatory point of view, and not related to the task at hand; subsequently, it takes on self-regulatory, task-related functions; and finally, as the process of internalization nears completion, private speech gradually becomes less audible as its functions are internalized.

In a cross-sectional study based on observations of first-grade and third-grade students engaged in math seatwork, Berk (1986) found that compared to first graders, third graders used Level 1 and Level 2 private speech less often, and the more advanced Level 3 private speech more often. Bivens and Berk (1990) found a parallel pattern in a longitudinal study incorporating observations during math seatwork in Grades 1, 2, and 3: over the course of the study, the frequency of Level 1 and Level 2 private speech decreased, whereas Level 3 private speech increased. Although the analyses were organized in terms of the specific Kohlberg

et al. (1968) categories rather than the three broader ontogenetic levels, Berk and Garvin (1984) found equivalent age differences across the age range 5 to 10 years, in another cross-sectional observational study in a school environment. In a cross-sectional study with younger children, Berk and Spuhl (1995) found no difference between four- and five-year-olds in terms of their use of Level 1 and Level 2 private speech, but Level 3 was more frequent among the five-year-olds than among the four-year-olds. Taken together, these findings would seem to provide substantial support for the hypothesis that the three broad private speech levels constitute an ontogenetic sequence, with private speech first becoming more task-relevant, then becoming less clearly articulated and less audible. The latter pattern is consistent with Watson's (1926) assertion that whispered speech is an intermediate phase of internalization. These studies produced no evidence, however, directly related to Vygotsky's (1934/1987) hypothesis about internalization of private speech, or to his hypothesis about the emergence of verbal planning and reorganization of temporal relations between speech and action.

Many other private speech classification systems have also been used in research with children (e. g., Azmitia, 1992; Beaudichon, 1973; Duncan & Pratt, 1997; Feigenbaum, 1992; Frauenglass & Diaz, 1985; Furrow, 1984, 1992; Gaskill & Diaz, 1991; Goudena, 1987; Manning & White, 1990; Manning, White, &

Daugherty, 1994; Murray, 1979; Pellegrini, 1980, 1981; Roberts, 1979; Roberts & Tharp, 1980; Rubin & Dyck, 1980). Nearly all these classification systems focused exclusively or almost exclusively on the semantic content of private speech. All but four were multiple-category coding systems, like the Kohlberg et al. (1968) system; four (Duncan & Pratt, 1997; Feigenbaum, 1992; Goudena, 1987; Manning & White, 1990) employed only binary (that is, two-category, rather than multiple-category) coding.

Some studies have produced evidence supporting Vygotsky's (1934/1987) claims concerning the development of verbal planning. Feigenbaum (1992) analyzed the speech of four-, six-, and eight-year-old children playing a board game, and found that percentages of private speech classified as 'planful' (rather than 'nonplanful') increased across age groups in this sample. Based on a pretest session, Azmitia (1992) classified six- and eight-year-olds as 'experts' or 'novices' on a construction task with blocks. During three subsequent sessions, experts and novices did not differ in terms of their use of single-step planning statements, but experts made more statements planning longer sequences of steps and more evaluative statements than novices. There were no age differences in this study.

A number of researchers have used nonsemantic classification criteria, classifying private speech in terms of its temporal relation with action (Berk & Spuhl, 1995; Duncan & Pratt, 1997; Goudena, 1987; Pellegrini, 1980, 1981;

Roberts & Tharp, 1980; Rubin, 1979; Rubin & Dyck, 1980). This approach permits a test of Vygotsky's (1934/1987) hypothesis concerning the development of self-regulation which is not constrained by the limitations inherent in the use of semantic coding criteria (for instance, the problem of excluding incomprehensible utterances).

Pellegrini (1981) used coding for temporal relations between speech and action in a cross-sectional study comparing three-, four-, and five-year-olds working on jigsaw puzzles. All private speech was classified as preceding action initiation, accompanying action, or following action. Pellegrini found that speech accompanying action was the most frequently occurring of the three temporal relation categories, whereas speech preceding action was the least frequent; there were no age differences. Utterances in this study were also classified in terms of self-regulatory semantic content, independently of the temporal relation coding. Utterances classified in the 'semantic self-regulation' category included statements of plans, commands, and questions (p. 449). Pellegrini found that the private speech of three-year-olds featured more questions than that of four- and five-year-olds. No other age differences in semantic self-regulation were evident.

In an experiment investigating the effect of collaboration with an adult experimenter on four-year-olds' subsequent use of private speech, Goudena (1987) classified all utterances with self-guiding semantic content, in terms of whether

they began before, during, or after actions. Goudena reported that although it was more common for private speech to accompany or follow action than to precede action, self-guiding utterances preceding action nonetheless constituted almost 10 % of the total sample of utterances. This percentage was unaffected by the collaboration manipulation. The methodology of this study suffers from the two problems discussed in connection with the Kohlberg et al. (1968) approach, because only a small portion of the data set was used in testing Vygotsky's hypothesis, and incomprehensible utterances could not be included in the test because of constraints imposed by semantic classification criteria.

Duncan and Pratt (1997) classified five-year-olds' private speech dichotomously, according to whether a given utterance either (1) preceded action, or (2) was simultaneous with or followed action. Duncan and Pratt found a microgenetic increase in the percentage of speech preceding action over a series of three sessions, on paper-folding tasks but not on story-sequencing tasks. A difficulty-novelty effect was found for both task types, with a greater percentage of speech preceding action on difficult items than on easy items (during Session 1) and on novel items than on familiar items (Sessions 2 and 3).

In their comparison of four- and five-year-olds working on construction tasks with blocks during 3 sessions, Berk and Spuhl (1995) used criteria focusing on temporal relations between speech and action in addition to semantic criteria

for two of four subcategories of Level 2 (task-relevant) private speech. The subcategory 'describing and labelling parts of the task' was defined as occurring simultaneously with action, and the subcategory 'expressing plans and goals' consisted of "statements initiated prior to action" (p. 156). Berk and Spuhl found no evidence of either cross-session microgenetic change or age differences in these two subcategories which would support the Vygotskian position. However, the coding system used in this study suffered from both of the specific problems inherent in the Kohlberg et al. (1968) classification system, in that only a small portion of the data were used in testing Vygotsky's (1934/1987) hypothesis, and utterances which could not be understood were excluded from the test.

The Kohlberg et al. (1968) private speech classification system has been influential in more recent research, despite its methodological flaws. A number of other classification systems have also been reported in the literature, most of them multiple-category systems based mainly or exclusively on the semantic content of speech. The hypothesis that with age, private speech becomes more difficult for a listener to comprehend has been supported by findings of several studies (Berk, 1986; Bivens & Berk, 1990; Berk & Garvin, 1984; Kohlberg et al., 1968, Study 3). Vygotsky's (1934/1987) hypothesis concerning the emergence of verbal planning and the shift in speech-action temporal sequencing has received relatively little support in research using semantic classficiation criteria (with the

exception of findings reported by Feigenbaum, 1992) or nonsemantic criteria (with the exception of Duncan & Pratt, 1997).

Psychological Predication

Several contemporary researchers have explored Vygotsky's (1934/1987) ideas concerning the development of psychological predication in children's private speech (Azmitia, 1992; Feigenbaum, 1992; Goudena, 1992; Pellegrini, 1981). Unfortunately, all these researchers (with the possible exception of Goudena, 1992) have resorted to classifying private speech in terms of grammatical or syntactic abbreviation or fragmentation, undoubtedly because of the difficulty inherent in coding private speech data in terms of the narrower 'psychological predication' construct (which denotes a specific subset of grammatical abbreviation).

In his cross-sectional study of three-, four-, and five-year-olds doing jigsaw puzzles, Pellegrini (1981) coded private speech for abbreviation of syntactic structure. He found that the simplest syntactic structure was not the most common, indicating that most private speech was not highly abbreviated. There were no age differences in terms of abbreviation. Azmitia (1992) observed five-year-olds carrying out construction tasks with blocks, during a series of four sessions. Private speech was classified "as either complete or abbreviated (i. e., word or phrase fragments, such as 'next, roof,' 'black,' 'no')" (p. 106). Overall,

approximately 85 % of private speech in this study was abbreviated, and no cross-session change was found.

Feigenbaum (1992) reported a cross-sectional study in which four-, six-, and eight-year-olds played a board game. Both social speech and private speech were classified in terms of fragmentation: any sentence unit which was not grammatically complete was classified as 'fragmented.' Feigenbaum found that private speech was more likely than social speech to be fragmented, and while most private speech was fragmented (57 %), no age differences were evident.

In another cross-sectional study, Goudena (1992) compared the private speech of four-year-olds with that of five- and six-year-olds, working on jigsaw puzzles. Goudena reported that private speech was categorized as either complete or psychologically predicative (pp. 217-218), but included no description of specific classification criteria, and precise coding for psychological predication would be very challenging at best, with Goudena's jigsaw puzzle task. Goudena found that approximately half of participants' private speech was predicative (or abbreviated), and there were no age differences.

Although by and large, the findings of these studies were null, this has little direct bearing on Vygotsky's (1934/1987) hypothesis concerning psychological predication, because of methodological limitations. All the research to date (with the possible exception of Goudena [1992], which is ambiguous) has

analyzed private speech in terms of abbreviation or fragmentation, rather than psychological predication. Vygotsky's (1934/1987) ideas about this characteristic of private speech have not been adequately investigated in contemporary research. In any case, none of the existing studies has found any evidence of ontogenetic differences. Study 2 reported in this thesis incorporates a test of microgenetic change in psychological predication in young adults' private speech, using a task specifically designed to facilitate clear speech classification.

Relations between Private Speech and Task Performance

Vygotsky's (1934/1987, 1978) ideas about the importance of speech for human cognition and the importance of private speech for the development of problem-solving, analytical processes, planning, and self-regulation lead to the expectation that there should be a predictable relationship between private speech use and performance on problem-solving tasks. On first consideration, it seems appropriate that this should be a direct relation, such that private speech and task performance ought to be positively correlated. If private speech is an instrument of thinking and problem-solving, then using it should result in enhanced task performance. Taking into consideration the association between private speech and task difficulty, though, a straightforward direct relationship seems less plausible. Children tend to verbalize when they are experiencing difficulty with a task rather than when they are not experiencing difficulty. Based on this

observation, an inverse relationship would seem more likely, with private speech co-occurring with failure on the task, and hence negatively correlated with performance.

Of course, it does not seem unreasonable to suppose that at times, perhaps with some kinds of activities or tasks, self-verbalization could assist a problem-solver's efforts and contribute in a clear positive manner to successful goal attainment; certainly there is no principled reason why this could not be the case. On the other hand, it is clear that, given its relationship with task difficulty, private speech will in many situations be associated with failure or poor performance. When both these points of view are considered jointly, perhaps the best prediction is one of no correlation. Overall, private speech and task performance should be uncorrelated (cf Diaz, 1986, 1992; Frauenglass & Diaz, 1985).

Though data addressing the issue are not plentiful, all three of these patterns (positive, negative and no correlation) have been reported. The first researcher to report analyses of private speech-task performance relations was Beaudichon (1973). She found a positive correlation between number of utterance units and performance on difficult picture-sequencing tasks, but not easy ones, for seven-year-olds but not for five-year-olds. Goodman (1981) found that in a sample of three- and four-year-olds who were observed while carrying out jigsaw

puzzles, rate of speech was negatively correlated with puzzle completion time (children who spoke more took less time to finish), and positively correlated with rate of manual puzzle-solving moves. Behrend et al. (1989) observed two- to five-year-old children working on jigsaw puzzles of low, moderate, and high difficulty, both alone and with a parent. Percentage of private speech while collaborating with a parent was positively correlated with task performance on moderately and highly difficult puzzles, and percentage of private speech while working independently was positively correlated with performance on moderately difficult puzzles. On the easy puzzles, private speech and performance were uncorrelated.

Gaskill and Diaz (1991) analyzed the private speech of three- to five-year-olds doing classification tasks, block design copying tasks, and jigsaw puzzles, during a sequence of two sessions, and found one very specific cross-session speech-performance relationship. Hierarchical regression analysis showed that the self-directed use of labels and descriptions of materials on the classification tasks during the first session contributed significantly to prediction of second-session classification performance, after first-session classification performance was statistically controlled.

Other studies have also found cross-temporal private speech-task performance relationships. Berk and Spuhl (1995) observed four- and five-year-olds during three independent block-building sessions. Among four-year-olds but

not among five-year-olds, the number of task-relevant private utterances during the first of these three sessions was positively correlated with improvement in task performance from the first session to the second session. The correlation between this speech measure in the second session and performance improvement from the second session to the third also approached significance. In a longitudinal study analyzing observations of children doing math seatwork in the classroom in Grades 1, 2, and 3, Bivens and Berk (1990) found that private speech and arithmetic marks were largely uncorrelated within each of the three years, but task-relevant private speech and incomprehensible speech during Grade 1 were both positively correlated with arithmetic marks in Grade 2, and incomprehensible speech in Grade 2 was positively correlated with marks in Grade 3.

Not all studies assessing relationships between private speech and task performance have found positive correlations. In a study involving four-year-olds, Goudena (1987) found that the number of private utterances was uncorrelated with the number of correct piece placements on a jigsaw puzzle task. In their study of preschoolers' private speech during semantic and perceptual tasks, Frauenglass and Diaz (1985) found an overall difference in task performance between children who were above and below the sample median in terms of private speech use, with low speakers having higher performance than high speakers. This pattern is consistent with the view that private speech is most

importantly associated with difficulty and relative failure, rather than success.

In her classroom observational study of first- and third-graders doing math seatwork, Berk (1986) found that for the entire sample, the percentage of task-relevant private speech (Level 2) was negatively correlated with overall math achievement, but uncorrelated with performance on a classroom math assignment. Analyses distinguishing between school grade and between three levels of intelligence, however, found a complex pattern which can be seen as supporting claims about ontogenetic change in private speech and its functions. The percentage of task-irrelevant private speech (Level 1) was negatively correlated with classroom math assignment performance among average-IQ first-graders, and with both classroom assignment performance and overall math achievement among average-IQ third-graders. Task-relevant private speech (Level 2) was negatively correlated with math achievement among high-IQ first-graders and average-IQ third-graders, and with classroom assignment performance among average- and high-IQ first-graders; task-relevant private speech was positively correlated with classroom performance among low-average-IQ third-graders. The percentage of private speech classified as external mainfestations of inner speech (Level 3) was positively correlated with math achievement among high-IQ first-graders and average-IQ third-graders, and negatively correlated with classroom assignment performance among low-average-IQ third-graders.

This pattern of correlations provides evidence of differences in the efficacy of private speech as a function of cognitive maturity. As would be expected given the ages of participants in the study, Level 1 - the least mature of Berk's (1986) three ontogenetic levels - was negatively correlated with one or the other of the two measures of math performance among average-IQ students. Level 2 private speech was negatively correlated with performance among both average- and high-IQ first-graders, and among average- but not high-IQ third graders, suggesting an age-related difference in its function among the most intellectually advanced students, but not among average-IQ students. Level 3 (the most mature of the three levels) was positively correlated with performance among advanced first-graders and average third-graders, again suggesting variation in function jointly determined by age and intellectual maturity. The pattern of correlations was different for low-average third-graders, whose math performance was positively correlated with Level 2 private speech (rather than negatively correlated, a finding which can be taken as suggestive of relative cognitive immaturity) and negatively (rather than positively) correlated with Level 3 private speech. Berk interpreted this collection of relationships as evidence that in general, "using the type of private speech that is in natural developmental ascendance given the child's level of intellectual maturity is positively related to performance, but reverting to less mature forms is negatively predictive" (p. 671).

Overall, no general pattern emerges from these studies investigating relations between private speech and task performance. A number of studies have reported positive speech-performance correlations under certain specific conditions (Beaudichon, 1973; Behrend et al., 1989; Berk & Spuhl, 1995; Gaskill & Diaz, 1991; Goodman, 1981). On the other hand, there has also been empirical support for the view that private speech and task performance ought to be negatively correlated (Frauenglass & Diaz, 1985) or uncorrelated (Goudena, 1987). Speech-performance correlations are examined using a number of tasks in the two experiments reported in this thesis.

Ontogenetic Change in Private Speech

As has already been mentioned, children's use of private speech has commonly been treated as a "stage" of ontogenetic development in contemporary research (see, for instance, Berk, 1992, p. 21, 39, 40; Daugherty, 1993, p. 288, 292; Daugherty, White, & Manning, 1994, p. 22; Kohlberg et al., 1968, p. 710; Olszewski, 1987, p. 71; Roberts & Tharp, 1980, p. 342), a view which clearly originates in Vygotsky's work (Vygotsky, 1934/1987; see also Vygotsky & Luria, 1929). According to this view, children use overt private speech from about three years to eight years, when the stage ends, and private speech is internalized and transformed to produce more adult-like inner speech or verbal thinking. A number of contemporary studies have produced evidence of various kinds supporting this

position.

In an observational study of four- and six-year-olds during free play and adult-structured preschool classroom activities, Kohlberg et al. (1968, Study 1) found that four-year-olds' percentages of private speech were greater than six-year-olds,' a pattern suggesting internalization during the late preschool years. Moreover, this age difference was greater among high-IQ children than among average-IQ children, linking the timing of internalization to intellectual maturity as well as chronological age. A somewhat similar pattern, involving socioeceonomic status rather than IQ, was reported by Quay and Blaney (1992), in a study comparing four- and five-year-olds engaged in free play. In this study, middle-SES five-year-olds used less private speech than middle-SES four-year-olds, whereas no age difference was found among low-SES participants.

In another cross-sectional study, Kohlberg et al. (1968, Study 2) compared the private speech of children aged 4 to 10 years, while they made sticker designs alongside an adult experimenter. Private speech production was greater among younger participants than older participants. Use of private speech was positively correlated with IQ among four- and five-year-olds, but among six- and seven-year-olds there was no correlation, suggesting that private speech is a sign of intellectual maturity at the younger age, whereas at the older age it no longer is. In a reanalysis of a subset of these data in which their six-category private speech

classification system was applied, Kohlberg et al. (Study 3) found an increase in inaudible muttering (Category 6) and a decrease in describing own activity (Category 3), across the age range five to nine years. In their study of four- and five-year-olds doing jigsaw puzzles, Deutsch and Stein (1972) found that children with higher MA scores used more private speech compared to lower MA children, and that their private speech was more advanced in terms of the Kohlberg et al. (1968) category sequence.

In her cross-sectional comparison of five- and seven-year-olds working on card-sequencing tasks, Beaudichon (1973) found that five-year-olds produced more private speech than seven-year-olds while working on the difficult tasks, but on the easy tasks no age difference was evident. This finding suggests that overt private speech is more important as an instrument of cognition for the younger children than for the older children, when faced with a challenging goal.

In the Behrend et al. (1989) cross-sectional study involving 2-, 3.5-, and 5-year-olds doing jigsaw puzzles, the percentage of private speech increased somewhat across the three age groups, consistent with the view that this form of overt verbal mediation is in its ontogenetic ascent over the course of the preschool years. Other findings, however, contradict the timing of this pattern. In his study of three-, four-, and five-year-olds, also doing jigsaw puzzles, Pellegrini (1981) found that the percentage of private speech was lower for five-year-olds than for

three- or four-year-olds, suggesting that by five years, the use of overt private speech is already on the decline, and not still increasing.

Three studies by Berk and colleagues (Berk, 1986; Berk & Garvin, 1984; Bivens & Berk, 1990) have produced evidence of age-related differences in the frequencies of the three ontogenetic levels of private speech, but no evidence of differences in the overall frequency of private speech. Berk and Garvin (1984) observed groups of 5- and 6-year-olds, 7- and 8-year-olds, and 10-year-olds, in a school environment. They found that the combination of the Level 2 subcategories describing own activity and self-guiding comments (which were collapsed because of problems establishing inter-rater agreement for the distinction between them) was more frequent in the youngest age group than in the two older groups, and the Level 3 subcategory, muttering, increased in frequency across all age groups. Berk (1986) compared first- and third-graders doing math seatwork, and found that first-grade children produced Level 1 and Level 2 private speech with greater frequency than third-graders, but third-grade children used Level 3 private speech more often than first-grade children. Among Grade 3 students, the frequency of private speech was inversely related to IQ: low-average-IQ students used private speech more frequently than average-IQ students, who used it more frequently than high-IQ students. And in their longitudinal analysis of math seatwork observations during Grades 1, 2, and 3, Bivens and Berk (1990) found

that Level 1 and Level 2 private speech declined across the three grades, while Level 3 private speech increased. Findings of these studies indicate that during the early elementary school years, private speech becomes less comprehensible to a listener.

None of these three studies (Berk, 1986; Berk & Garvin, 1984; Bivens & Berk, 1990) found evidence of an ontogenetic decline in the overall frequency or quantity of private speech. On the other hand, five other studies did find such a pattern (Beaudichon, 1973; Kohlberg et al., 1968, Studies 1 and 2; Pellegrini, 1981; Quay & Blaney, 1992). This discrepancy can perhaps be accounted for by differences in the activities employed as contexts for generating the private speech data. In the studies reporting a developmental decline in private speech use, observations were made while children carried out card-sequencing tasks (Beaudichon, 1973), made sticker designs (Kohlberg et al., 1968, Study 2), worked on jigsaw puzzles (Pellegrini, 1981), and engaged in free play (Kohlberg et al., 1968, Study 1; Quay & Blaney, 1992). The majority were carried out under laboratory conditions. The three studies by Berk and colleagues (Berk, 1986; Berk & Garvin, 1984; Bivens & Berk, 1990) were all based on observations made during math seatwork in the classroom or other school activities, more ecologically appropriate and probably for the most part more challenging activites, which elicited private speech regardless of age. Of the five studies showing a

decline, only one (Kohlberg et al., 1968, Study 2) included children in the sample as old as those in the research by Berk and colleagues (Berk, 1986; Berk & Garvin, 1984; Bivens & Berk, 1990). It could perhaps be argued, then, that Berk's observational studies failed to find the pattern of internalization because the samples did not include children of a sufficiently young age, and the private speech observed in these studies was a residue of the phenomenon which persists after the internalization process; however, the frequencies of private speech in these studies were far too high to support this suggestion (Berk, 1992, p. 40). In any case, the general pattern of findings in these studies is mixed and ambiguous with regard to the status of private speech production as a stage of ontogenetic development.

Private Speech in Older Age Groups

Though small, the empirical literature on private speech in older age groups is quite varied. This literature includes several studies on the use of private speech by adult second-language learners (e. g., Frawley & Lantolf, 1985; Lantolf & Frawley, 1984; McCafferty, 1992; see also McCafferty, 1994), naturalistic observations of adult private speech (John-Steiner, 1992; Soskin & John, 1963), an experimental study of private speech use by adolescents during a written exam (Kronk, 1994), self-report questionnaire data on self-verbalization by elite athletes (Highlen & Bennett, 1983), and a questionnaire study on self-directed speech

among undergraduate university students (Siegrist, 1995).

In studies of private speech use by adult second-language learners, participants have typically been observed while carrying out picture narration tasks, which involve narrating a story represented in a series of pictures (McCafferty, 1994). In these studies, the experimenter was present during performance of the experimental tasks, and all extra-textual, non-narrative verbalizations were analyzed as private speech, including speech addressed to the experimenter (see, for instance, McCafferty, 1992, pp. 183-184). This does not correspond to a standard definition of the category, 'private speech,' and this research is of only limited relevance to the present thesis work or to other studies on private speech. These second-language learning studies have, nonetheless, produced a form of replication of the task difficulty effect.

Frawley and Lantolf (1985) compared the verbalizations of adult intermediate-level and advanced English as a Second Language (ESL) learners, native-speaking adults, and native-speaking children, while they carried out a picture narration task. Frawley and Lantolf reported that native-speaking children and intermediate second-language learners - who alike experienced considerable difficulty with the task - used more private speech (loosely defined) than advanced second-language learners or native-speaking adults, who experienced little difficulty. This finding extends the result of an earlier study by Lantolf and

Frawley (1984), in which adult intermediate second-language learners used more private speech than advanced learners or native-speaking adults. Also using a picture narration task, McCafferty (1992) compared low-intermediate, intermediate, and advanced level adult ESL learners. In this study, private speech use decreased across groups with increasing English-language proficiency.

Taken together, the findings of these studies indicate that those participants experiencing the greatest difficulty with the task produced the most private speech (problems of definition aside), paralleling the task difficulty effect found in research on private speech in children. McCafferty (1994) concludes that "a Vygotskian view of private speech affords a valuable window onto the intrapersonal processes in which L2 learners engage" (p. 434), adding to knowledge about "how learners endeavor to gain control over the various difficulties that confront them in communicating in a foreign tongue" (p. 422).

In a naturalistic study of patterns of verbal communication, Soskin and John (1963; see also John-Steiner, 1992) recorded instances of private speech along with other kinds of speech. Audio recordings were made of young adult married couples' speech in a variety of settings at a holiday resort, including during mealtimes, while rowing and playing golf, and while learning to make leather sandals in a craft shop. Soskin and John (1963) identified two distinct "forms of intrapersonal talk" (p. 255) in their data. One was "expressive

statements," which are used "to discharge immediately experienced tension," and "are not aimed at interpersonal communication" (p. 255). These utterances constituted 5.70 % of the speech data, overall. The second form of intrapersonal talk was "exocogitative statements," "the verbal acts most commonly described as 'thinking aloud'" (p. 255). Speech of this kind functioned as a means of "verbal exploration of a problem or situation" (p. 255). Exocogitative speech was infrequent, amounting to only .91 % of the sample. John-Steiner (1992) concludes that although "private speech among adults is apparently infrequent" and "is usually inhibited in the presence of others" (p. 286), it is nonetheless clear that it constitutes "a language-mediated connection [which] continues to help structure the mental ecology of adults" (p. 295).

Kronk (1994) documented private speech use by older adolescents (M age = 17 years, SD = 1.5) while they wrote a mock exam. The exam consisted of 10 questions of three kinds, including "reasoning problems" (p. 792) or "word problems" (p. 791), "association problems," and "word scrambles" (p. 792). Kronk noted that "seven of the ten problems were language oriented to encourage verbal behavior" (p. 792), but did not describe the tasks in detail. Participants were instructed to work on the exam without writing any notes or rough work. They were observed in individual sessions while writing the exam alongside a same-age confederate. During the first 10 minutes of the 30-minute session, the confederate

worked on the exam silently, without speaking; during the last 20 minutes, the confederate self-verbalized at least once each minute. This manipulation was intended to reduce participants' social inhibitions against using self-directed speech. The experimenter was also seated in the room during the session, and kept written records of participants' speech.

Kronk (1994) reported that 46 of the 47 participants used private speech while writing the exam, at an overall mean rate of .45 utterances per minute (SD = .35). Thirty-seven participants self-verbalized during the first 10 minutes, before the confederate began to speak. Even so, the manipulation involving confederate self-verbalization was effective in increasing the rate of private speech during the last 20 minutes, compared to the first 10 minutes. (In Kronk's design, though, the disinhibiting influence of the confederate's speech was confounded with order: because the period when the confederate was silent occurred at the beginning of the session in every case, an alternative interpretation of the finding might involve the notion of a warm-up effect, such that after about 10 minutes, participants became more engrossed in the exam, and began to self-verbalize more.) Rate of private speech during the first 10 minutes was negatively correlated with performance score on the exam, indicating that the more participants self-verbalized before the confederate was doing so, the more difficulty they had with the exam; no relationship was found between speech and performance during the

last 20 minutes. Kronk found that overall, 56 % of participants' private speech was incomprehensible.

Highlen and Bennett (1983) studied self-verbalization among Canadian older adolescent and young adult elite athletes, using a self-report questionnaire designed to assess cognitive and behavioural strategies used during training and competition. Four of the 110 items on this questionnaire assessed self-directed speech. These items measured the overall frequency of self-talk, and the frequency of self-directed instruction, praise, and criticism. The questionnaire was administered to a sample of divers and a sample of wrestlers, all of whom were participating in qualifying competitions for major international events.

Highlen and Bennett (1983) described the overall frequency of self-reported self-verbalization as moderate. They found that among divers, those who succeeded in qualifying for the major international event reported a greater overall frequency of self-talk than those who did not qualify, as well as more instruction and less praise. Among wrestlers, qualifiers reported using more criticism than nonqualifiers. No differences were found between divers and wrestlers.

A self-report questionnaire method has also been used by Siegrist (1995) to study "inner speech," which Siegrist defined as including both overt and covert self-directed speech (p. 261). Siegrist's questionnaire consisted of 19 items, each with a six-point Likert scale. These items "described various situations in which

people might talk to themselves about themselves" (p. 260); examples include "In difficult situations I try to influence myself by means of calming and encouraging words," and "If I am very confused, I try to find some orientation by talking to myself in my thoughts" (p. 262). This questionnaire was administered to a sample of 82 German undergraduate university students (M age = 27.8 years, SD = 5.6), along with questionnaires measuring self-consciousness and self-deception.

Siegrist (1995) found a positive correlation between the inner speech questionnaire and the measure of self-consciousness, and a negative correlation between inner speech and self-deception. Participants with high inner speech scores also had high self-consciousness scores (indicating high awareness of their own thoughts and feelings and high awareness of themselves as social objects), and reported deceiving themselves only infrequently, supporting Siegrist's hypothesis that "people who often talk to themselves know a lot about themselves" (p. 261). These findings suggest that verbal mediation may play an important role in processes involving self-knowledge during adulthood, but because Siegrist did not distinguish between overt and covert self-verbalization, it is not possible to ascertain the extent to which adults endorsed overt self-verbalization in this study.

Results of these few studies involving older age groups indicate that private speech is not strictly a phenomenon of childhood. It persists well beyond

the age range on which virtually all the existing research has been focused. Use of self-directed speech has been documented in older adolescents and adults using naturalistic observational (Soskin & John, 1963), experimental (Kronk, 1994), and self-report questionnaire (Highlen & Bennett, 1983; Siegrist, 1995) methods. Overall, though, these studies have done little more than establish the existence of this speech form in older age groups, and further research is needed to explore its prevalence and specific characteristics.

The studies reported in this thesis were designed to contribute to these goals, using both self-report questionnaire data and experimental data based on a university undergraduate population. Study 1 was an initial questionnaire survey, providing self-report data concerning the occurrence of private speech in adults. This initial study assesses whether young adults do indeed report self-verbalizing. The questionnaire was then used as a selection instrument in recruiting participants for the two experimental studies, Studies 2 and 3. Study 2 investigated the task difficulty effect and the occurrence of microgenetic change in self-directed speech, while participants worked on computer tasks and paper-folding tasks, without being informed until the end of the study that they were being observed or that their speech was the focus of the study. Study 3 further investigated relations between self-verbalization and both task difficulty and task type (verbal and nonverbal tasks).

Study 1: Self-Reported Private Speech in Young Adults: A Self-Verbalization Questionnaire

Self-report questionnaire methodology has not been applied to analysis of the kinds of uses of private speech emphasized by Vygotsky (1934/1987, 1978), that is, functions of a general cognitive and self-regulatory character, as opposed to the kinds of questions related to self-knowledge and self-deception which were investigated by Siegrist (1995) in his study of inner speech. As an initial step in this programme of research investigating spontaneous self-verbalization in young adults, a 27-item self-report questionnaire assessing the use of self-directed speech was constructed, and administered to samples of undergraduate university students during three university terms.

It was expected that while many respondents would report some self-verbalization, there would be a wide range of individual differences and many low scores. The overall mean Self-Verbalization Questionnaire (SVQ) score was expected to be only moderately high at the most, based on the initial working assumption that self-verbalization among adults, though not as unusual as has typically been assumed, would nonetheless not turn out to be especially common or frequent. No gender differences or age differences were predicted. These predictions applied to the overall data set, and were also extended to the separate

subsamples generated during each of the three university terms. Findings such as these would constitute a challenge to the view that private speech is internalized during the early school years and does not occur in adults.

Method

Participants

Participants in this study were undergraduate students in introductory psychology classes at the University of Waterloo, Waterloo, Ontario, Canada. The sample was drawn from classes in three consecutive university terms. For the complete sample, N = 1132 (674 males and 458 females), with M age = 20.06 years (SD = 3.29; range = 17 to 47 years). For the subsample from Term 1, N = 652 (408 males and 244 females), with M age = 19.66 years (SD = 2.36; range = 17 to 44 years); for Term 2, N = 304 (165 males and 139 females), with M age = 19.97 years (SD = 3.72; range = 17 to 46 years); for Term 3, N = 176 (101 males and 75 females), with M age = 21.72 years (SD = 4.69; range = 18 to 47 years).

Materials

Materials consisted of the SVQ, a self-report instrument on self-directed speech use (see Appendix A). This questionnaire included 27 items, each with a seven-point Likert-type rating scale; thus, the range of possible total scores was 27 to 189. Each item briefly described a scenario or set of circumstances in which private speech use seemed likely, and respondents were asked to indicate the

extent to which they agreed that they would sometimes self-verbalize in the situation (7 = strongly agree, and 1 = strongly disagree). Guided by Vygotsky's (1934/1987, 1978) analysis, items were chosen with the goal of capturing a broad range of activities and situational contexts in which adults might self-verbalize.

Procedure

Copies of the SVQ were included, along with numerous other questionnaires and psychological tests, in Mass Testing booklets distributed to students in introductory psychology classes. Booklets were returned over the following month, either in class or in a drop box located in the psychology building. Data were collected during three consecutive university terms. For each term, three different orderings of the various instruments in the booklets were used. Forty-six participants completed the SVQ a second time, at the beginning of the debriefing session following participation in Study 3, facilitating estimation of test-retest reliability.

Results

The average value for SVQ total scores was quite high, $M = 120.16$ ($s. d. = 27.07$). This mean was significantly above the mid-point of the scale, $t\ (1131) = 15.11$, $p < .001$. The range of observed scores spanned the full range of the scale (27 to 189). Women ($M = 125.48$, $SD = 26.07$) tended to report somewhat more self-verbalization than men ($M = 116.54$, $SD = 27.15$), $t\ (1130) = 5.52$, $p < .001$.

Although statistically significant, this gender difference is small in magnitude. SVQ score was not related to age.

The internal consistency of the SVQ was high, coefficient $\alpha = .94$, and test-retest reliability was moderately high, $r\ (44) = .78$, $p < .001$. The high internal consistency of the SVQ was replicated across the three university terms: for all three subsamples, $\alpha = .94$.

A one-way ANOVA indicated that SVQ means differed significantly among the three subsamples, $F\ (2, 1129) = 4.76$, $p < .01$. For the subsample from Term 1, $M = 119.41$ ($SD = 27.05$; range = 31 to 189); for Term 2, $M = 123.87$ ($SD = 26.45$; range = 37 to 187); for Term 3, $M = 116.48$ ($SD = 27.60$; range = 27 to 189). Scheffe tests indicated that Term 2 differed from both Term 1 and Term 3, but Terms 1 and 3 did not differ. However, like the gender difference in SVQ scores, these differences between terms are very small in magnitude.

Discussion

Results of this study are consistent with the position that many adults use private speech. The self-report data described here suggest that rather than being completely internalized during the early school years, spontaneous self-directed speech continues to serve intrapsychological purposes in the activities of adults. The average value of SVQ scores was quite high (well above the mid-point of the scale), indicating that most respondents reported a distinct tendency to use self-

directed speech. Moreover, observed scores spanned the full range of possible values, paralleling findings of very wide individual variation in quantities of private speech in research on children (see Berk, 1992; Fuson, 1979).

The high internal consistency of the SVQ suggests that this instrument primarily measures a general tendency to report self-verbalizing (or not) in the various situations described in the questionnaire items. However, an exploratory factor analysis of these data, reported elsewhere (Duncan & Cheyne, in press), has identified a four-factor structure among the 27 items. This exploratory analysis suggested that although it is internally consistent, the SVQ is nonetheless divisible into four secondary but relatively distinct functional categories of self-verbalization (Spatial-Search, Behavioural-Organizational, Cognitive-Attentional, Affective) which are readily interpretable in terms of Vygotskian theory, corresponding quite closely to the kinds of cognitive and self-regulatory functions originally observed by Vygotsky (1934/1987, 1978). Within the overall general unity of the SVQ, then, secondary factors can be discriminated.

The questionnaire used in this study appears to have sound psychometric properties, including both high internal consistency and moderately high test-retest reliability. As an approach to studying private speech, however, the self-report method has disadvantages as well as advantages. An obvious advantage, of course, is the relative ease with which a large data set can be generated, compared

with the more labour-intensive process of observing private speech first-hand. The disadvantages of this approach, however, are not trivial. It is possible that adults self-verbalize more than they are consciously aware of, such that self-reports underestimate rates of actual occurrence. Under-reporting might also occur because of a self-presentation effect, particularly in view of social stigmatization about talking to oneself, and the popular association of self-directed speech with deviance and mental illness. It seems likely, then, that the present study underestimates the actual incidence of self-verbalization in this sample. In any case, results of Study 1 indicate a need for observational and experimental research on private speech in adults, in order to determine the extent to which adults' use of this speech form resembles children's. Although the late preschool and early school years may be an especially important period for development of relations between speech and thinking and for development of verbal thinking, it would seem that self-directed speech is not a developmental stage ending during childhood, but instead persists into adulthood.

Study 1 indicated that according to their own self-reports, young adults are quite likely to use self-directed speech in a wide variety of situations. Studies 2 and 3 were designed to actually elicit private speech in a laboratory setting, and to examine the effects of experimental manipulations which have been shown to be effective in research with children.

Samples for Studies 2 and 3 were drawn from among the 1132 cases in the sample from Study 1. Based on the assumption that many adults would not speak out loud to themselves in a laboratory setting, the SVQ was used as a selection instrument in order to recruit participants who would be likely to speak while being observed. The large majority of participants in Studies 2 and 3 were recruited on the basis of high SVQ scores. A small number with low SVQ scores were also recruited, in order to validate the SVQ by assessing whether low self-report scores predicted negligible quantities of speech in the laboratory.

Study 2: A Microgenetic-Experimental Study of Young Adults' Private Speech

Study 2 investigated the effects of task difficulty and task repetition on adults' private speech. In this experiment, young adult undergraduate students worked on computer tasks and paper-folding tasks during two sessions. Each session included a series of six phases, three for each task type. One of the computer task phases during each session was an easy data entry task, one was a difficult data entry task, and one was an exact repetition of the difficult task. The contrast between the easy computer task and the first trial on the difficult computer task constituted a manipulation of task difficulty. The three paper-folding phases in each session involved copying a challenging origami model. This repeated-measures design was influenced by Vygotsky's (1978) ideas about "experimental-developmental" (p. 61) or 'microgenetic' (see Wertsch, 1985, p. 55; 1991, p. 23) methodology. Vygotsky (1978) argued that a dynamic, process-oriented approach to experimental research is useful for inducing theoretically-consistent changes within the time-frame of the study itself, with accumulation of experience on an experimental task. Ideally, such an experiment "artificially provokes or creates a process of psychological development" (p. 61) which can be observed as it occurs. The repetitions of tasks in this experiment, both within and between sessions, were intended to provoke short-term change in participants' use

of self-directed speech.

The rate of self-directed speech (utterances per minute) was the basic quantitative speech measure used in this research. Other speech measures in addition to the rate of speech included both rates and percentages of speech preceding action, semantically self-regulatory speech, incomprehensible speech, and psychologically predicative speech. A number of hypotheses were tested concerning these measures.

It was hypothesized that during both sessions, the rate of speech would be higher when participants worked on the difficult computer task for the first time than when they worked on the easy task. Thus, a replication of the task difficulty effect was predicted. Rates and percentages of speech preceding action and semantically self-regulatory speech were also expected to be higher on the first difficult task than on the easy task.

It was hypothesized that during both sessions, rate of speech would be higher when participants worked on the difficult computer task the first time compared to the second time. Rates and percentages of speech preceding action and semantically self-regulatory speech were expected to be higher the second time, as a result of previous experience with the task.

Cross-session decreases in rate of speech and increases in rates and percentages of speech preceding action, semantically self-regulatory speech, and

incomprehensible speech were predicted, for all three computer tasks, as a result of increasing experience with the tasks. Within-session and between-session increases in rate and percentage of psychologically predicative speech were predicted, when participants worked on the first and second difficult computer tasks again as a function of experience with the tasks.

For the paper-folding tasks, within-session and between-session decreases in rate of speech and increases in rates and percentages of speech preceding action, semantically self-regulatory speech, and incomprehensible speech were predicted.

Although there are some grounds to expect that rates of private speech should be uncorrelated with task performance, a strong argument can also be made for a negative correlation (Diaz, 1986, 1992; Frauenglass & Diaz, 1985). The hypothesis was advanced, then, that rate of speech and task performance would be negatively correlated in this experiment. These predictions were made for both computer tasks and paper-folding tasks.

The majority of participants in this study were selected because they had high SVQ scores in the mass administration of the SVQ in introductory psychology classes (described in Study 1), while a small number were selected because of low SVQ scores. At the outset of this research, the working assumption was that adult private speech is a relatively rare phenomenon, and for

that reason high-SVQ individuals were sampled to maximize the opportunity to observe it. It was expected that low-SVQ participants would produce little, if any, self-directed speech; their data were expected to be of relatively little interest in relation to the particular questions addressed in this experiment, aside from providing support for the working assumption that some adults do not self-verbalize at all and validating the SVQ. No gender differences were expected in this study.

Method

Participants

Participants in this experiment were 53 undergraduate students in introductory psychology classes at the University of Waterloo. These participants were accessed through the Psychology Department Subject Pool and recruited by telephone. Participants received course credit in introductory psychology for their participation. The sample included 27 males and 26 females (M age = 19.43, SD = 1.01; range = 18 to 23). Forty-two of the 53 participants (21 males and 21 females) were selected because they had SVQ scores of 130 or higher; 11 (6 males and 5 females) were selected because their SVQ scores were 95 or lower.

Materials and Equipment

Questionnaires. Three questionnaires were used in this experiment. One of these was the SVQ (see Appendix A). The second was the 'Computer

Experience Scale' (CES), a three-item instrument providing an estimate of experience with using computers, using spreadsheets, and using MS Excel (see Appendix B). The third questionnaire was the 'Computer Attitudes Scale' (CAS), an 11-item modification of the Computer Attitudes Scale (Bandalos & Benson, 1990) which assesses positive and negative predispositions toward using computers (see Appendix C). Like the SVQ, both the CES and the CAS employ seven-point Likert-type rating scales for each item.

Task materials. Task materials in this experiment included numerical data, instructions, origami models, and paper for making origami objects. The pages of numerical data entered into MS Excel during the easy computer task phases consisted of rows of randomly-sequenced single-digit numbers (see Appendix D). The pages for the difficult computer task phases consisted of Excel spreadsheet co-ordinates paired with five-digit numbers; each five-digit number was preceded by a lower-case letter. A randomly-chosen 10 % of these lower-case letters were the letter 'r,' and another randomly-chosen 10 % were the letter 'x' (see Appendix E). The cell co-ordinates specified spreadsheet cells located in rows ranging from 1 to 300, and columns ranging from A to AZ (52 columns). The data pages were located on an upright clipboard beside the computer keyboard.

Instruction sheets listed the sequence of task phases during the session, and included specific instructions for each task as well as the duration of each

phase (see Appendix F). The instruction sheet for each session was tacked on the wall above the computer.

Two very challenging origami objects - a 'canoe' (Temko, 1991) and a 'sailboat' (Temko & Simon, 1968) - were used as models for the paper-folding tasks. Three sheets of paper (numbered 1, 2, and 3, one for each of the three paper-folding phases) were provided during each session. An additional supplementary paper object (a 'file folder,' which was also very challenging; Huber & Claudius, 1990) was provided for participants to work on until the end of the phase, if they finished the primary task with time remaining during any of the paper-folding phases.

Equipment. Equipment used in this experiment included a computer, audiovisual recording equipment, and a timer. A PC-type microcomputer with the spreadsheet programme MS Excel for Windows was used for the computer data entry tasks. A Sony brand 8 mm camcorder and a remote Realistic brand Pressure Zone Microphone (PZM) were used to record the sessions. The camcorder was located in an adjacent room, on the opposite side of a one-way mirror, approximately 10 feet from the participant. The PZM is essentially a metal plate (12 cm square); this piece of equipment does not visually resemble a standard microphone, and for this reason it was feasible to locate it on the wall directly in front of the participant, above the computer. Recordings were copied from the 8

mm videotapes to VHS videotapes; as part of this procedure the audio signal was passed through a Realistic brand stereo equalizer, with 10 channels per side. This was done in order to enhance the quality of the speech records, by reducing extraneous noise (including the computer hard drive, the air conditioning and ventilation system in the room, and the timer) and augmenting the frequencies in which participants' voices were located. Different equalizer settings were used in dubbing the records of female participants and male participants, to accommodate differences in pitch between female and male voices. For females, the 2 khz and 4 khz frequencies were maximized, the 1 khz frequency was set in the middle neutral position (neither augmented nor diminished), and the remaining seven frequencies (ranging from 31 hz to 16 khz) were all minimized. For males, the 500 hz and 1 khz frequencies were maximized, the 2 khz frequency was set in the middle position, and the remaining seven were minimized. A spring-driven kitchen timer was used to time the phases.

Procedure

The three questionnaires were administered as part of Mass Testing in introductory psychology classes, as described in Study 1.

Sessions and phases. The experiment included two sessions with each participant, on separate days, not more than 10 days apart. Each session was approximately 30 minutes in duration. Each session included a sequence of six

four-minute phases (see Appendix F). Participants timed these phases themselves, using the kitchen timer. Each sesson began with either a computer task phase or a paper-folding phase (depending on counterbalancing, described below), and the remaining five phases alternated between the two task types. The first session was preceded by an information period of approximately 5 minutes' duration, at the end of which initial consent for participation was obtained; the second session was followed by a debriefing period of approximately 10 minutes' duration, during which the purpose of the study and the need for deception were carefully explained to the participant in considerable detail (see Appendix G). At the beginning of this debriefing period, the participant was asked two questions: (1) "Do you touch-type numbers?;" and (2) "Did you say anything during the sessions?" At the end of the debriefing, the participant was explicitly given the opportunity to withhold consent and withdraw from the study, and a second consent form was presented to the participant, in order to obtain informed consent for using the data from the two sessions. (Consent forms are included in Appendix H.)

Experimental tasks. Participants in this experiment carried out computer tasks and paper-folding tasks. During each of the two sessions, the participants performed an easy computer task once, a difficult computer task twice, and a paper-folding task three times. Six Excel spreadsheet documents were created for

each participant, prior to the sessions (one spreadsheet document for each of the three computer task phases in each of the two sessions).

For the easy computer task, participants were provided with pages with rows of single-digit numbers which they entered in the spreadsheet, one number per cell. For the difficult computer task, participants were provided with pages with spreadsheet co-ordinates followed by five-digit numbers, each preceded by a lower-case letter. The task involved first finding a specified cell in the spreadsheet, then entering the number following the cell co-ordinates. If the lower-case letter preceding the five-digit number was a 'r,' the number was to be entered from right to left rather than left to right; if the letter was a 'x,' the participant was to omit the five-digit number, and instead proceed to the next specified spreadsheet cell. If the lower-case letter was neither a 'r' nor a 'x,' the participant was to simply enter the five-digit number, from left to right (see instructions in Appendix F). For the second difficult computer task phase, participants were provided with identical copies of the data sheets for the first difficult computer task phase. Within each session, then, the identical difficult computer task was carried out twice. Different pages of data were used during each of the two sessions, for both the easy and the difficult computer tasks.

For the 'origami' task, participants were provided with sheets of paper and a completed model origami object, and asked to make copies of the model.

Participants carried out this task three times during each session, once during each of the three paper-folding phases. Two different model origami objects were used (one during each session). A third paper object was provided for participants to work on if they finished the primary task with time remaining during any of the paper-folding phases.

Instructions to participants. Each participant was met by the experimenter in a waiting area in the psychology building and taken to the room where the experimenter waited during the sessions. At this time the experimental tasks were briefly described to the participant and he or she was told a cover story about the purpose of the study (see Appendix I). An initial consent form was then presented to the participant. The participant was not told about the audiovisual recordings or the study's focus on speech until the end of the second session. The participant was told that the experimenter would wait in this room during the session, and that he or she should come to this room and tell the experimenter when he or she was finished the session. After initial consent was obtained, the participant was taken from this room to the room in which the experiment was run, approximately 50 feet along a hallway in a research area of the psychology building. (This separation of the two rooms - the room in which the participant worked on the tasks and the room where the experimenter waited - was intended to increase participants' feelings of being entirely alone while working on the tasks.)

At this time, the experimental tasks and procedure were explained. First the origami task was explained, in terms of the basic objective of using the paper that had been provided to make copies of the model. The participant was asked to use the sheet of paper numbered 1 on the first origami task trial, the sheet numbered 2 on the second trial, and the sheet numbered 3 on the third trial. Next the computer tasks were explained, beginning with the MS Excel spreadsheet programme itself as a matrix of numbered rows and lettered columns. The participant was shown how to move around the spreadsheet (1) using the arrow keys, and (2) by clicking the arrows in the scroll bar. The participant was shown the pages of data to be entered, and the page of instructions tacked on the wall behind the computer. Lastly, the participant was instructed to time the four-minute phases using the kitchen timer, and the use of the timer was briefly demonstrated.

Counterbalancing. Four counterbalanced orderings of the various tasks and materials were used (see Appendix J), and participants were randomly assigned to one of the four (with the constraint that each ordering was used an approximately equal number of times). The ordering of the 'easy' and 'difficult' data entry tasks was counterbalanced across the four orders. The particular computer task materials (that is, the specific data to be entered) were counterbalanced across orders and across sessions, within each order. The two paper-folding items (the sailboat and the canoe) were counterbalanced across sessions, such that

participants assigned to two of the four orders carried out one of the two items during Session 1 and the other during Session 2, and half did the two items in the reverse order. The order of the computer and paper-folding phases was counterbalanced across orders and across sessions.

Task performance. Computer task performance was estimated on the basis of the size of the completed Excel spreadsheet document for each phase, in terms of kilobytes. Differences in this measure reflected differences in the amount of numerical data entered during the phases. This measure assessed the overall quantity of data entered, and did not take into account errors in data entry.

Paper-folding task performance was assessed by scoring participants' objects on a three-point scale. The product from each paper-folding phase was scored as a 0, 1, or 2, according to whether it bore no resemblance, some resemblance, or close resemblance to the model. A second judge scored participants' three paper-folding objects from a randomly-chosen 22 sessions (11 first sessions and 11 second sessions; 12 sailboats and 10 canoes). This was 20.75 % of the sample. Inter-judge agreement for scoring the paper-folding objects was 93.94 %.

Touch-typing classification. Based on the video record for the first 30 seconds of the easy computer task during the first session, participants were classified as to whether they touch-typed numbers (that is, typed numbers without

looking at their hands, and looking consistently instead at the pages of numerical data). An independent observer classified a randomly chosen 12 participants, or 22.64 % of the sample. Interobserver agreement for this touch-typing classification was 91.67 %.

Classification of speech. Rather than using a multiple-category classification system designed to test a number of different kinds of research questions (cf. Berk & Garvin, 1984; Furrow, 1984; Kohlberg et al., 1968), the approach taken in this experiment was to design independent dichotomous classification systems specific to each research question.

Participants' speech while working on the experimental tasks was transcribed into utterance units on the basis of temporal isolation from other speech. A verbalization was considered a discrete utterance unit if the participant did not speak for at least two seconds before and after the verbalization (after Furrow, 1984). Sounds which were not transcribed as speech in this research included unvoiced sighs, unvoiced yawns, laughing, coughing, clearing the throat, voiced or unvoiced sneezing, sniffling, breathing, and tongue clicking. All other vocalizations while on task were transcribed as speech data.

Utterance units were coded using either three or four orthogonal binary classification systems. (An example transcript is included in Appendix K.) An independent observer classified the speech in two of the six phases of 47 sessions

(24 Session 1 samples and 23 Session 2 samples); this included 1332 utterance units altogether, or 23.23 % of the total sample of speech (5734 utterances). This interobserver agreement sample was chosen randomly from among those phases during which speech was observed.

The classification systems used in this experiment were as follows: (1) Speech Preceding Action (nonsemantic criteria for self-regulation): Each utterance was classified according to whether the participant (1) began to vocalize prior to the beginning of the closest identifiable task-related action ('speech preceding action'), or alternatively, (2) did not begin vocalizing before the beginning of an action (instead, either the participant began to vocalize simultaneously with or following the beginning of the action, or the utterance was not associated with action in any way). This classification was based solely on the timing of the utterance in relation to action, without consideration of the semantic content of the utterance. It was based, in other words, on when the participant began to speak, and not what the participant said. An utterance which both began and ended before the participant began to move could be classified as speech preceding action if the interval between the end of the utterance and the beginning of the action was not longer than two seconds; if this interval was greater than two seconds, the utterance was not classified as preceding action. Most task-related actions were hand movements. As well as more obvious examples such as typing

and folding paper, task-related actions also included moving or clicking the mouse, arranging the pages of numerical data, reaching for or picking up the paper-folding model, indicatory pointing gestures, sitting down, standing up, and moving the chair. Movements which were not considered task-related actions included the participant touching his or her face or hair, stretching, looking at his or her watch, shrugging his or her shoulders, and shaking or nodding his or her head. Interobserver agreement for this classification was moderate, $\underline{k} = .74$ (84.76 % agreement).

(2) Semantically Self-Regulatory Speech: Each utterance was classified in terms of self-regulatory semantic content. An utterance which specified a task-related action which the participant was concurrently carrying out (or attempting to carry out) or was about to carry out (or attempt to carry out) was classified as 'semantically self-regulatory.' This applied to abbreviated and fragmentary utterances as well as to more complete sentences, including utterances which were abbreviated such that they did not include a verb, but did include the object of a task-related action. Examples of abbreviated utterances classified as semantically self-regulatory include "AC167, "32451," "enter," "this down like this," "like that," "that goes down," "this one," and "this part." Utterances in which the specification of the action constituted less than half of the utterance unit were not classified as semantically self-regulatory. Interobserver agreement for this

classification was high, k = .91 (96.40 % agreement).

(3) Incomprehensible Speech: Each utterance was classified according to whether the majority of the semantic content of the utterance either could be understood or not (for instance, because it was muttered, mumbled, or whispered); utterances which for the most part could not be understood were classified as 'incomprehensible.' Utterances which were clearly articulated but devoid of obvious conventional semantic content (for example, "Aargh!" or "Hm," or humming) were not classified as incomprehensible. Interobserver agreement for this classification was high, k = .92 (96.32 % agreement).

(4) Psychological Predication: Each utterance produced while working on the difficult computer tasks was classified as to whether it (1) included only the psychological predicate, or (2) included both the psychological predicate and other speech or only other speech. Data for the difficult data entry tasks were suitable for this kind of analysis, because the task was structured such that the 'given'/'new' organization of information was relatively clear, and psychological predicates could be readily identified in participants' speech. An utterance was classified as 'psychologically predicative' if the participant either (1) verbalized only cell co-ordinates (for example, "AD214"), or (2) verbalized only the number to be entered in a cell (for example, "53219" or "g53219"). Utterances like these usually explicated that information which would be needed to carry out the next step in

the task, given the requirements of the difficult data entry task. If an utterance included any content in addition to these two categories, it was not classified as psychologically predicative. Utterances consisting of partial psychological predicates (for example, "AD" or "214") were classified as psychologically predicative, as were utterances in which a predicate or partial predicate was repeated (for example, "A44 - A44" or "A - A44"). A single utterance unit including two or more predicates (for example, "g53219. AD214") was not classified as psychologically predicative. The interobserver agreement sample for this classification consisted of 467 utterances. Interobserver agreement for this classification was high, $\underline{k} = .96$ (98.29 % agreement).

Study 2 - Results

Computer Tasks

Task Performance

Mean performance scores for each of the six computer task cells in the design are reported in Table 1. These data represent the size (in kilobytes) of participants' completed spreadsheet documents, for each computer task phase. To reduce heterogeneity of variance among cells, transformations were carried out with the task performance data. A square root transformation reduced heterogeneity to some degree; a log 10 transformation resulted in greater reduction, although it did not entirely solve the problem. O'Brien's test found significant heterogeneity for the untransformed, square root transformed, and log 10 transformed data. The log 10 transformed data were used for analyses because these data had the smallest ratios of variances between cells (means for log 10 transformed task performance scores also are reported in Table 1).

Table 1.

Mean Untransformed and Log 10 Transformed Performance Scores on Computer Tasks by Session (Standard Deviations in Parentheses)

Untransformed (in kilobytes)

	Computer Task		
	Easy	Difficult 1	Difficult 2
1 Session	3382.45 (810.46)	1575.47 (71.34)	1645.75 (111.77)
2	3887.28 (898.46)	1670.25 (124.10)	1726.40 (164.38)

Log 10 Transformed

1 Session	3.52 (.10)	3.20 (.02)	3.22 (.03)
2	3.58 (.10)	3.22 (.03)	3.24 (.04)

Total scores on the three-item CES questionnaire were positively correlated with both transformed and untransformed performance scores during all six computer task phases. Correlations for the transformed data are reported in

Table 2.

Table 2.

Pearson Product-Moment Correlations between Computer Experience Scale Total Score and Transformed Computer Task Performance Score (N = 53)

		Computer Task		
		Easy	Difficult 1	Difficult 2
Session	1	.49*	.38*	.43*
	2	.40*	.36*	.57*

*p<.01

The degrees of freedom for many of the F ratios in these analyses were adjusted because of violations of the requirement of sphericity (that is, the requirement that cell variances are equal and covariances are zero, or at least equal), both in these task performance data and in the speech data reported below. Either the Greenhouse-Geisser or the Huynh-Feldt correction procedure was used in adjusting degrees of freedom. The Huynh-Feldt statistic is somewhat less conservative than the very stringent Greenhouse-Geisser statistic, and was used in these analyses whenever the value of the Huynh-Feldt correction factor was .75 or

lower. A set of three rules regarding adjustments to degrees of freedom (adapted from Keppel, 1982) was used in this study: (1) if the Mauchley's test for sphericity was not significant (indicating the presence of sphericity in the data), unadjusted degrees of freedom were used; (2) if the Mauchley's test for a particular effect in the ANOVA was significiant (indicating a failure to satisfy the requirement of sphericity, for the test of the effect in question), and the value of the Huynh-Feldt correction factor was greater than .75, then the Greenhouse-Geisser correction factor was used to adjust the degrees of freedom; and (3) if the Mauchley's test was significant and the Huynh-Feldt statistic was .75 or lower, then the Huynh-Feldt correction factor was used to adjust the degrees of freedom. The overall effect of this procedure was to make the analysis of variance moderately conservative, but not severely conservative, as would sometimes be the case if the Greenhouse-Geisser correction was applied indiscriminately whenever the Mauchley's test was significant. Unless otherwise noted, degrees of freedom in these analyses were not adjusted; in instances in which adjustments were made, the particular correction factor that was used (Greenhouse-Geisser or Huynh-Feldt) is specified.

The log 10 transformed computer task performance data were analyzed using an ANCOVA with CES total score as a covariate and session (two levels) and computer task (three levels) as within-subjects factors. This analysis found a

significant covariate effect of CES score, F (1, 51) = 26.08, p<.001, a main effect of session, F (1, 51) = 7.24, p<.05, a main effect of task, F (1, 55 [Huynh-Feldt]) = 66.41, p<.001, a CES X task interaction, F (1, 55 [Huynh-Feldt]) = 8.23, p<.01, and a session X task interaction, F (1, 67 [Huynh-Feldt]) = 7.15, p<.01. The pattern of Pearson r correlations in Table 2 suggests the CES X task interaction reflects the closer association of CES score with performance on the second difficult task trial than on the first, although none of the Pearson r values differ significantly from one another.

To analyze the session X task interaction, simple main effects of the 'task' factor were examined during each session (see Table 1). The analysis for Session 1 found a significant task effect, F (1, 56 [Huynh-Feldt]) = 539.01, p<.001. Orthogonal contrasts were used to compare transformed performance score means across the different computer tasks. The first contrast indicated that performance scores were significantly higher for the easy task than for the first and second trials on the difficult task, combined, F (1, 56 [Huynh-Feldt]) = 1067.78, p<.001. The second orthogonal contrast found no difference in performance between the first trial on the difficult task and the second trial (see Table 1).

The simple effect of task was also significant during Session 2, F (1, 59 [Huynh-Feldt]) = 748.29, p<.001. Orthogonal contrasts were again used to make comparisons among tasks. The first contrast indicated that, as in Session 1,

performance scores during Session 2 were higher on the easy task than on the first and second difficult tasks combined, F (1, 59 [Huynh-Feldt]) = 1492.53, $p<.001$. This predicted performance difference in both sessions probably reflects in part the qualitative difference between the tasks designated as 'easy' and 'difficult,' in addition to relative difficulty per se: on the easy task, numbers were simply entered in every cell of the row, without the need to search for the specified cells in the spreadsheet, and so participants spent more time entering numbers on the easy task, as a result of the organization of the two different tasks. Nonetheless, these findings provide support for the validity of the computer task difficulty manipulation employed in this experiment. The second orthogonal contrast found no difference in performance during Session 2 between the first and second difficult tasks (see Table 1).

Repeated-measures t-tests between task means for the two sessions found significant cross-session performance differences on all three tasks: for the easy task, t (52) = 5.62; for the first difficult task, t (52) = 6.41; and for the second difficult task, t (52) = 4.31, all $ps<.001$.

Self-Directed Speech

All 53 participants in this experiment produced self-directed speech while working on the computer tasks. Forty-four of the 53 participants verbalized during every one of the six computer task phases. The overall mean rate of speech while

working on the computer tasks was 2.95 utterances per minute (SD = 1.94; range = .17 to 7.29). The distribution of the overall rate of speech on the computer tasks was not significantly skewed nor kurtotic.

There were no gender differences in rates of speech during any of the six computer task phases. Randomly-assigned counterbalanced order, CES total score, and CAS total score all were unrelated to speech production. In response to the question, "Do you touch-type numbers?," 24 of the 53 participants answered 'yes,' and 29 answered 'no,' but these responses were unrelated to rates of speech during the study. Sixteen participants were later judged (by the experimenter, using the video record) to have been touch-typing while working on the easy task during Session 1, and 37 were classified as not touch-typing. This distinction was related to speech production during only one of the six computer task phases: on the easy task in Session 2, rates of speech were higher for participants classified as not touch-typing (M = 3.12 utterances per minute, SD = 2.45) than for those classified as touch-typing (M = 1.59, SD = 1.46), t (adjusted df = 46) = 2.80, $p<.01$. None of these six variables (gender, order, CES, CAS, touch-type question response, or touch-type judgement) were included in the analyses of computer task speech data reported below.

SVQ group membership (SVQ total scores of 130 or higher in the high-SVQ group, compared with 95 or lower in the low-SVQ group) was unrelated to

rates of speech during the computer task phases, and was not included in analyses of computer task speech data. In response to the question, "Did you say anything during the sessions?," 31 of the 53 participants answered 'yes,' and 22 answered 'no.' (As has already been reported, all 53 participants did self-verbalize during the experiment.) Responses to this question were related to many of the dependent speech measures investigated in this research, and this 'question response' group membership was used as a between-subjects factor throughout the analyses of speech data reported below. The two question response groups were differentially distributed across the two SVQ groups, χ^2 (1) = 5.56, $p<.05$, indicating significant correspondence between these classifications. Twenty-eight of the 42 high-SVQ participants responded that they had spoken during the study and 14 responded that they had not; of the 11 low-SVQ participants, 3 responded 'yes' and 8 responded 'no.' 'Yes' group members had higher SVQ total scores (M = 143.16, SD = 24.20) than 'no' group members (M = 117.73, SD = 38.00), t (adjusted df = 33) = 2.77, $p<.01$. Question response was not related to gender (the 'yes' group comprised 16 males and 15 females; the 'no' group included 11 males and 11 females).

Rate of Speech

The rate of speech (utterances per minute) while working on the computer

tasks was analyzed with a 2 (question response) X 2 (session) X 3 (task) mixed ANOVA, with participants' responses (yes or no) to the question, "Did you say anything during the sessions?," as a between-subjects factor, and session and task as within-subjects factors. This analysis found main effects of question response, F (1,51) = 18.14, $p<.001$, and task, F (2, 78 [Greenhouse-Geisser]) = 7.00, $p<.01$, and a question response X task interaction, F (2, 83 [Greenhouse-Geisser]) = 8.54, $p<.001$. (All analyses of speech on the computer tasks were repeated with randomly-assigned counterbalanced order included as a factor in the design, and order did not interact with other factors.)

To analyze the question response X task interaction, simple main effects of task (collapsing across sessions) were examined in each question response group. Mean rates of speech for the two question response groups on the three tasks are reported in Table 3. The analysis for the group who responded that they had spoken during the study (that is, the 'yes' group; $N = 32$) found a significant effect of task, F (2, 46 [Greenhouse-Geisser]) = 8.90, $p<.001$. Likewise for the group who responded that they had not spoken (the 'no' group; $N = 21$), the task effect was significant, F (1, 31 [Huynh-Feldt]) = 8.31, $p<.01$.

Table 3.

Mean Rate of Speech on Computer Tasks by Question Response Group (Standard

Deviations in Parentheses)

		Computer Task		
		Easy	Difficult 1	Difficult 2
Question Response Group	Yes	3.28 (1.95)	4.38 (2.11)	3.69 (1.87)
	No	2.16 (2.08)	1.93 (1.41)	1.27 (1.31)

Linear contrasts were used with both groups to test the hypotheses that rates of speech were (1) higher on the first trial on the difficult task (Difficult 1) than on the easy task, and (2) higher on the first difficult task than on the second (Difficult 2). The first of these hypotheses was supported for the 'yes' group, F (2, 46 [Greenhouse-Geisser]) = 17.41, $p<.001$, but not for the 'no' group. The rate of speech in the 'yes' group was higher on the first difficult task than on the easy task, as predicted, but this pattern did not hold for the 'no' group (see Table 3).

The hypothesis that the rate of speech would be higher on the first difficult task than on the second was supported both for the 'yes' group, F (2, 46 [Greenhouse-Geisser]) = 6.87, $p<.01$, and for the 'no' group, F (1, 31 [Huynh-Feldt]) = 8.53, $p<.01$. In both groups, rates of speech declined with repetition of

the difficult computer task, as hypothesized. Independent groups t-tests found that rates of speech differed significantly between the two question response groups on the first difficult task, t (51) = 4.73, $p<.001$, and the second difficult task, t (51) = 5.22, $p<.001$, but not on the easy task (see Table 3).

Correlations between Rate of Speech and Computer Task Performance

Correlations were computed between rates of speech and log 10 transformed computer task performance scores. In addition to simultaneous correlations between speech and performance within each phase of the design, cross-correlations were also examined, both between phases of the same session (for the two difficult tasks), and across the two sessions. This cross-temporal analysis was motivated by the possibility of replicating published evidence that speech-performance relationships may be cross-lagged or diachronic in nature, rather than (or in addition to) simultaneous or synchronic (e. g., Bivens & Berk, 1990; Gaskill & Diaz, 1991).

None of the speech-performance correlations for the difficult computer tasks were significant, including both simultaneous and cross-temporal relationships. Overall, rate of speech on the difficult tasks was not related to task performance.

On the easy computer tasks, Session 1 speech was not correlated with task performance during either session. Session 2 rate of speech, however, was

negatively correlated with performance during both sessions: between Session 2 speech and Session 1 performance, $r(51) = -.39$, $p<.01$, and between Session 2 speech and Session 2 performance, $r(51) = -.40$, $p<.01$. This pattern suggests that if participants were still verbalizing at a relatively high rate on the easy task in the second session, this was partly a reflection of difficulty with the task, resulting in low performance.

Binary Speech Classifications

Analyses of data generated using the binary coding systems for speech preceding action, semantically self-regulatory speech, incomprehensible speech, and psychological predication involved percentages as well as rates of speech. Data for the nine participants who did not verbalize during all six computer task phases in the experiment were not included in these analyses. Analyses reported in the following sections are based on a sample of 44 participants (23 males and 21 females; 36 high-SVQ participants and 8 low-SVQ).

SVQ groups differed significantly on several of the measures analyzed in this section. However, given its significant redundancy with question response, SVQ group was not included as a factor in these analyses. Both participants' responses to the question about touch-typing and the experimenter's videotape-based judgements regarding touch-typing were significantly related to speech preceding action (rate and percentage) on easy computer tasks, with touch-typers

having lower values than non-touch-typers. In addition, touch-type judgement was significantly related to rate of semantically self-regulatory speech on the easy tasks. The counterbalanced order of the computer tasks was related only to percentages of speech preceding action in two of the six computer task cells (the second difficult task in Session 1, and the easy task in Session 2). Order was not related to rate of speech preceding action, nor to the other three speech classification systems analyzed in this experiment, and it was not included in the analyses of the binary classification data.

Speech Preceding Action

The rate of speech preceding action (utterances per minute) was analyzed using a 2 X 2 X 3 mixed ANOVA, with question response as a between-subjects factor and session and task as within-subjects factors. There was a main effect of question response, F (1, 42) = 11.73, $p<.01$, and a question response X task interaction, F (2, 66 [Greenhouse-Geisser]) = 5.83, $p<.01$. The session X task interaction approached significance, F (2, 84) = 2.64, $p<.08$.

The question response X task interaction was analyzed by examining the simple effects of task separately for each question response group. Mean rates of speech preceding action are reported by question response group and task in Table 4. The analysis for the 'yes' group (N = 29) found a significant effect of task, F (2, 43 [Greenhouse-Geisser]) = 5.83, $p<.01$, as did the analysis for the 'no' group (N =

15), $\underline{F}$ (2, 28) = 4.55, $\underline{p}$<.05.

Table 4.

Mean Rate of Speech Preceding Action on Computer Tasks by Question Response Group (Standard Deviations in Parentheses)

		Computer Task		
		Easy	Difficult 1	Difficult 2
Question Response Group	Yes	.85 (.96)	1.09 (.75)	1.44 (.99)
	No	.59 (.55)	.40 (.33)	.33 (.34)

Linear contrasts were used to make comparisons between the computer tasks in order to test the hypotheses concerning task difficulty and repetition of the difficult task, with both question response groups. The first contrast found no difference between the easy task and the first difficult task, for either group. For the 'yes' group, the second contrast found an increase from the first difficult task to the second, F (2, 43) = 4.13, $p<.05$. In the 'no' group, this second contrast was not significant. Independent groups t-tests indicated that the rate of speech preceding action differed between the two groups on the first difficult task, t (adjusted df = 41) = 4.26, $p<.001$, and the second difficult task, t (adjusted df = 38) = 5.47,

$p<.001$, but not on the easy task (see Table 4).

The percentage of speech preceding action was analyzed using the 2 (question response) X 2 (session) X 3 (task) mixed design. There were main effects of question response, F (1, 42) = 8.39, $p<.01$, and task, F (2, 84) = 3.87, $p<.05$, a question response X task interaction, F (2, 84) = 3.61, $p<.05$, and a session X task interaction, F (2, 72 [Greenhouse-Geisser]) = 5.32, $p<.01$. The main effect of session also approached significance, F (2, 84) = 3.97, $p<.06$.

To analyze the question response X task interaction, the simple main effects of task were examined separately for each question response group. Mean percentages of speech preceding action are reported by question response group and task in Table 5. The analysis for the 'yes' group found a significant effect of task, F (2, 56) = 9.71, $p<.001$; the analysis for the 'no' group found no effect.

Table 5.

Mean Percentage of Speech Preceding Action on Computer Tasks by Question Response Group (Standard Deviations in Parentheses)

		Computer Task		
		Easy	Difficult 1	Difficult 2
Question Response Group	Yes	20.12 (18.80)	24.08 (12.75)	37.56 (20.03)
	No	17.18 (17.25)	15.30 (12.66)	16.89 (16.94)

'Yes' group task means were compared using linear contrasts. One contrast found a significant increase in the percentage of speech preceding action from the first difficult task to the second, F (2, 56) = 10.54, $p<.001$. A second contrast failed to detect a task difficulty effect: no difference was evident between the easy task and the first difficult task. Independent t-tests indicated that the two question response groups differed in terms of the percentage of speech preceding action on the first difficult task, t (42) = 2.17, $p<.05$, and on the second, t (42) = 3.41, $p<.01$, but not on the easy task (see Table 5).

To investigate the session X task interaction, the simple effects of task

were examined during each of the two sessions. These analyses found a significant effect of task in Session 1, F (2, 86) = 12.94, p<.001, but not in Session 2. Mean percentages of speech preceding action are reported by session and task in Table 6.

Table 6.

Mean Percentage of Speech Preceding Action on Computer Tasks by Session (Standard Deviations in Parentheses)

		Computer Task		
		Easy	Difficult 1	Difficult 2
Session	1	17.78 (19.67)	13.55 (15.88)	32.00 (24.96)
	2	20.45 (23.15)	28.62 (20.62)	29.03 (27.22)

Linear contrasts with the Session 1 task means found no task difficulty effect, in that the easy and first difficult tasks did not differ, but did find a significant increase from the first to the second difficult task, F (2, 86) = 23.59, p<.001. Consistent with the claim that the shift in location or temporal positioning

of speech in relation to action described by Vygotsky (1934/1987) can occur within a short-term microgenetic time frame, with practice and familiarization with an experimental task, the percentage of speech preceding action increased with the initial repetition of the difficult computer task, during the first session, and then remained in the neighbourhood of 30 % during subsequent trials on the difficult tasks, during Session 2. (This interpretation involving microgenetic change is supported also by the observed increase in the 'yes' group, in both rate and percentage of speech preceding action, from the first difficult task to the second.) Repeated-measures t-tests found a significant increase across sessions in the percentage of speech preceding action on the first difficult task, t (43) = 3.92, $p<.001$, but not on the second difficult task or the easy task (see Table 6).

Semantically Self-Regulatory Speech

Rate of semantically self-regulatory speech (utterances per minute) was analyzed with a 2 (question response) X 2 (session) X 3 (task) mixed ANOVA. There was a main effect of question response, F (1, 42) = 7.64, $p<.01$, and no other significant effects. Participants in the 'yes' group had higher rates of semantically self-regulatory speech (M = 1.79 utterances per minute, SD = 2.09) than participants in the 'no' group (M = .47, SD = 1.08).

Percentage of speech classified as semantically self-regulatory was analyzed using the 2 (question response) X 2 (session) X 3 (task) mixed design.

This analysis found a main effect of question response, F (1, 42) = 8.08, p<.01. Participants in the 'yes' group had higher percentages of semantically self-regulatory speech (M = 33.08, SD = 24.56) than those in the 'no' group (M = 10.87, SD = 24.56). There were no other significant effects, although the question response X task interaction approached significance, F (2, 84) = 2.71, p<.08.

Incomprehensible Speech

The rate of speech classified as incomprehensible (incomprehensible utterances per minute) was analyzed with a 2 X 2 X 3 mixed ANOVA, with question response (2) as a between-subjects factor and session (2) and task (3) as within-subjects factors. There was a main effect of task, F (2, 84) = 11.96, p<.001, and a question response X task interaction, F (2, 84) = 7.71, p<.01. No other effects were significant.

The question response X task interaction was investigated using simple effects analyses for the task factor, with each question response group. Rates of incomprehensible speech on the computer tasks are reported for each question response group in Table 7. The simple main effect of task was significant both in the 'yes' group, F (2, 56) = 20.12, p<.001, and in the 'no' group, F (1, 20 [Greenhouse-Geisser]) = 4.51, p<.05.

Table 7.

Mean Rate of Incomprehensible Speech on Computer Tasks by Question Response Group (Standard Deviations in Parentheses)

		Computer Task		
		Easy	Difficult 1	Difficult 2
Question Response Group	Yes	1.54 (1.01)	2.69 (1.27)	1.98 (1.14)
	No	2.00 (1.30)	2.08 (1.01)	1.39 (.91)

Tasks were compared using linear contrasts, for each question response group (see Table 7). For the 'yes' group, these contrasts indicated that rates of incomprehensible speech were higher on the first difficult task than on the easy task, F (2, 56) = 39.54, $p<.001$, and also higher on the first difficult task than on the second, F (2, 56) = 15.07, $p<.001$. Contrasts for the 'no' group found no difference between the first difficult and easy tasks, but did find a decline from the first difficult task to the second, F (1, 20) = 7.45, $p<.05$ (see Table 7). Independent groups t-tests found no differences between question response groups in terms of the rate of incomprehensible speech, on any of the three tasks.

The percentage of speech classified as incomprehensible was analyzed

using the 2 (question response) X 2 (session) X 3 (task) mixed design. There were main effects of question response, F (1, 42) = 7.19, $p<.05$, and task, F (2, 73 [Greenhouse-Geisser]) = 6.41, $p<.01$, a question response X task interaction, F (2, 73 [Greenhouse-Geisser]) = 5.89, $p<.01$, and a session X task interaction, F (2, 84) = 3.70, $p<.05$.

To analyze the question response X task interaction, the simple effects of task were examined separately for each question response group. Mean percentages of incomprehensible speech while working on the computer tasks are reported by question response group in Table 8. The simple effect of task was significant in the 'no' group, F (1, 21 [Huynh-Feldt]) = 7.35, $p<.05$, but only approached significance in the 'yes' group, F (2, 56) = 2.86, $p<.07$.

Table 8.

Mean Percentage of Incomprehensible Speech on Computer Tasks by Question Response Group (Standard Deviations in Parentheses)

		Computer Task		
		Easy	Difficult 1	Difficult 2
Question Response Group	Yes	61.12 (44.43)	65.54 (34.53)	58.34 (34.62)
	No	73.53 (23.19)	87.71 (13.66)	89.92 (13.95)

Linear contrasts comparing tasks indicated that in the 'no' group, the percentage of incomprehensible speech was higher on the first difficult task than on the easy task, F (1, 21 [Huynh-Feldt]) = 10.08, $p<.01$, but that the first and second difficult tasks did not differ. Conversely, in the 'yes' group, linear contrasts found no difference between the easy task and the first difficult task, but did find a significant decrease from the first to the second difficult task, F (2, 56) = 5.62, $p<.01$ (see Table 8). Independent groups t-tests indicated that the percentage of incomprehensible speech was higher in the 'no' group than in the 'yes' group while working on the first difficult task, t (42) = 2.88, $p<.01$, and the second difficult

task, t (42) = 3.95, p<.001, but not on the easy task (see Table 8).

The session X task interaction was investigated using simple effects analyses for task, in each session. Mean percentages of incomprehensible speech are reported by session and task in Table 9. The task effect was significant in Session 1, F (2, 75 [Greenhouse-Geisser]) = 9.51, p<.001. The analysis for Session 2 found no effect.

Table 9.

Mean Percentage of Incomprehensible Speech on Computer Tasks by Session (Standard Deviations in Parentheses)

		Computer Task		
		Easy	Difficult 1	Difficult 2
Session	1	61.78 (35.67)	76.61 (26.46)	69.73 (30.83)
	2	68.93 (37.28)	69.59 (29.22)	67.81 (31.85)

Linear contrasts comparing tasks in Session 1 found significant differences in the percentage of incomprehensible speech between the easy task and the first

difficult task, F (2, 75 [Greenhouse-Geisser]) = 19.00, p<.001, and between the first and second difficult tasks, F (2, 75 [Greenhouse-Geisser]) = 4.09, p<.05. Repeated-measures t-tests indicated that the percentage of incomprehensible speech differed across sessions on the first difficult task, t (43) = 2.43, p<.05, but not on the second difficult task or the easy task (see Table 9).

Psychological Predication

The rate of psychologically predicative speech (utterances per minute classified as psychologically predicative) during the difficult computer task phases was analyzed using a 2 X 2 X 2 mixed ANOVA, with question response as a between-subjects factor and session and task as within-subjects factors. Mean rates of psychologically predicative speech on the difficult computer tasks are reported by session in Table 10. The analysis found a significant main effect of question response, F (1, 42) = 7.56, p<.01. The rate of psychologically predicative speech was higher in the 'yes' group (M = 1.22 utterances per minute, SD = 1.08) than in the 'no' group (M = .28, SD = 1.08). In addition, the main effect of session approached significance, F (1, 42) = 3.33, p<.08, suggesting a tendency for the rate of predicative utterances to increase across sessions (see Table 10).

Table 10.

Mean Rate of Psychologically Predicative Speech on Difficult Computer Tasks

by Session (Standard Deviations in Parentheses)

		Difficult Computer Task Trial	
		Difficult 1	Difficult 2
Session	1	.79 (1.18)	.78 (1.16)
	2	1.04 (1.62)	.99 (1.22)

The percentage of speech classified as psychologically predicative on the difficult computer tasks was analyzed using the 2 (question response) X 2 (session) X 2 (task) mixed design. Mean percentages of predicative speech are reported by session and task in Table 11. There were main effects of question response, F (1, 42) = 8.22, $p<.01$, and session, F (1, 42) = 4.62, $p<.05$. No other effects were significant. The main effect of question response indicates that the percentage of psychologically predicative speech was higher in the 'yes' group (M = 23.59, SD = 17.29) than in the 'no' group (M = 7.81, SD = 17.30). The main effect of session indicates an increase in the percentage of predicative speech from Session 1 (M = 15.34, SD = 19.04) to Session 2 (M = 21.34, SD = 21.69).

Table 11.

Mean Percentage of Psychologically Predicative Speech on Difficult Computer Tasks by Session (Standard Deviations in Parentheses)

		Difficult Computer Task Trial	
		Difficult 1	Difficult 2
Session	1	13.78 (18.18)	17.32 (22.93)
	2	20.38 (24.17)	21.37 (23.09)

Paper-Folding Tasks

Task Performance

The paper-folding task performance data for all 53 participants were analyzed using a 2 X 2 X 3 mixed factorial ANOVA, with paper-folding order (two levels) as a between-subjects factor, and session (two levels) and trial (three levels) as within-subjects factors. Randomly assigned order of paper-folding tasks was included as a factor in this analysis to control for differences between the two paper-folding items used in the experiment. The analysis found a main effect of trial, F (2, 102) = 33.90, $p<.001$, and an order X session interaction, F (1, 51) =

48.72, $p<.001$. No other effects were significant.

Linear contrasts were used to analyze the main effect of trial. These contrasts indicated that task performance was lower on Trial 1 ($M = .58$, $SD = .56$) than on Trial 2 ($M = .76$, $SD = .62$), $F(2, 102) = 6.09$, $p<.01$, and lower on Trial 2 than on Trial 3 ($M = 1.02$, $SD = .59$), $F(2, 102) = 11.09$, $p<.001$. As expected, performance on the paper-folding tasks increased consistently across trials.

To analyze the order X session interaction, the simple main effects of the session factor were examined separately for each of the two orderings of paper-folding items. Mean performance scores are reported by order and session in Table 12. Among participants assigned to Order 1 ($N = 27$), task performance was higher during Session 2 (when the 'sailboat' item was presented) than during Session 1 (when the 'canoe' was presented), $F(1, 26) = 45.56$, $p<.001$, whereas for participants assigned to Order 2 ($N = 26$), the opposite pattern was observed, with higher performance in Session 1 than in Session 2, $F(1, 25) = 13.90$, $p<.01$ (see Table 12). These analyses clearly demonstrated the difference in difficulty between the two paper-folding items: task performance scores were higher on the 'sailboat' item than on the 'canoe,' regardless of which sessions the items were presented in. Independent groups t-tests found that task performance differed significantly between orders during Session 1, $t(51) = 5.66$, $p<.001$. During

Session 2, this difference approached significance, t (51) = 1.98, p<.06 (see Table 12).

Table 12.

Mean Paper-Folding Task Performance by Session and Order (Standard Deviations in Parentheses)

		Order of Paper-Folding Items	
		Order 1	Order 2
Session	1	.31 (.53)	1.19 (.61)
	2	1.01 (.54)	.64 (.79)

Self-Directed Speech

Fifty-two of the 53 participants in this experiment produced self-directed speech while working on the paper-folding tasks. Twenty-seven of the 53 participants verbalized during every one of the six paper-folding task phases. The overall mean rate of speech while working on the paper-folding tasks was 1.26 utterances per minute (SD = 1.26; range = 0 to 6.05). The distribution of overall rate of speech on the paper-folding tasks was somewhat positively skewed

(skewness = 1.93, z = 5.85, p<.001) and leptokurtic (kurtosis = 4.16, z = 6.5, p<.001). A repeated-measures t-test indicated that the overall rate of speech was higher on the computer tasks than on the paper-folding tasks, t (52) = 7.98, p<.001.

There were no gender differences in rates of speech during any of the six paper-folding phases. SVQ groups differed significantly in rates of speech in two of the six paper-folding phases. High-SVQ participants had higher rates of speech than low-SVQ participants during Trial 1 of Session 1 (high group M = 1.98, SD = 1.49; low group M = .91, SD = 1.33), t (51) = 2.15, p<.05, and during Trial 2 of Session 2 (high group M = 1.36, SD = 1.58; low group M = .32, SD = .41), t (51) = 3.83, p<.001. Participants' responses to the question, "Did you say anything during the sessions?," were related to a number of measures of speech while working on the paper-folding tasks. This question response variable was used as a between-subjects factor in analyses of paper-folding speech data. To control for the difference in performance between the two paper-folding tasks, order of the two tasks was included as a between-subjects factor in analyses of speech data.

Rate of Speech

Rate of speech while working on the paper-folding tasks was analyzed using a 2 X 2 X 2 X 3 mixed ANOVA, with participants' responses (yes or no) to the question, "Did you say anything during the sessions?," and order of paper-

folding tasks as between-subjects factors (each with two levels), and session (two levels) and trial (three levels) as within-subjects factors. There were significant main effects of trial, F (2, 84 [Greenhouse-Geisser]) = 39.13, $p<.001$, and question response, F (1, 49) = 8.76, $p<.01$, and a session X order interaction, F (1, 49) = 6.36, $p<.05$. The main effect of question response indicated that participants in the 'yes' group had significantly higher rates of speech (M = 1.69, SD = 1.56) than those in the 'no' group (M = .70, SD = 1.87).

Linear contrasts were used to analyze the main effect of trial. These contrasts indicated that the rate of speech on Trial 1 (M = 1.74 utterances per minute, SD = 1.51) was higher than the rate of speech on Trial 2 (M = 1.18, SD = 1.23), F (2, 84 [Greenhouse-Geisser]) = 44.70, $p<.001$, which in turn was higher than the rate on Trial 3 (M = .87, SD = 1.21), F (2, 84 [Greenhouse-Geisser]) = 13.67, $p<.001$. This analysis indicated that as hypothesized, the rate of speech on the paper-folding tasks declined consistently from trial to trial.

To analyze the order X session interaction, the simple main effects of session were examined separately for each ordering of the paper-folding items. Mean rates of speech are reported by order and session in Table 13. The analysis for Order 1 found no difference between sessions, while in the analysis for Order 2, the effect of session approached significance, F (1, 25) = 4.07, $p<.06$. Participants assigned to Order 2 tended to speak more while working on the more

challenging paper-folding item (the 'canoe,' presented during Session 2) than on the easier item (the 'sailboat'). Although the pattern of means for Order 1 was also consistent with this tendency, no significant difference was detected between sessions. Independent groups t-tests indicated that participants assigned to the two orders did not differ significantly in rate of speech, during either session.

Table 13.

Mean Rates of Speech on Paper-Folding Tasks by Session and Order (Standard Deviations in Parentheses)

		Order of Paper-Folding Items	
		Order 1	Order 2
Session	1	1.31 (1.06)	1.20 (1.35)
	2	1.04 (1.36)	1.50 (1.54)

Correlations between Rate of Speech and Paper-Folding Task Performance

Within-session and cross-session Pearson r correlations between rates of speech and paper-folding task performance were examined. Only 3 correlations were significant. Rate of speech and task performance were negatively correlated within Trial 1, $r(51) = -.34$, $p<.05$, and within Trial 2, $r(51) = -.28$, $p<.05$, and rate of speech in Trial 2 was negatively correlated with Trial 1 task performance, $r(51) = -.33$, $p<.05$. On the first two trials, then, private speech was associated with low task performance, and low task performance on Trial 1 was also associated with high rates of speech on Trial 2.

Binary Speech Classifications

Analyses of data generated using the binary coding systems for speech preceding action, semantically self-regulatory speech, and incomprehensible speech involved percentages as well as rates of speech. Data for the 26 participants who did not verbalize during all six paper-folding task phases in the experiment were not included in these analyses. Analyses reported in the following sections are based on a sample of 27 participants (17 males and 10 females; 24 high-SVQ participants and 3 low-SVQ).

Participants' responses to the question, "Did you say anything during the sessions?," were related to several of these measures of speech while working on the paper-folding tasks; question response was used as a between-subjects factor in the analyses reported in the following sections. To control for the difference in performance between the two paper-folding tasks, order of the two tasks was included as a between-subjects factor in these analyses. Because the sample of 27 cases included only 3 low-SVQ participants, SVQ group was not considered in these analyses.

Speech Preceding Action

The rate of speech preceding action while working on the paper-folding tasks was analyzed using a 2 (question response) X 2 (paper-folding order) X 2 (session) X 3 (trial) mixed ANOVA. This analysis found no significant effects. The overall mean rate of speech preceding action was .15 (SD = .20).

The percentage of speech preceding action was analyzed using the 2 (question response) X 2 (paper-folding order) X 2 (session) X 3 (trial) mixed design. There was a main effect of trial, F (2, 46) = 4.21, $p<.05$. Orthogonal contrasts found that the percentage of speech preceding action was lower on Trial 1 (M = 4.47, SD = 5.12) than on Trials 2 (M = 7.94, SD = 8.28) and 3 (M = 18.65, SD = 21.98) combined, F (2, 46) = 3.44, $p<.05$, and lower on Trial 2 than on Trial 3, F (2, 46) = 3.80, $p<.05$. The percentage of speech preceding action increased across trials, with practice on the paper-folding tasks.

Semantically Self-Regulatory Speech

The rate of speech classified as semantically self-regulatory was analyzed using a 2 (question response) X 2 (paper-folding order) X 2 (session) X 3 (trial) mixed ANOVA. This analysis found no significant effects. The overall mean rate of semantically self-regulatory speech was .09 (SD = .27).

The percentage of speech classified as semantically self-regulatory was analyzed using the 2 (question response) X 2 (paper-folding order) X 2 (session) X 3 (trial) mixed design. There were no significant effects. The overall mean percentage of semantically self-regulatory speech was 2.58 (SD = 6.09).

Incomprehensible Speech

The rate of incomprehensible speech was analyzed using the 2 (question response) X 2 (paper-folding order) X 2 (session) X 3 (trial) mixed ANOVA. This

analysis found a main effect of trial, F (2, 46) = 17.61, p<.001. There were no other significant effects, although the main effect of question response approached significance, F (1, 23) = 4.05, p<.06, as did the order X session interaction, F (1, 23) = 3.87, p<.07. Orthogonal contrasts indicated that the rate of incomprehensible speech was higher on Trial 1 (M = 1.99, SD = 1.17) than on Trials 2 (M = 1.38, SD = .99) and 3 (M = 1.08, SD = 1.07) combined, F (2, 46) = 23.10, p<.001, but that Trial 2 and Trial 3 did not differ. These findings for the rate of incomprehensible speech parallel the findings for the overall rate of speech, which is not surprising considering that the incomprehensible category accounts for some four-fifths of all speech on the paper-folding tasks.

The percentage of incomprehensible speech was analyzed using the 2 (question response) X 2 (paper-folding order) X 2 (session) X 3 (trial) mixed ANOVA. This analysis found a question response X session interaction, F (1, 23) = 4.96, p<.05, and no other significant effects. To analyze this interaction, the simple effects of session were examined for each question response group. Mean percentages of incomprehensible speech are reported by question response group and session in Table 14. The analysis for the 'no' group (N = 8) found no effect of session, while for the 'yes' group (N = 19) the session effect approached significance, F (1, 18) = 4.00, p<.07. The percentage of speech classified as incomprehensible tended to decline across sessions somewhat in the 'yes' group,

but not in the 'no' group (see Table 14). Independent groups t-tests indicated that question response groups did not differ significantly during either session.

Table 14.

Mean Percentage of Speech Classified as Incomprehensible on Paper-Folding Tasks by Session and Order (Standard Deviations in Parentheses)

		Question Response Group	
		Yes	No
Session	1	80.92 (13.77)	79.92 (14.41)
	2	74.20 (18.71)	87.14 (16.12)

Discussion

All 53 participants in Study 2 used self-directed speech, 52 of them on both the computer tasks and the paper-folding tasks. The mean rate of speech was nearly three utterances per minute on the computer tasks, and more than one utterance per minute on the paper-folding tasks. These findings strongly suggest that self-verbalization is not at all uncommon in young adults, consistent with the self-reports described in Study 1.

The finding that when asked the question, "Did you say anything during the sessions?," approximately two-fifths of the sample responded they had not spoken suggests that many adults may self-verbalize without being aware of doing so. The strength of this suggestion is qualified somewhat, though, by ambiguity in the meaning of participants' responses to this question. Three meanings are possible. The first is that a participant who responded 'no' may indeed have spoken and been aware of it, but did not wish to report this to the experimenter, presumably for the sake of self-presentation. The second possible meaning of a 'no' response is that the participant was aware of having muttered, mumbled, or whispered during the study, but that he or she decided this did not constitute 'speech' per se. The interpretation that the participant who said 'no' was not aware that he or she had verbalized during the study is the third possibility. While it is certainly possible that all three of these scenarios occurred, it seems very likely

nonetheless that a substantial number of participants in this experiment verbalized without being aware of it. This point will be considered more extensively in the concluding section of this thesis.

As has already been explained, it was expected that the high and low SVQ groups would differ markedly in terms of their self-directed speech. Instead, analyses found that it was the question response variable, and not SVQ group, which reflected differences between participants on many of the speech measures, despite the finding that question response group and SVQ group were significantly related. This correspondence between question response group and SVQ group suggests there is a certain amount of common ground in the characteristics assessed by these two forms of self-report. A 'no' response to the question about speaking and a low SVQ score may reflect a similar lack of awareness of self-verbalizing.

Although the manipulation of task difficulty on the computer tasks in Study 2 was validated by the task performance data, the effect of difficulty on the rate of speech was replicated only in the 'yes' group. Replication of this central finding in the literature on children's private speech (Beaudichon, 1973; Behrend et al., 1989; Duncan & Pratt, 1997; Kohlberg et al., 1968, Study 4; Murray, 1979; Roberts, 1979) provides important support for the claim that the self-verbalization documented in this sample of young adults is the same phenomenon that has been

observed in children, susceptible to the same kind of experimental manipulation. This point is pursued further in Study 3.

Rate of speech declined significantly in both question response groups with the within-session repetition of the difficult computer task, providing evidence of microgenetic change in adults' self-directed speech as a function of increasing familiarity and experience with the task and the situation and decreasing task difficulty (although the latter was not corroborated by task performance data, in that performance did not increase significantly with repetition of the difficult task). Further evidence of microgenetic within-session change with repetition of the difficult computer task, occurring in the 'yes' group but not the 'no' group, includes significant increases in rate and percentage of speech preceding action, and percentage of incomprehensible speech. A session X task interaction indicated that the increase in speech preceding action occurred only in the first session, and not the second. Speech preceding action increased following the first difficult task in Session 1 and then did not change over the remaining three difficult task phases (see Table 6). This suggests that in young adults, the reorganization of temporal relations between speech and action can occur quickly, after only a few minutes' experience, reflecting advanced development of speech-for-oneself.

The only effects found in analyses of semantically self-regulatory speech

were question response effects, with higher quantities in the 'yes' group than in the 'no' group; there were no effects of task difficulty nor any evidence of microgenetic change. However, more than two-thirds of participants' speech on the computer tasks was incomprehensible, calling into question the viability of semantic speech classification criteria with these data. Nonetheless, despite this high proportion of incomprehensible speech, an increase was evident across sessions in the percentage of speech classified as psychologically predicative, on the difficult computer tasks.

The two paper-folding items (the 'sailboat' and the 'canoe') differed in terms of task difficulty, contrary to expectations. This difference was reflected in the session X order interaction. Regardless of the order of the paper-folding items, though, task performance increased within sessions, with repetition across the three trials. More importantly, this increase in task performance was paralleled by the hypothesized decrease from trial to trial in the rate of speech. Microgenetic change across trials was also evident in terms of the percentage of speech preceding action, which - as predicted - increased as a function of practice with the particular paper-folding items. Approximately four-fifths of participants' speech on the paper-folding tasks was classified as incomprehensible. No significant effects were found in analyses of semantically self-regulatory speech.

As well as replicating the task difficulty effect in the 'yes' group, this

experiment found evidence of theoretically consistent short-term microgenetic changes in several speech measures (including rate of speech, speech preceding action, and psychologically predicative speech), some of which are analogous to findings reported by Duncan and Pratt (1997). This study found important differences between the private speech of participants who responded 'yes' to the question regarding talking during the sessions, and those who answered 'no.' Although this was not a primary focus of the design, Study 2 also suggested that adult private speech use is more frequent on tasks with language-related (or at least printed) materials, compared with tasks with minimal language-related characteristics. Study 3 further investigated the effects of task difficulty and task type on adult private speech, as well as following up findings related to the question response variable.

Study 3: Effects of Task Difficulty and Task Type on Young Adults' Private Speech

Participants in Study 3 carried out both easy and difficult versions of two tasks with prominent verbal, language-related features (verbal tasks) and two tasks without verbal features (nonverbal tasks). The experiment involved one session with each participant, consisting of eight phases (one phase for the easy and difficult versions of the four tasks). This design was oriented toward both further replication of the task difficulty effect, and more systematic comparison of self-verbalization on different types of experimental tasks than was inherent in the design of Study 2. This study also followed up on findings from Study 2 concerning differences between participants who responded affirmatively or negatively to the question about speaking during the study. As well as the overall rate of speech, the rate of speech that was not reading aloud was also analyzed, in order to assess the extent to which self-verbalization was being directly elicited by the verbal characteristics of the task materials.

The measures which proved most interesting in Study 2 were the rate of speech, and the rate and percentage of speech preceding action. These measures were used again in Study 3. (Coding for psychological predication is possible only with certain kinds of experimental tasks, and this variable was not investigated in Study 3.) Four speech measures were analyzed in this experiment. One was the

overall rate of self-directed speech, and the second was the rate of speech that was clearly not reading aloud from task materials. The third and fourth measures were the rate and the percentage of speech preceding action.

Several hypotheses were tested concerning these measures. Based on findings of Study 2, it was hypothesized that participants who responded 'yes' to the question, "Did you say anything during the session?," would have higher overall rates of speech and higher rates of speech that was not reading aloud, compared to participants who responded 'no.' As in Study 2, most participants in Study 3 were selected on the basis of high SVQ scores, while a small number were sampled because of low SVQ scores; it was expected, however, that findings of Study 2 would be replicated, and high- and low-SVQ participants' speech during the experimental session would not differ appreciably.

Task difficulty effects were predicted for all four speech measures, with overall rate of speech, rate of speech that was not reading aloud, and rate and percentage of speech preceding action all expected to be higher when participants worked on the difficult tasks compared to the easy tasks. It was hypothesized that both the overall rate of speech and the rate of speech that was not reading would be higher on the verbal tasks than on the nonverbal tasks. Negative correlations were predicted between task performance and both overall rate of speech and rate of speech that was not reading.

Method

Participants

Participants in this experiment were 44 undergraduate students in introductory psychology classes at the University of Waterloo. Participants were accessed through the Psychology Department Subject Pool and recruited by telephone, and they received course credit for their participation. The sample included 22 males and 22 females (M age = 20.5 years, SD = 1.34; range = 19 to 25). Thirty-two of the 44 participants (16 males and 16 females) were selected because they had SVQ scores of 130 or higher; 12 (6 males and 6 females) were selected for their SVQ scores of 95 or lower.

Materials and Equipment

In addition to the SVQ (Appendix A), materials for this study included easy and difficult versions of two verbal tasks and two nonverbal tasks (eight sets of task materials altogether). An instruction sheet indicating the sequence of phases and including instructions for each phase was also provided (Appendix L). The verbal tasks were (1) arithmetic word problems and (2) scrambled word tasks (similar to anagrams); the nonverbal tasks were (1) block pattern copying tasks and (2) paper-folding tasks (resembling simple origami art).

Arithmetic word problems. Participants were presented with arithmetic problems couched in the form of sentences and paragraphs, and asked to solve

them. Five items were adapted from the Quantitative test of the Stanford-Binet Intelligence Scale (Thorndike, Hagen, & Sattler, 1986), and seven were adapted from the Arithmetic test of the Wechsler Adult Intelligence Scale - Revised (WAIS-R; Wechsler, 1981). Twenty additional problems were generated using these items as models (see Appendix M).

Scrambled words. Participants were presented with strings of randomly-ordered letters which could be re-ordered to form words. In other words, participants were presented with "scrambled" words, and asked to unscramble them. Solutions to the easy word puzzles were three- and four-letter words with frequencies per million of 2.00 or greater; solutions to the difficult word puzzles were five- to seven-letter words with frequencies per million of 1.00 or greater (based on Carroll, Davies, & Richman, 1971). It seems probable that the difficulty of these items was largely dependent on the number of letters involved; word frequency was taken into account as well primarily in order to avoid unintentionally increasing the difficulty of the items by including rare words (see Appendix N).

Block pattern copying. Participants were presented with geometric designs and asked to copy them using plastic cubes with patterned surfaces. Twenty-seven items were adapted from the Pattern Analysis test of the Stanford-Binet (Thorndike et al., 1986), and nine items from the Block Design test of the

WAIS-R (Wechsler, 1981). Solutions to the easy items required using two to four blocks, and solutions to the difficult items required six to nine blocks.

Paper-folding. Participants were presented with model paper objects and asked to make copies of them. Participants were provided with paper which had been pre-cut in the appropriate shape for making each paper-folding item. For each item, participants were provided with a sheet of paper showing the folds involved in making the object (that is, a sheet which had been used to make the object, and then unfolded and flattened out), as well as the finished model. The difficult paper-folding item was the 'canoe' (previously used in Experiment 1). The easy items were eight simple objects, seven of which had previously been used in research with five-year-olds (Duncan & Pratt, 1997).

Instructions and most of the task materials for each of the eight task sets were located in eight file folders. The eight folders were numbered, one for each of the eight phases, and they were placed in a stack on the corner of the table. A page of specific task instructions was stapled inside each folder (see Appendix O). For the verbal tasks, all the materials (pages of arithmetic word problems and pages of scrambled words) were located inside the folders. For the block pattern copying tasks, the folders contained pages with the geometric designs to be copied, and the blocks were located on the tabletop; for the paper-folding tasks, the folders contained paper for copying the models, and the models themselves

were located on the tabletop.

Equipment. A Sony brand 8 mm camcorder and a remote Realistic brand Pressure Zone Microphone (PZM) were used to record the sessions. As in Experiment 1, the camcorder was located in an adjacent room, on the opposite side of a one-way mirror, and the PZM was located on the wall in front of the participant. Recordings were again dubbed from 8 mm to VHS videotapes, and the audio signal was passed through a Realistic brand stereo equalizer to enhance the quality of the speech records. The same equalizer settings were used in dubbing the records as in Study 2: for females, the 2 khz and 4 khz frequencies were maximized, the 1 khz frequency was set in the middle neutral position, and the remaining seven frequencies were minimized; for males, the 500 hz and 1 khz frequencies were maximized, the 2 khz frequency was set in the middle position, and the remaining seven were minimized. A spring-driven kitchen timer was used to time the phases, and a pen was provided for the verbal tasks.

Procedure

Phases. The experiment involved a single session with each participant, approximately 40 minutes in duration. The session consisted of a sequence of eight four-minute phases (counterbalanced for order), during which the participant worked on easy and difficult versions of the four tasks. Participants timed these phases themselves, using the kitchen timer. The session was preceded by an

information period approximately 5 minutes in duration, at the end of which initial consent for participation was obtained. The session was followed by a debriefing period approximately 10 minutes in duration, during which the purpose of the study and the need for deception were carefully explained to the participant (see Appendix P). At the beginning of the debriefing period, the participant was asked, "Did you say anything during the session?" The participant then completed the SVQ a second time (to facilitate estimation of test-retest reliability, reported in Study 1), before being debriefed. At the end of the debriefing, the participant was explicitly given the opportunity to withhold consent and withdraw from the study, and a second consent form was presented, in order to obtain informed consent for using the data from the session (consent forms are included in Appendix Q).

Instructions to participants. As in Study 2, each participant was met in a waiting area and taken to the room where the experimenter waited during the session. The experimental tasks were described, and the participant was told a cover story about the purpose of the study (see Appendix R). An initial consent form was then presented to the participant. No information was given concerning the audiovisual recording or the study's focus on speech until the debriefing period at the end of the session. Again as in Study 2, the participant was told that the experimenter would wait in this room, and that he or she should come to this room when he or she was finished. The participant was then taken along the

hallway to the room in which the experiment was run. He or she was shown the task materials for the eight phases (including the eight numbered file folders and the instructions and materials inside them), and the objective of each type of task was explained. The instruction sheet on the wall was explained, and the participant was instructed to time the phases using the kitchen timer.

For the arithmetic word problems and the scrambled word tasks, participants were instructed not to write except in the specific spaces indicated on the pages, in order to encourage spoken verbal mediation rather than written verbal mediation, or what John-Steiner (1992) refers to as "inner speech writing" (p. 292).

Counterbalancing. Participants were randomly assigned to one of three counterbalanced sequences of the eight sets of materials. These three sequences were counterbalanced for order of (1) the four tasks, and (2) difficult and easy items, within each task (see Appendix S).

Task performance. A total of eight measures of task performance were used in this experiment, including three different measures of performance for each of the two verbal tasks and one measure for each of the two nonverbal tasks. For both the arithmetic word problems and the scrambled words, task performance was assessed as (1) the number of items attempted, (2) the number of items correct, and (3) the percentage of attempted items correct. For the block pattern copying tasks, the performance measure was the number of patterns done during

the phase; if the participant was working on a pattern when the timer sounded, that pattern was included in the count. This measure did not take into account incorrect block placements, on the assumption that given the straightforward requirements of the task, errors would be relatively infrequent (an assumption supported by informal observations during the transcription process).

As in Study 2, each paper-folding product made by the participant was scored as a 0, 1, or 2, according to whether it bore no resemblance, some resemblance, or close resemblance to the model. The scores for all products made during each of the two paper-folding phases were summed, providing an aggregate score for each phase. A second judge scored participants' paper-folding objects from a randomly-chosen 9 sessions, or 20.45 % of the sample. Inter-judge agreement for scoring the paper-folding objects was 89.23 %.

Classification of speech. As in Study 2, participants' speech while working on the experimental tasks was transcribed into utterance units on the basis of temporal isolation from other speech, such that a verbalization was considered a discrete utterance unit if the participant did not speak for at least two seconds before and after the verbalization. An example transcript is provided in Appendix T. Each utterance was classified in terms of (1) whether the utterance might be reading aloud, and (2) temporal relations with action. An independent observer classified the speech during three of the eight phases of 11 sessions, which were

chosen randomly with the constraint that the sample from each of the 11 sessions contained speech. This subsample included 449 of the overall total of 2027 utterances, or 22.15 % of the speech sample.

Reading Aloud: Utterances were classified according to whether the participant might be reading aloud from printed materials - that is, reading the verbal task materials, the instructions on the wall, or the instructions in the file folders. This classification system consisted of three categories: each utterance unit was categorized according to whether it was definitely not reading, could possibly be reading, or definitely was reading. The specific classification criteria were as follows:

Category 1: Definitely Not Reading: An utterance was classified as 'Definitely Not Reading' if any of the following disjunctive criteria were satisfied: (a) a sufficiently large portion of the utterance could be understood to ascertain that it was not reading; (b) the utterance began while the participant was writing, immediately (one second or less) before the participant began to write, or immediately after the participant finished writing; or (c) the participant was not looking at any printed materials (verbal task materials, the instructions on the wall, or the instructions in the file folders) at the moment of the onset of the utterance.

Category 2: Ambiguous: An utterance was classified as 'Ambiguous' (indicating

that it may or may not have been reading aloud, and it was not possible to judge with a reasonable degree of certainty) if the semantic content of the utterance could not be understood, but the participant was looking at printed materials at the moment of the onset of the utterance, and the utterance did not begin while or immediately before or after the participant was writing.

Category 3: Definitely Reading: An utterance was classified as 'Definitely Reading' if the utterance satisfied the criteria for Category 2, and in addition a sufficient portion of the utterance could be understood to determine with a high degree of certainty that the utterance was definitely reading.

Interobserver agreement for this classification was moderate, $\underline{k} = .66$ (83.07 % agreement).

Speech Preceding Action (nonsemantic criteria for self-regulation): Based only on temporal relations with action (and not on semantic content), each utterance was classified according to whether the participant (1) began to vocalize prior to the beginning of the closest identifiable task-related action ('speech preceding action'), or alternatively, (2) did not begin vocalizing before the beginning of an action (instead, either the participant began to vocalize simultaneously with or following the beginning of the action, or the utterance was not associated with action in any way). An utterance which both began and ended before the participant began to move could be classified as speech preceding action if the interval between the

end of the utterance and the beginning of the action was not longer than two seconds; if this interval was greater than two seconds, the utterance was not classified as preceding action. Task-related actions included writing, placing blocks, making folds, arranging pages, reaching for or picking up paper-folding models, paper, blocks, or the pen, indicatory pointing gestures, sitting down, standing up, and moving the chair. Most task-related actions were hand movements. Movements which were not considered task-related actions included the participant touching his or her face or hair, stretching, looking at his or her watch, shrugging his or her shoulders, and shaking or nodding his or her head. Interobserver agreement for this classification was moderate, $\underline{k}$ = .53 (84.63 % agreement).

Study 3 - Results

Task Performance

Mean scores on each of the eight task performance measures are reported by difficulty in Table 15. Task performance data were analyzed using repeated-measures t-tests. These comparisons between easy and difficult tasks were all significant, supporting the internal validity of the manipulations of task difficulty. The t-values for each task performance measure are reported in Table 15.

Table 15.

Mean Scores on Task Performance Measures by Task Difficulty (Standard Deviations in Parentheses)

Task Performance Measure	Easy	Difficult	t value (df = 43)
Number of arithmetic problems attempted	17.75	3.82	27.13**
	(3.76)	(1.97)	
Number of arithmetic problems correct	17.09	2.61	29.92**
	(3.88)	(1.87)	
Percentage of arithmetic problems correct	96.00	62.98	7.45**
(number correct / number attempted)	(6.07)	(31.76)	
Number of scrambled words attempted	49.80	7.66	14.41**
	(22.03)	(3.86)	
Number of scrambled words correct	48.18	6.68	14.04**
	(22.36)	(3.77)	
Percentage of scrambled words correct	95.84	88.16	3.08*
(number correct / number attempted)	(5.90)	(18.58)	
Number of block patterns	16.82	4.82	13.81**
	(5.97)	(2.16)	
Summed scores on paper-folding items	6.70	.80	17.50**
	(1.96)	(1.29)	

*$p<.01$

**$p<.001$

Self-Directed Speech

All 44 participants in this study self-verbalized while carrying out the experimental tasks. Thirty-seven of the 44 used self-directed speech in all four task conditions (easy and difficult verbal and nonverbal tasks). The mean overall rate of speech (disregarding reading classification) was 1.72 utterances per minute (SD = 1.02; range = .30 to 3.95). The distribution of the overall rate of speech was neither skewed nor kurtotic. The mean percentage of speech classified as 'Definitely Not Reading' (Category 1) was 59.03 % (SD = 16.28) on the verbal tasks, and 100 % on the nonverbal tasks; the mean percentage classified as 'Ambiguous' (Category 2) was 39.19 % (SD = 18.06) on the verbal tasks, and 0 % on the nonverbal tasks; and the mean percentage classified as 'Definitely Reading' (Category 3) was 1.78 % (SD = 4.20) on the verbal tasks, and 0 % on the nonverbal tasks. The mean rate of speech excluding speech which might be or is reading (that is, Category 1, excluding Categories 2 and 3) was 1.29 utterances per minute (SD = .91; range = .13 to 3.60). The distribution of this variable was slightly positively skewed (skewness = .91, $z = 2.53$, $p<.05$, 2-tailed), and not kurtotic.

A gender difference in rate of speech emerged in only one cell of the design: the rate of Category 1 speech (not reading) on the easy verbal tasks was higher for males (M = 1.43, SD = 1.30) than for females (M = .80, SD = .60), t (adjusted df = 30) = 2.06, $p<.05$. Neither overall rate of speech nor rate of speech

that was not reading was influenced by assignment to order of the four experimental task conditions. The high and low SVQ groups differed during the difficult verbal task phases, both in terms of overall rate of speech (high-SVQ group $\underline{M} = 3.43$, $\underline{SD} = 1.71$; low-SVQ group $\underline{M} = 2.09$, $\underline{SD} = 1.31$), $\underline{t}\ (42) = 2.44$, $\underline{p}<.05$, and in terms of Category 1 speech (high-SVQ group $\underline{M} = 2.17$, $\underline{SD} = 1.44$; low-SVQ group $\underline{M} = .84$, $\underline{SD} = .77$), $\underline{t}\ (42) = 3.04$, $\underline{p}<.01$. Twenty-four of the 44 participants (11 males and 13 females) responded 'yes' to the question, "Did you say anything during the session?," and 20 responded 'no' (11 males and 9 females). These question response groups differed on many of the dependent measures in these analyses, and this variable was included as a between-subjects factor throughout. Question response was not related to gender, SVQ group membership, or SVQ total score.

Overall Rate of Speech

The overall rate of speech (utterances per minute) was analyzed using a 2 X 2 X 2 mixed factorial ANOVA, with participants' responses (yes or no) to the question, "Did you say anything during the session?," as a between-subjects factor, and task difficulty and task type as within-subjects factors. These data were the sums of all three reading code categories (Category 1: Definitely Not Reading; Category 2: Ambiguous; and Category 3: Definitely Reading). The analysis found main effects of question response, $\underline{F}\ (1, 42) = 16.91$, $\underline{p}<.001$, difficulty, $\underline{F}\ (1, 42) =$

89.00, $p<.001$, and task type, F (1, 42) = 46.90, $p<.001$, a question response X difficulty interaction, F (1, 42) = 14.77, $p<.001$, and a difficulty X task type interaction, F (1, 42) = 12.78, $p<.01$.

The question response X difficulty interaction was analyzed further by examining the simple main effects of task difficulty separately for each question response group. Mean overall rates of speech are reported by question response group and difficulty in Table 16.

Table 16.

Mean Overall Rate of Speech by Question Response Group and Task Difficulty (Standard Deviations in Parentheses)

	Question Response Group	
	Yes	No
Easy	1.47	.81
	(.94)	(.55)
Difficulty		
Difficult	2.96	1.44
	(1.31)	(.73)

The simple effect of difficulty was significant both in the 'yes' group, F (1, 23) = 67.22, $p<.001$, and in the 'no' group, F (1, 19) = 30.84, $p<.001$, supporting the prediction of a general task difficulty effect. Comparisons between groups indicated that the rate of speech was higher in the 'yes' group than in the 'no' group on both the easy tasks, t (adjusted df = 38) = 2.88, $p<.01$, and the difficult tasks, t (adjusted df = 37) = 4.85, $p<.001$. Although these analyses do not clearly identify the source of the question response X difficulty interaction, the pattern of means in Table 16 suggests that this effect reflects the greater magnitude of the task difficulty effect in the 'yes' group (difference between means for easy and difficult

tasks = 1.49) than in the 'no' group (difference = .63).

Simple main effects of difficulty were also examined separately for each task type, in order to analyze the difficulty X task interaction. Means for these data are reported in Table 17.

Table 17.

Mean Overall Rate of Speech by Task Difficulty and Task Type (Standard Deviations in Parentheses)

	Task Type	
	Verbal	Nonverbal
Difficulty		
Easy	1.56	.78
	(1.26)	(.74)
Difficult	3.06	1.47
	(1.71)	(1.29)

The simple main effect of difficulty was significant for both the verbal tasks, F (1, 43) = 57.13, $p<.001$, and the nonverbal tasks, F (1, 43) = 28.22, $p<.001$. Comparisons between task types were significant for the easy tasks, t (43) = 4.39, $p<.001$, and for the difficult tasks, t (43) = 7.10, $p<.001$. The pattern in

Table 17 suggests that although the statistical analyses do not isolate the source of the difficulty X task type interaction, this effect was generated by the difference in the magnitude of the task difficulty effect on the verbal tasks (difference between means for easy and difficult tasks = 1.50) and the nonverbal tasks (difference = .69).

Rate of Speech Classified as 'Definitely Not Reading'

The rate of speech classified as 'Definitely Not Reading' (Category 1) was analyzed using the 2 X 2 X 2 mixed ANOVA design, with question response as a between-subjects factor, and task difficulty and task type as within-subjects factors. No speech during the nonverbal tasks was classified as either 'Ambiguous' (Category 2) or 'Definitely Reading' (Category 3); data for the nonverbal tasks, then, are identical in this section and the previous section, consisting in both cases exclusively of speech classified as 'Definitely Not Reading.' The ANOVA found main effects of question response, F (1, 42) = 23.05, $p<.001$, task difficulty, F (1, 42) = 39.55, $p<.001$, and task type, F (1, 42) = 5.02, $p<.05$, and a question response X difficulty interaction, F (1, 42) = 14.89, $p<.001$. The main effect of task type indicated that the rate of speech that was definitely not reading was significantly greater on the verbal tasks (M = 1.46, SD = 1.09) than on the nonverbal tasks (M = 1.18, SD = .96).

To analyze the question response X difficulty interaction, the simple effect

of difficulty was computed separately for each question response group. Rates of Category 1 speech are reported by question response group and difficulty in Table 18.

Table 18.

Mean Rate of Speech Classified as 'Definitely Not Reading' by Question Response Group and Task Difficulty (Standard Deviations in Parentheses)

	Question Response Group	
	Yes	No
Easy	1.25	.58
	(.84)	(.40)
Difficulty		
Difficult	2.32	.83
	(1.22)	(.41)

The simple effect of difficulty was significant both in the 'yes' group, F (1, 23) = 35.59, $p<.001$, and in the 'no' group, F (1, 19) = 9.52, $p<.01$, again providing evidence for the predicted task difficulty effect. Comparisons indicated that the rate of Category 1 speech was higher in the 'yes' group than in the 'no' group both on the easy tasks, t (adjusted df = 34) = 3.49, $p<.01$, and on the difficult tasks, t

(adjusted df = 29) = 5.61, p<.001. These analyses do not identify the source of the question response X difficulty interaction. As can be seen in Table 18, though, the magnitude of the difficulty effect was more than four times greater in the 'yes' group (difference between means for easy and difficult tasks = 1.07) than in the 'no' group (difference = .25), a pattern which presumably accounts for this significant interaction effect.

Correlations between Rates of Speech and Task Performance

Correlations were examined between both overall rates of speech and rates of speech that was not reading on the verbal and nonverbal tasks, on the one hand, and the various measures of task performance, on the other hand. (These correlations with speech on the verbal and nonverbal tasks were examined separately for the easy and difficult versions of each of the four tasks in this experiment, because the measures of performance were not sufficiently similar to permit combining them for the verbal and nonverbal task types.) On the block pattern copying and paper-folding tasks, rates of speech and performance scores were uncorrelated. Correlations for the easy and difficult arithmetic word problems and scrambled word tasks are reported in Table 19. Some significant positive speech-performance relationships were found. Rates of speech were positively correlated with the number of easy and difficult arithmetic word problems attempted, the number of easy and difficult arithmetic problems correct,

and the number of easy scrambled word items attempted and correct (see Table 19).

Table 19.

Pearson Product-Moment Correlations between Rates of Speech and Performance on Arithmetic Word Problems and Scrambled Word Tasks (N = 44)

Task Performance Measure	Easy		Difficult	
	Overall	Not Reading	Overall	Not Reading
Number of arithmetic problems attempted	.41**	.38*	.33*	.31*
Number of arithmetic problems correct	.35*	.32*	.34*	.31*
Percentage of arithmetic problems correct (number correct / number attempted)	-.07	-.07	.19	.14
Number of scrambled words attempted	.22	.31*	-.20	-.15
Number of scrambled words correct	.24	.33*	-.21	-.17
Percentage of scrambled words correct (number correct / number attempted)	.20	.20	-.13	-.12

*p<.05

**p<.01

Speech Preceding Action

Analyses of speech preceding action involve percentages as well as rates of speech. Data for the seven participants who did not verbalize during all four task conditions in the design were not included in these analyses, because the data were proportionalized, and thus cell frequencies of 0 could not be accommodated. Analyses of speech preceding action are based on a sample of 37 participants (16 females and 21 males; 28 high-SVQ participants and 9 low-SVQ).

The overall mean rate of speech preceding action was .24 utterances per minute (SD = .18; range = 0 to .65). The distribution of this variable was neither skewed nor kurtotic. The overall mean percentage of speech preceding action was 9.03 % (SD = 4.38; range = 0 to 17.85). The distribution of this percentage measure was neither skewed nor kurtotic.

Assignment to order of task conditions had no effect on either the rate or the percentage of speech preceding action. There were no gender differences or SVQ differences in either of these measures. Twenty-one of the 37 participants reported that they had spoken during the session, while 16 said they had not. Question response groups differed significantly in terms of the rate of speech preceding action on the difficult tasks, but not on the easy tasks. Rates were higher in the 'yes' group than in the 'no' group on both the difficult verbal tasks ('yes' group M = .82, SD = .51; 'no' group M = .28, SD = .27), t (adjusted df = 32)

= 4.17, p<.001, and the difficult nonverbal tasks ('yes' group M = .25, SD = .27; 'no' group M = .11, SD = .11), t (adjusted df = 28) = 2.24. p<.05. In terms of the percentage of speech preceding action, question response groups differed only on the difficult verbal tasks ('yes' group M = 18.96, SD = 8.73; 'no' group M = 12.56, SD = 7.86), t (35) = 2.30. p<.05. Question response was used as a between-subjects factor in the analyses of speech preceding action.

Rate of Speech Preceding Action

The rate of speech classified as preceding action was analyzed using the 2 X 2 X 2 mixed ANOVA design, with question response as a between-subjects factor and task difficulty and task type as within-subjects factors. In this analysis, all seven effects were significant. There were main effects of question response, F (1, 35) = 14.92, p<.001, task difficulty, F (1, 35) = 39.19, p<.001, and task type, F (1, 35) = 45.11, p<.001, a question response X difficulty interaction, F (1, 35) = 11.24, p<.01, a question response X task type interaction, F (1, 35) = 8.88, p<.01, a difficulty X task type interaction, F (1, 35) = 8.24, p<.01, and a question response X difficulty X task type interaction, F (1, 35) = 4.55, p<.05.

To analyze the question response X difficulty X task type interaction, difficulty (2) X task type (2) repeated measures ANOVAs were carried out separately for each question response group. Mean rates of speech are reported by question response, difficulty, and task type in Table 20.

Table 20.

Mean Rates of Speech Preceding Action by Question Response Group, Task Type, and Task Difficulty (Standard Deviations in Parentheses)

Yes Group (N = 21)

	Task Type	
	Verbal	Nonverbal
Easy	.20	.02
	(.23)	(.05)
Difficulty		
	.82	.25
Difficult	(.51)	(.27)

No Group (N = 16)

	Task Type	
	Verbal	Nonverbal
Easy	.12	.01
	(.19)	(.03)
Difficulty		
	.28	.11
Difficult	(.27)	(.11)

The analysis for the 'yes' group found main effects of difficulty, F (1, 20) =

35.31, $p<.001$, and task type, F (1, 20) = 39.22, $p<.001$, and a difficulty X task type interaction, F (1, 20) = 11.20, $p<.01$. This difficulty X task type interaction was investigated by calculating the simple main effect of difficulty separately for the two types of tasks. The effect of difficulty was significant for the verbal tasks, F (1, 20) = 30.11, $p<.001$, and for the nonverbal tasks, F (1, 20) = 16.60, $p<.01$. Comparisons between means for the different task types in the 'yes' group found significant differences both for the easy tasks, t (20) = 3.68, $p<.01$, and the difficult tasks, t (20) = 5.09, $p<.001$. Again, although the statistical analyses do not clearly show this, the difficulty X task type interaction appears to reflect the much greater difficulty effect in the 'yes' group on the verbal tasks (difference between means for easy and difficult tasks = .62) compared with the nonverbal tasks (difference = .23), as can be seen in Table 20.

The analysis for the 'no' group found main effects of difficulty, F (1, 15) = 7.20, $p<.05$, and task type, F (1, 15) = 21.88, $p<.001$, and no significant interaction. In the 'no' group, rate of speech preceding action was higher on the difficult tasks (M = .19, SD = .04) than on the easy tasks (M = .06, SD = .02), and higher on the verbal tasks (M = .20, SD = .04) than on the nonverbal tasks (M = .06, SD = .01).

Percentage of Speech Preceding Action

The percentage of speech preceding action was analyzed using the 2 X 2

X 2 mixed design, with question response as a between-subjects factor and task difficulty and task type as within-subjects factors. This analysis found main effects of task difficulty, F (1, 35) = 38.65, $p<.001$, and task type, F (1, 35) = 29.47, $p<.001$. Percentage of speech preceding action was higher on the difficult tasks (M = 13.29, SD = 6.85) than on the easy tasks (M = 4.77, SD = 4.90), and higher on the verbal tasks (M = 12.26, SD = 6.16) than on the nonverbal tasks (M = 5.80, SD = 5.05). The question response X task type interaction approached significance, F (1, 35) = 3.75, $p<.07$.

Discussion

All 44 participants in Study 3 self-verbalized, with an overall mean rate of close to two utterances per minute, and 37 of the 44 spoke in all four task conditions. Study 3 replicated the effects of both task difficulty and task type. This experiment also replicated findings from Study 2 concerning the response to the question, "Did you say anything during the session?," as a variable discriminating between participants in terms of their self-directed speech.

This study again replicated the task difficulty effect, using manipulations that were very clearly validated by analyses of task performance data. Both overall rate of speech and rate of speech that was not reading were higher when participants worked on difficult tasks compared to easy tasks. Though significant in both groups, this difficulty effect was greater for both these rate measures in the

'yes' group than in the 'no' group, and greater for the measure of overall rate on verbal tasks than on nonverbal tasks. Despite the interactions, the effect of task difficulty on participants' private speech was nonetheless significant in every instance. Taken together with the replication from Study 2, these findings provide compelling evidence that the relationship between private speech and task difficulty is the same in adults as in children.

Consistent with the pattern suggested by Study 2, rates of speech in Study 3 were higher when participants worked on verbal tasks than nonverbal tasks, extending findings reported by Frauenglass and Diaz (1985) of greater quantities of private speech when children worked on semantic tasks compared with perceptual tasks. The difference between task types for the overall rate measure was qualified by a two-way interaction with task difficulty, but was nonetheless significant for both easy and difficult tasks.

Effects of task difficulty and task type were significant for both rate and percentage of speech preceding action. In the 'yes' group, the effect of difficulty on the rate of speech preceding action was greater for the verbal tasks than for the nonverbal tasks, as reflected in the three-way interaction, but was nonetheless statistically significant for both task types. These findings replicate observations described by Levina (1981), of an increase in speech preceding action with increasing task difficulty.

Findings concerning relationships between rates of speech and task performance measures in this experiment did not correspond to predictions. Whereas negative correlations were expected between rates of speech and performance scores, some positive relationships were found, most noticeably between speech and both the number of arithmetic problems attempted and the number of arithmetic problems correct (see Table 19). Rates of speech and task performance were largely unrelated. No correlations at all were found for the nonverbal tasks. Judging by these data, it appears that self-directed speech can have a minor facilitative effect on some limited aspects of performance on tasks with strongly verbal characteristics.

General Discussion

This research convincingly documents extensive self-verbalization or private speech in young adult undergraduate university students. The self-report questionnaire data in Study 1 indicate that young adults readily report using private speech. The validity of these self-reports is confirmed by the two experimental studies, Study 2 and Study 3. Every participant in these two experiments used private speech while being observed (in marked contrast with experimental studies on private speech in children, in which it is common for only about half of the children in a sample to actually use any private speech; Berk, 1992; Diaz, 1992). In Studies 2 and 3, young adults' private speech was sensitive to several experimental manipulations which have proven effective in research with children, suggesting similarities in self-verbalization across these disparate age groups. This basic finding that adults not only use private speech but that their private speech appears to be similar to that of children raises fundamental issues concerning the ontogenetic development of this form of semiotic mediation. Data from Study 2 demonstrate that certain changes which have been assumed to occur ontogenetically can be elicited within a short-term microgenetic time frame; these include changes in the quantity of speech, in temporal relations between speech and action, and in the degree of psychological predication. These data also suggest that some individuals may use self-directed speech without being aware of it, and

that there are substantial differences between the speech of those who are aware and those who appear not to be. Findings of the research reported in this thesis lead to several ideas for further studies extending the small literature on private speech in age groups beyond childhood and investigating possible patterns of ontogenetic development.

The results of these studies challenge Vygotsky's (1934/1987, 1978) account of the internalization of private speech, but support his general cultural-historical framework for human psychology in a broader and more important way. Clearly, Vygotsky's claim that private speech is internalized during the early school years and is no longer used during adulthood is erroneous and in need of modification. Private speech is not exclusively a phenomenon of childhood, nor can it be regarded as a stage or phase of ontogenetic development. On the other hand, findings of this research indicate that overt self-verbalization continues to play a mediational role in problem-solving and self-regulatory processes during early adulthood. Presumably this remains the case throughout the life span. This provides support for the more general Vygotskian position that human psychological processes have a verbally-mediated character, certainly a broader and more important theoretical claim than Vygotsky's internalization hypothesis. This conclusion is consistent with the view that Vygotsky's cultural-historical theory is a general human psychology, rather than a theory of child development

per se.

Task Difficulty, Task Type, and Microgenesis

The three studies reported in this thesis establish conclusively that young adults use private speech. The self-report questionnaire data in Study 1 suggested that self-verbalization occurs during early adulthood with considerable frequency, a suggestion which was confirmed by experimental data in both Study 2 and Study 3. Scores on the SVQ spanned the entire scale, suggesting large individual differences in terms of private speech use, consistent with findings reported in research with children (see Berk, 1992; Diaz, 1992; Frauenglass & Diaz, 1985). Large individual differences were also evident in Studies 2 and 3, although every participant did self-verbalize. In the two experimental studies, mean rates of speech were high, ranging from 1.13 utterances per minute (SD = 1.02) while working on the nonverbal tasks in Study 3 to 2.95 (SD = 1.94) utterances per minute on the computer tasks in Study 2. Moreover, every one of the 97 participants in these two experimental studies produced self-directed speech, including even those with low self-report questionnaire scores and those who told the experimenter they had not spoken.

The two experiments reported in this thesis provide strong evidence that the self-verbalization observed in these samples of young adults is very similar to the private speech of children. The task difficulty effect - which has been

replicated in a number of studies with children (Beaudichon, 1973; Behrend et al., 1989; Duncan & Pratt, 1997; Kohlberg et al., 1968; Murray, 1979; Roberts, 1979) - was unequivocal in both experiments. In Study 2, a difficulty effect was evident in terms of the rate of speech, and in Study 3, in terms of the rate of speech and in terms of both rate and percentage of speech preceding action, as well.

The more frequent use of private speech when working on more difficult tasks has been interpreted in the literature on private speech in children - beginning with Vygotsky (1934/1987, 1978) - as reflecting greater cognitive effort. When faced with a particularly difficult task, the individual relies more heavily on overt, explicit verbal mediation for orientation, organization, analysis, and problem-solving. This interpretation is equally applicable in the present research with young adults. Replication of this well-established finding from the literature on children's private speech with these two samples of young adults provides experimental evidence that the relationship between private speech production and task difficulty is the same in adults as in children.

The finding of difficulty effects in terms of speech preceding action replicates findings from Vygotsky's research with children, described by Levina (1981; see also Duncan & Pratt, 1997). This pattern suggests that speech tends to be used in a more anticipatory manner when an individual is faced with challenging tasks, compared with tasks that are not very challenging. The

particular measures with which this effect was found did not take into account the semantic content of speech, but it can be argued that regardless of whether its semantic content can be understood, verbalization immediately prior to action is relatively unlikely to be altogether non-self-regulatory: it seems reasonable to speculate that the majority of these utterances are motivational, preparatory, or initiatory in some way, in terms of their subjective function, and in a broad sense at least, self-regulatory.

Self-verbalization in these experiments was greater on tasks with verbal characteristics than on tasks without verbal characteristics. In Study 3, this effect was significant even when speech which might possibly have been reading was eliminated from the hypothesis test. Although not identical, these findings are analogous to the finding by Frauenglass and Diaz (1985) of greater private speech use by preschoolers on semantic tasks (classification and picture sequencing) than on perceptual tasks (puzzles and block design matching), further linking findings of the present research with the literature on private speech in children.

Short-term microgenetic change in self-verbalization with repetition of experimental tasks was evident in several ways in Study 2. In terms of the rate of speech, predicted decreases were found across trials both on the difficult computer tasks and on the paper-folding tasks with repetition, as a function of increasing familiarity with and decreasing difficulty of the experimental tasks. Speech

preceding action, on the other hand, increased across trials, also as predicted. On the difficult computer tasks, the rate of speech preceding action increased for participants who said they had spoken during the sessions, but not for those who said they had not. In both question response groups, the percentage of speech preceding action increased across trials in Session 1, but not in Session 2. This proportional increase, then, was observed following the initial exposure to the task, and not thereafter, suggesting that in young adults at least, only a small amount of experience with these kinds of tasks is needed to bring about this kind of change. This is consistent with the assumption that the private speech of young adults should be highly developed in terms of a characteristic such as its self-regulatory function. On the paper-folding tasks, the percentage of speech preceding action showed a straightforward linear increase across trials.

Rates of speech and both rates and percentages of speech preceding action tended to change across trials within sessions, but not across the two sessions. The percentage of speech classified as psychologically predicative, on the other hand, increased from the first session to the second, but not across trials within sessions. This increase in the relative amount of predication indicates that the discernable semantic content of speech was more focused on the central elements of the task - more focused, that is, on psychological predicates - during the second session than during the first, again as a function of practice and familiarization.

The patterns of microgenetic change in the rate of speech and in speech preceding action resemble findings reported in preschoolers by Duncan and Pratt (1997), and - along with the cross-session increase in psychological predication - provide evidence that some kinds of changes which Vygotsky (1934/1987, 1978) described as occurring ontogenetically can also be observed within a microgenetic time frame. These findings raise a question regarding which kinds of change in private speech might be true ontogenetic developmental changes, and which kinds of change might be better conceptualized as local, contextually-specific processes reflecting learning and experience. Changes in terms of the frequency of private speech use and in terms of its self-regulatory and predicative characteristics may reflect localized knowledge based on particular experiences and activity rather than - or perhaps in addition to - generalized patterns of ontogenetic development.

These two experiments demonstrate, then, that the private speech of young adult university students is influenced in ways that parallel findings in the literature on private speech in children, by three different experimental manipulations, including task difficulty, task type, and task repetition. These parallels provide strong grounds for claiming that the self-verbalization of adults is essentially the same phenomenon which has been studied rather extensively in children.

The percentage of speech classified as incomprehensible in Study 2 was

high (approximately 70 % on the computer tasks, and approximately 80 % on the paper-folding tasks), and the experimental manipulations had little effect on this characteristic of self-verbalization. To the extent that incomprehensibility can be interpreted as reflecting a degree of internalization (see, for instance, Berk, 1986), these very high proportions of incomprehensible speech are consistent with the view that young adults' private speech should be more ontogenetically advanced - in this case, more internalized - than that of children. If private speech does become increasingly internalized with age, and lack of clear overt articulation is an indication of this kind of change, then it follows that in a sample of young adults, a large proportion of private speech would be incomprehensible.

This research suggests that classification of speech based on semantic content may in some cases result in misleading analyses, and may in fact produce questionable hypothesis tests for certain kinds of research questions. In Study 2, the semantic content of the large majority of utterances could not be understood. As might be expected under these circumstances, self-regulatory speech as identified using semantic coding criteria was not sensitive to any experimental manipulations, with the only significant effects being differences between question response groups. These results are consistent with the view that not all hypotheses should be tested only with data generated using semantic criteria for classification of speech. The finding of a cross-session increase in psychological

predication, however, also indicates that even with a large proportion of incomprehensible speech, semantic coding can nonetheless produce interesting results, and should not be discounted. As suggested by Diaz (1992), appropriate procedures for classification of private speech are closely dependent on the particular research questions being investigated, and coding systems should be specifically designed in relation to the hypotheses being tested.

The procedure used in Study 2 for classifying participants' speech according to psychological predication represents a clear advance in terms of precision and rigor over classification criteria reported in previous research (Azmitia, 1992; Feigenbaum, 1992; Goudena, 1992; Pellegrini, 1981). In order to code speech for psychological predication (as opposed to broader categories such as abbreviation or fragmentation), it is necessary to employ an experimental task specifically designed to facilitate this coding; this requires a task for which psychological predicates (rather than incomplete sentences) can be clearly operationalized and readily identified. No age differences indicating ontogenetic change in abbreviation, fragmentation, or predication have been reported in existing research with children. The cross-session microgenetic increase evident in Study 2 - which suggests the possibility that change in psychological predication may reflect experience and practice more than ontogeny - is the first substantive positive finding concerning this feature of private speech.

Awareness of Self-Verbalization

An additional factor which proved very informative in these two experiments was participants' responses to the question concerning whether they had spoken during the experimental session or sessions. Forty-two of the 97 participants in the two studies - 43 %, overall - reported that they did not speak during the session or sessions (22 of 53 in Study 2 and 20 of 44 in Study 3).

There were a number of differences between the self-directed speech of those participants who said they had spoken and those who said they had not. In most of the analyses, there were either signficant main effects of question response, or interactions involving question response and task type or task difficulty. Overall, these interactions suggest that the self-directed speech of participants in the two 'no' groups was perhaps somewhat less similar to private speech as studied in children than was the self-directed speech of those in the 'yes' groups. As mentioned in the discussion of Study 2, however, there is a degree of ambiguity concerning the precise meaning of participants' responses to this question about speaking. Whereas interpretation of a 'yes' response is straightforward, there are three possible meanings of a 'no' response: (1) the participant was aware that he or she had spoken, but said he or she had not because of self-presentation pressure (in other words, the participant responded 'no' in order not to appear deviant); (2) the participant was aware that he or she

had verbalized in the form of whispering, muttering, or some other kind of sound that was not clearly articulated, but the participant reported that he or she had not spoken because he or she did not consider these sounds to be 'speech' per se; (3) the participant responded 'no' because he or she was unaware of having spoken. While this third interpretation is intriguing from a theoretical point of view, it is not possible to empirically estimate the actual proportions of these samples falling into this category. It does seem likely, though, that at least some cases do fall in this last category, suggesting that verbal mediation is so intrinsic an aspect of human cognition that at least some people sometimes use it overtly without noticing. This suggestion is corroborated by anecdotal evidence described by Kronk (1994, p. 796), who reported that two participants who had already been self-verbalizing asked the confederate to stop doing so, and then continued to do so themselves, apparently not noticing their own self-verbalization.

Participants' responses to the question about speaking could be partially disambiguated through the use of a graduated contingent series of three questions, rather than a single question. The question employed in the experiments reported in this thesis was "Did you say anything during the session(s)?" This initial question could be supplemented by two subsequent, broader questions, the second asking, "Did you vocalize at all during the session?," and the third, "Did you make any sound at all during the session?" (each contingent upon a 'no' response to the

preceding question).

This expanded questioning procedure would address the second of the three possibilities (that the participant vocalized in ways which he or she decided did not qualify as "speech" per se), but would not clarify responses with regard to the first, the possibility of a self-presentation effect. This remaining possibility could be addressed indirectly and imperfectly by administering a brief questionnaire assessing the extent to which participants consider self-verbalization to be an important mark of deviance. Higher scores on such a questionnaire would indicate greater sensitivity to social disapproval concerning talking to oneself. The hypothesis to be tested with this instrument would be that participants who respond that they did not vocalize during the study would have higher sensitivity scores on the questionnaire than those who respond 'yes.' Such a test would not be straightforward, though, because participants who respond 'yes' to questions concerning speaking might also spuriously tend not to indicate that they consider self-verbalization to be deviant, in order not to be seen to imply that they consider themselves to be deviant.

Given the likelihood that some participants in the two experiments were not aware of having spoken, it also seems quite possible that the self-report data generated using the SVQ underestimate the occurrence of private speech during early adulthood, for at least some individuals. If there were indeed individuals in

the experimental samples who were unaware that they had verbalized when they were questioned about it shortly afterward, it seems very likely that individuals like these would also underrate their everyday use of self-directed speech when completing the questionnaire, reflecting a general tendency to self-verbalize without noticing. In the analyses of the experimental data, SVQ group was not as useful as the question response group variable in identifying differences between participants. Nonetheless, although the questionnaire data were not especially revealing in the context of the two experimental studies, the findings of the initial questionnaire study do indicate that young adults self-verbalize under everyday circumstances. The speech elicited in the two experiments, then, was not an artificial laboratory phenomenon. It seems likely that this experimentally-elicited private speech is at least a reasonable approximation to more everyday commonplace kinds of uses of private speech, as measured for instance by the SVQ. In any case, these various findings with undergraduate university students invite replication with samples drawn from other age groups and other kinds of populations.

Speech and Task Performance

Negative correlations were expected between rates of speech and task performance in the two experiments, based on the assumption that private speech reflects difficulty with a task and therefore tends to be associated with poor

performance and failure. In Study 2, this hypothesis was supported only for performance on the easy computer tasks; no other speech-performance correlations were found in this experiment. Rate of speech on the easy computer tasks during Session 2 was negatively correlated with performance on these tasks during both Session 1 and Session 2, a pattern suggesting that a high rate of speech on the Session 2 easy task was a sign of difficulty: participants who experienced difficulty with this task tended to verbalize more during Session 2 than those who did not have difficulty, whereas verbalizing during Session 1 - when the task was novel - was not associated with particular difficulty. In Study 3, overall rate of speech and rate of speech that was not reading were positively correlated, rather than negatively correlated, with two of the three measures of performance on the arithmetic word problems (the number of problems attempted and the number correct, but not the percentage correct) for both easy and difficult tasks, and rate of speech that was not reading was positively correlated with these same two performance measures for the easy scrambled word tasks. Thus, it is clear that private speech-performance relations are not uniform, but instead vary across different kinds of tasks, and although private speech tends to be associated with difficulty and relatively poor performance, it can have facilitative effects on performance, at least on tasks with verbal characteristics. Further research is needed to clarify specific task characteristics influencing patterns of speech-

performance relationships.

Summary of Major Findings

In summary, the data collected using the SVQ suggested that young adults do use private speech, contrary to the assumption guiding virtually all previous private speech research. This finding based on self-reports was confirmed by results of the two experimental studies, in which all 97 participants used self-directed speech while being observed. In the experiments, young adults' private speech was found to be sensitive to manipulations of task difficulty and task type, and was also attenuated by repetition of experimental tasks. These three findings parallel findings reported in research with children, strongly suggesting that private speech has important functional similarities across age groups. In Study 2, nonsemantic coding criteria for self-regulation proved more productive than semantic coding, in part because the large majority of participants' private speech was incomprehensible and therefore unsuited for semantic coding. Correlations between private speech and performance on the experimental tasks were few, and those correlations that were found were mostly positive, rather than negative as predicted. The direction of these relationships appears to vary among different kinds of tasks. A finding emerging from the experiments which is without precedent in existing research is the finding that many participants seemed unaware of their own self-directed speech, and furthermore, the self-verbalization

of these individuals differed in several ways from that of individuals who were aware of speaking. This result needs to be replicated and clarified in further research.

Internalization and Social Convention

The hypothesis that adults use private speech has, then, received strong support. This is not to suggest, however, that private speech does not undergo age-related change. Nor is the intention to deny that the period of ontogeny studied by Vygotsky and by most contemporary researchers is a particularly important one for the development of relations between speech and thinking. Perhaps it is the case that there is a process of internalization during the late preschool and early school years, such that, for instance, children younger than seven or eight years do not do what would be regarded as internal verbal thinking or 'inner speech,' whereas children past that age do. Thus, it may be the case that the capacity for, or ability to use, fully internalized verbal mediation develops around this age. There is nothing in a change of this kind, however, which precludes the use of overtly-vocalized self-directed speech by older individuals: children do not stop using private speech when they become able to use covert inner speech.

The hypothesis that the ability to use inner speech or internal verbal thinking develops during the late preschool and early school years receives support from two studies. Conrad (1971) studied performance on a picture-

matching recall task, with a sample ranging in terms of MA from 3 years to 11 years (chronological age = 4 to 11 years). The task involved matching test picture-cards with identical pictures which were briefly displayed and then concealed. Two sets of pictures were used, one set with names that were all near-homophones (e.g., rat, cat, and so on) and one set with names that were not homophones. The experimenter verbalized the names of the test pictures, immediately prior to the test. Conrad reported that among participants with MA 5 years and older, task performance on trials on which pictures with nonhomophone names were used was better than performance on trials using pictures with homophone names, a difference which he interpreted as resulting from interference in the processing of the verbal code introduced by the similarity among the homophone names. Furthermore, this advantage for the nonhomophone set increased with MA. Among children with MA 3 to 4 years, no difference in performance was evident between homophone and nonhomophone trials, suggesting that these youngest children did not use a covert verbal code (in other words, inner speech) in carrying out the task. These findings suggest that participants with MA 5 years or older relied on an internal verbal form of cognition in carrying out this task, whereas children with MA less than 5 years did not, consistent with the position that preschoolers do not use inner speech but that it develops around the time of school entry.

Recent research by Flavell, Green, Flavell, and Grossman (1997) suggests that preschoolers have very little awareness of or knowledge about inner speech. In a first experiment, four-year-olds, six- and seven-year-olds, and adults watched an adult experimenter carrying out tasks for which inner speech was clearly necessary. On one task, for example, one experimenter announced that she had forgotten to write down items for a shopping list, then set about silently trying to remember them. A second experimenter questioned the participant as to whether he or she thought the first experimenter was engaging in inner speech, asking questions such as "Is she just thinking, up in her head, or is she also saying things to herself, up in her head?" (p. 41).

Flavell et al. (1997) found that on tasks of this kind, four-year-olds performed well below chance in terms of correctly inferring the presence of inner speech. Among the six- and seven-year-olds, average performance was significantly better than chance on half the tasks, and more than half of the group demonstrated awareness of inner speech phenomena. Adult performance was above chance on all tasks. A similar pattern of age differences was found in terms of participants' responses to the questions, "Can a person say the words to a story up in his head, without moving his lips?" and "Can a person tell himself things or talk to himself up in his head?" (p. 40). These findings suggest that unlike adults, four-year-olds lack awareness of inner speech, and that the six- to seven-year age

range may be the period when this awareness develops.

In a second experiment, four-year-olds, five-year-olds, and adults performed verbal and visual imagery tasks; then, for each task, they were asked to report whether they had used verbal or visual processing. For one of the verbal tasks, for example, "participants were asked to think silently about how their name sounds;" for one of the visual tasks, participants "thought silently about how their house looked" (Flavell et al., 1997, p. 43). Flavell et al. found that four-year-olds performed below chance on both verbal and visual tasks (in that they were no more likely to report verbal than visual processing on verbal tasks, and no more likely to report visual processing than verbal processing on visual tasks), five-year-olds performed below chance on the verbal tasks but above chance on the visual tasks, and adults performed above chance on both. Flavell et al. interpret the children's poorer performance as evidence of undeveloped introspective skills, resulting in an inability to detect or recognize their inner speech. However, these results can also be seen as supporting the view that four- and five-year-olds do not use inner speech, consistent with Conrad's (1971) conclusion, rather than simply not having introspective access to it.

It seems many people (including for instance the present author) have the impression from their everyday experience that young children use private speech much more than adults. It is possible that this common impression can be

accounted for by age differences in sensitivity to social conventions about and proscriptions against talking to oneself. Adults are more aware of social pressures against using self-directed speech, and of the association in popular conception between talking to oneself and mental illness, or at least deviance. Young children, unlike adults, have relatively little understanding of these social conventions, and they self-verbalize freely in the presence of others. It may be, then, that what seems to be the relatively common belief that young children use private speech more than adults arises from the strong tendency for adults to inhibit self-verbalization in the presence of other people, because of greater sensitivity to social pressures against it. During the late preschool and early school years, then, children begin to talk to themselves less in social situations - including situations in which they are being observed by researchers - because they become increasingly aware of the social meaning of talking to oneself; and the resulting change to greater reliance on internal rather than external verbal thinking is facilitated (but not caused) by the concurrent development of the ability to use verbal mediation internally. What develops is not only the capacity for inner speech, but also sensitivity to social disapproval regarding talking to oneself.

This suggestion receives support through reinterpretation of data from a number of studies on children's private speech. Four of the studies reviewed

earlier (Beaudichon, 1973; Kohlberg et al., 1968, Studies 1 and 2; Quay & Blaney, 1992) found cross-sectional patterns of decreasing quantities of private speech with increasing age. In none of these studies, though, was any attempt made to isolate participants from the possible social influence introduced by the presence of the experimenter, nor to conceal the audiovisual recording. In such a situation, then, it is entirely plausible that any age-related decline in private speech could be a result of age-related change in terms of awareness of social conventions about self-directed speech. It may be that older children produce less private speech when being observed because they are more reluctant to self-verbalize in the presence of others than younger children, rather than because their private speech is being internalized. No extant studies take this possibility into account in any way.

Data from the three classroom observational studies by Berk and colleagues (Berk, 1986; Berk & Garvin, 1984; Bivens & Berk, 1990) also afford a similar reinterpretation. These three studies all found no decreases in the quantity of private speech with age, but did find increases in the proportion of Level 3 speech (external manifestations of inner speech), a pattern interpreted as evidence of internalization. Here again, though, the possibility cannot be ruled out that the increase in Level 3 speech across age groups reflected increasing reticence about speaking aloud with an observer nearby. Compared to younger children, older

children are more enculturated with regard to the social meaning of talking to oneself, and more sensitive to social pressures against doing so, and for this reason they make a greater effort than younger children to speak to themselves only in quiet mutters and whispers when being observed, in order not to be noticed or at least not understood. This reinterpretation is consistent with the general position that the use of private speech is not limited to a particular period of childhood.

It should be pointed out that this account of the decline of private speech use is in marked contrast with Piaget's (1923/1926) account of the involvement of social processes in the decline of 'egocentrism' as reflected in egocentric speech. Piaget's ideas about reduction in children's egocentric speech are derived from his ideas about the development of the logical principle of reversibility and related equilibrative processes occurring at the internal organismic level. The child becomes able to adapt his or her speech to the perspective of a listener as a result of individual processes involving cognitive conflict and disequilibrium, operating within the child's cognitive system. The present account, on the other hand, suggests that children gradually inhibit private speech in the presence of other people primarily as a result of enculturation involving familiarization with social and cultural meanings and norms. Thus, change occurs not because of internal organismic cognitive development, but instead as a direct result of contact with

more experienced, more knowledgeable members of the culture. Emphasis is placed, then, on external contextual and ecological relations, not on the internal development of logical principles. The focus is not on changes in cognitive structures, but on increasing understanding of the conventions of society.

In the two experiments reported in this thesis, participants worked alone, with the experimenter waiting in another room some distance along a hallway. Participants were not informed about the audiovisual recordings or the interest in speech until the end of each study, and considerable trouble was taken to provide plausible cover stories and to conceal the recording equipment. Under these conditions, a great deal of self-verbalization was recorded. This outcome may have been very different, though, had participants been informed about the audiovisual recording. It is of interest in this connection to compare the rates of speech in Studies 2 and 3 with the rate reported by Kronk (1994). Recall that in Kronk's study, older adolescents worked on word scrambles and reasoning and association problems, in the presence of two other people (the experimenter and the confederate). The overall mean rate of private speech in these circumstances was .45 (SD = .35) utterances per minute, a figure which seems relatively low in comparison with 2.95 (SD = 1.94) on the computer tasks and 1.26 (SD = 1.26) on the paper-folding tasks in Study 2 of the present work, and 2.31 (SD = 1.48) on the verbal tasks and 1.13 (SD = 1.02) on the nonverbal tasks in Study 3. The

obvious difference between Kronk's (1994) experimental setting and the situation in Studies 2 and 3 has to do with the presence of other people during the session. Kronk's finding that participants' rates of self-verbalization increased when the confederate began to self-verbalize is of course also very consistent with the view that social pressure plays an important role in reducing quantities of overt self-verbalization in age groups beyond middle childhood.

The hypothesis that adults will self-verbalize during an experiment if they are not informed about audiovisual recording, but not (or significantly less) if they are informed, could be tested in the experimental setting used in the research reported in this thesis using a within-subjects manipulation of awareness of (or at least information about) the recording. A manipulation of this kind could be implemented using a decoy videocamera, located in full view in the room with the participant. The experimental session would consist of two parallel halves, during one of which - with the participant's knowledge - the decoy camera would be recording and during the other half, turned off. As in the two experiments reported in this thesis, data would actually be collected using the videocamera located on the opposite side of the one-way mirror. This camera would be recording during the entire session. Tasks like those used in Study 3 would be suitable for this purpose, and additional experimental manipulations such as task difficulty or task type could also be included in the design. The central prediction in this study

would be that the rate of self-verbalization would be negligible during the half of the session in which the decoy camera was recording, and higher during the half when this camera was turned off. Expanded to include a cross-sectional dimension, such a study could provide important evidence concerning the role of changes in sensitivity to social convention about talking to oneself and in the experience of social pressure against it, in the development and internalization of private speech. The specific prediction would be that the difference in rate of speech between the 'aware' and 'unaware' conditions would be greater for older age groups than for younger, with little or no difference being evident during the preschool years.

Inhibition undoubtedly plays an important role in research of this kind. In Studies 2 and 3, inhibitory cues against self-verbalization were removed by leaving the participant alone to work on the experimental tasks, concealing the audiovisual recording equipment, and providing a plausible cover story; under these circumstances, self-verbalization was readily observable. A manipulation of participants' awareness of audiovisual recording, like the one that has been described, can be seen as a manipulation of a strong inhibitory cue, with the prediction that self-verbalization would be disinhibited when the decoy camera is not recording. White (1965) has argued that internalization of private speech between five and seven years reflects the development of a general "mechanism of

inhibition which is presumed to have its first sizable influence on behavior during this age range" (p. 189). A reduction in overt private speech around this age could be interpreted solely in terms of increasing inhibitory capability: perhaps seven-year-olds begin to use less private speech when being observed simply because they become better able to inhibit it when appropriate. This more parsimonious account need not invoke either development of the ability to use verbal mediation internally, or increased sensitivity to social conventions regarding talking to oneself; presumably, these changes precede internalization of private speech. On the other hand, research has already been reviewed which supports the suggestion that the ability to use inner speech or internal verbal thinking develops during this age range (Conrad, 1971; Flavell et al., 1997). Clearly, changes in verbal mediation during the late preschool and early school years are complex, and many issues await resolution in this area of research.

Inner Speech Writing

Another experimental manipulation which would be of interest for further research involves writing rough notes when working on arithmetic word problems. A considerable proportion of the speech produced by participants in Study 3 while working on these tasks might be described as 'spoken arithmetic,' similar in content to written rough work, suggesting a degree of functional equivalence. John-Steiner (1992) has argued that notes written for one's own use -

what she terms 'inner speech writing' - are similar in terms of their basic mediational function to inner speech and private speech. It would be informative to test this idea that writing rough notes for oneself is functionally similar to using self-directed speech, by examining whether prohibition against writing rough work while trying to solve arithmetic word problems increases the rate of private speech, compared to a condition in which written rough work is not prohibited. Such a pattern would suggest that spoken mediation substitutes for writing notes or rough work. This hypothesis could be evaluated using a 2 (difficulty) X 2 (instructions) repeated measures factorial, with easy and difficult arithmetic word problems, and instructions that writing rough work for solving the tasks either is or is not prohibited. An honours student is currently conducting an experiment of this design under the supervision of the present author (Tarcza, 1998). It is expected that the view that inner speech writing is equivalent to or at least somewhat redundant with spoken mediation will be supported by a pattern in which the 'proscription' condition is associated with higher rates of self-directed speech than the 'no proscription' condition. This study opens questions concerning functional similarities between various forms of self-directed language, questions which - like the issue of sensitivity to social convention - ultimately will need to be investigated using a combination of cross-sectional and experimental designs.

Conclusion: Private Speech in Young Adults

The results of this research provide compelling evidence that young adults use private speech, directly challenging the conventional view that this overt form of verbal mediation is peculiar to childhood. Private speech use cannot be regarded as the equivalent of an ontogenetic developmental stage lasting five years from preschool age to early school age. The common construal of private speech as a discrete stage of ontogenetic development (Berk, 1992; Daugherty, 1993; Daugherty et al., 1994; Kohlberg et al., 1968; Olszewski, 1987; Roberts & Tharp, 1980) constitutes a misunderstanding of the phenomenon. The questionnaire data in Study 1 indicate that young adults report using self-directed speech in a variety of real-life, everyday kinds of situations. The experimental data in Studies 2 and 3 demonstrate that young adults self-verbalize when working on a variety of tasks, alone in a laboratory setting. Participants in these experiments spoke to themselves with considerable frequency even when carrying out tasks with no verbal characteristics. Furthermore, three experimental manipulations produced effects analogous to those reported in research with children, supporting the claim that the private speech documented in this thesis is the same phenomenon as, or at least a very similar phenomenon to, children's private speech. While this research clearly undermines Vygotsky's (1934/1987, 1978) specific hypothesis about internalization of private speech during childhood, it supports the more general Vygotskian cultural-historical postulate

that human problem-solving and thinking is verbally mediated, with private speech continuing to function during adulthood as a tool for organizing individual activity.

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Appendix A.

Self-Verbalization Questionnaire Items.

Instructions: Please circle the number from 1 to 7 indicating the extent to which you agree with each of the following statements.

1. I sometimes verbalize my thoughts when I'm working on a difficult problem.

1----------2----------3----------4----------5----------6----------7

strongly disagree slightly neutral slightly agree strongly

disagree disagree agree agree

2. I sometimes think out loud to myself when I'm trying to write with a lot of distraction.

3. I sometimes verbalize my thoughts when I'm playing a complicated computer game or video game.

4. I sometimes think out loud to myself when I'm trying to organize pages of notes.

5. I sometimes verbalize my thoughts when I'm memorizing something for an exam.

6. I sometimes think out loud to myself when I need to remember a new telephone number.

7. I sometimes plan my actions out loud when I'm getting organized.

8. I sometimes think out loud to myself when I'm trying to clean up a mess in a big hurry.

9. I sometimes guide my actions using speech when I'm using unfamiliar equipment.

10. I sometimes think out loud to myself when I'm searching for something I've misplaced.

11. I sometimes verbalize my thoughts when I'm deciding whether I've done a good job.

12. I sometimes think out loud to myself when I'm working on a crossword puzzle.

13. I sometimes think out loud to myself when I'm proofreading something I've written.

14. I sometimes verbalize my thoughts when I'm learning to use new computer software.

15. I sometimes verbalize my thoughts when I discover that I've locked my keys inside my car or my home.

16. I sometimes verbalize my thoughts when I'm searching for an unfamiliar

room.

17. I sometimes verbalize my thoughts when I'm searching for a book in a library.

18. I sometimes guide myself using speech when I'm searching through a newspaper or a magazine.

19. I sometimes guide myself using speech when I'm driving an unfamiliar car.

20. I sometimes think out loud to myself when I'm looking for a number in the phone book.

21. I sometimes verbalize my thoughts when I'm trying not to get angry.

22. I sometimes think out loud to myself when I'm doing mental arithmetic.

23. I sometimes think out loud to myself when I'm trying to solve a puzzle.

24. I sometimes verbalize my thoughts when I'm feeling angry or upset about something.

25. I sometimes think out loud to myself when I'm trying to remember what to buy, after arriving at the supermarket and discovering that I've forgotten my grocery list.

26. I sometimes verbalize my thoughts when I'm trying to figure out why some machine or piece of equipment isn't working properly.

27. I sometimes verbalize my thoughts when I'm feeling disappointed about something.

Appendix B.

Computer Experience Scale Items.

Instructions: Circle the number from 1 to 7 which best describes your experience.

1. How would you rate the extent of your experience using computers?

1----------2----------3----------4----------5----------6----------7

very inexperienced | somewhat experienced | very experienced

2. How would you rate the extent of your experience using spreadsheet software packages?

3. How would you rate the extent of your experience using the spreadsheet program, MS Excel?

Appendix C.

Computer Attitudes Scale Items.

Circle the number from 1 to 7 that best reflects your ageement with each statement.

1. The challenge of solving problems with computers does not appeal to me.

1----------2----------3----------4----------5----------6----------7

strongly disagree slightly disagree neutral slightly agree agree strongly agree

2. Figuring out computer problems does not appeal to me.

3. I think working with computers would be enjoyable and stimulating.

4. I like working with computers.

5. I don't understand how some people can spend so much time working with computers.

6. Once I start working with computers, I would find it hard to stop.

7. I do as little work with computers as possible.

8. Computers do not scare me at all.

9. I have lots of self-confidence when it comes to working with computers.

10. Generally, I would feel OK about trying a new problem on a computer.

11. I'm not the type to do well with computers.

Appendix D.

Example of Easy Computer Task Materials.

1 3 6 3 5 8 6 1 8 5 8 3 6 5 8 3 2 4 3 6 5 4 1 2 1 7 5 6 9 4 6 1 5

1 4 3 7 8 5 3 2 3 6 8 4 9 3 7 4 2 7 5 3 1 2 6 1 7 8 9 3 5 2 6 1 5

3 4 7 2 8 7 5 9 9 1 4 2 5 2 6 4 3 8 2 9 3 1 5 7 3 8 1 5 3 7 6 3 8

2 6 4 9 8 5 6 1 8 5 8 3 6 5 8 3 2 4 3 6 5 4 1 2 1 7 5 6 9 4 6 1 5

1 4 3 7 8 5 3 2 3 6 8 4 9 3 7 4 2 7 5 3 1 2 6 1 7 8 9 3 5 2 6 1 5

3 4 7 2 8 7 5 9 9 1 4 2 5 2 6 4 3 8 2 9 3 1 5 7 3 8 1 5 3 7 6 3 8

2 8 3 2 7 3 9 1 9 7 5 3 4 6 8 6 5 8 3 2 4 3 6 5 4 1 2 1 7 5 6 9 4

Appendix E.

Example of Difficult Computer Task Materials.

AJ76 y82474 AW219 g62316 E66 t53831 AP287 h94758 AY44 e82415

L199 x44529 C293 g48562 P277 u68438 AQ94 j32533 K168 s93294

AB254 k91165 D293 r64898 K54 h68589 R81 f56931 AR231 x18535

A79 a45265 T133 f85931 E297 j18442 W115 r64769 AE252 k52153

N67 s78075 AP2 r68792 Q17 w67201 C93 t77395 Y124 e87185

B121 y64832 D118 u72305 AW104 x57395 AC50 z12627 L276 k61548

Appendix F.

Instruction Page for Study 2.

Instructions

Before beginning the first phase, read through all the instructions. Then set the timer for the first phase and begin. For each phase, review the instructions before setting the timer.

Phase 1 - 4 minutes

paper-folding - make a copy of the model, using the piece of paper numbered 1

Phase 2 - 4 minutes

data entry - p. 1:

- enter each character in a cell in the spreadsheet, beginning with Row 1, Column A
- at the end of each row of characters on the page, go back to Column A of the spreadsheet and begin again in the next row

Phase 3 - 4 minutes

paper-folding - make a copy of the model, using the piece of paper numbered 2

Phase 4 - 4 minutes

data entry - p. 2:

- upper case letters & the numbers immediately following them indicate the cell - these are the spreadsheet cell co-ordinates for the next number

- enter the numbers to the right of the lower case letters

- a lower case "r" indicates that the number which follows it is to be entered in reverse order (from right to left, rather than left to right)

- a lower case "x" indicates that the number which follows it is to be omitted, rather than entered

- any other lower case letters do not mean anything (e.g., disregard them, and enter the number)

Phase 5 - 4 minutes

paper-folding - make a copy of the model, using the piece of paper numbered 3

Phase 6 - 4 minutes

data entry - p. 3:

- upper case letters & the numbers immediately following them indicate the cell - these are the spreadsheet cell co-ordinates for the next number

- enter the numbers to the right of the lower case letters

- a lower case "r" indicates that the number which follows it is to be entered in reverse order (from right to left, rather than left to right)

- a lower case "x" indicates that the number which follows it is to be omitted, rather than entered

- any other lower case letters do not mean anything (e.g., disregard them, and enter the number)

Appendix G.

Debriefing for Study 2.

Thank you very much for taking part in this study. We really appreciate your time and effort. This study investigates the relationship between speech, and problem-solving - it's a study about how people use self-directed speech (or, speech which isn't directed toward anyone but themselves) as a tool for problem-solving, and as a means for planning and organizing their actions.

We were making audiovideo recordings of the sessions. I really want to apologize for not telling you about that beforehand, but what we're interested in with this study is what people say to themselves when they're working on these tasks, and we felt pretty sure that if we did tell people about the recording ahead of time, this would affect their speech. Probably it would mean a lot of people wouldn't say anything at all, and there wouldn't be any point running the study. We would have liked to have been able to avoid running the study this way, and we did think a lot about other possibilities, but in the end there really just didn't seem to be any alternative. There's strong social pressure against talking to yourself - people sometimes think other people who talk to themselves are maybe a little odd. There's stigmatization about talking to yourself, and a lot of social pressure against it, even though many completely normal people do it quite a lot. So we believed that if people knew they were being videotaped, in a psychology

experiment, they probably wouldn't speak out loud very much - maybe not at all. It's very likely that if we didn't withhold information about the recordings until the end of the study, it wouldn't be feasible to do this kind of research at all. And we believe this research is important, because the findings could have far-reaching implications for theories about human thinking, based on the idea that thinking is closely related to speech. And this seems to be the only way of getting at this kind of information. So we decided to do the study anyway, despite these complications.

Again, I want to apologize for not telling you beforehand about the recording. You have the opportunity now to withhold consent for the use of the data from your sessions, if you want to.

Appendix H.

Consent Forms for Study 2.

Consent Form

I have read the information letter describing the purposes and the tasks involved in participation in a study on performance on computer data entry tasks and paper-folding tasks, which is being conducted by Robert Duncan and Dr. A. Cheyne of the department of Psychology at the University of Waterloo. I further understand that should the information I provide be used in publications, my identity will be protected. I acknowledge that I may withdraw my consent to participate at any time.

This study has been reviewed by, and has received ethics clearance through, the Office of Human research at the University of Waterloo. This Office will receive any complaints or concerns with regard to your involvement in this study.

Participant's Name: (please print) _____

Participant's Signature: _____

Witness's Signature: _____

Date: ____/____/____

D M Y

Post-Debriefing Consent Form

I have read the debriefing letter describing the purposes of the study on adults' self-directed speech while they work on computer data entry tasks and paper-folding tasks, which is being conducted by Robert Duncan and Dr. A. Cheyne of the department of Psychology at the University of Waterloo, and also describing the audiovisual recording during the study and the reason for withholding full information about this aspect of the study until after the sessions were finished. I further understand that should the information I provide be used in publications, my identity will be protected. I acknowledge that I may withdraw my consent for use of the data from the sessions in which I participated.

This study has been reviewed by, and has received ethics clearance through, the Office of Human research at the University of Waterloo. This Office will receive any complaints or concerns with regard to your involvement in this study.

Consent for use of data: YES _____ NO _____

Participant's Name: (please print) _____

Participant's Signature: _____

Witness's Signature: _____

Date: ____/____/____

D M Y

Appendix I.

Cover Story for Study 2.

This study examines the effects of practice on task management strategies, with two different kinds of tasks. Sometimes on a task there's a trade-off between speed and accuracy: if we go fast we might get more done but make more mistakes, and if we go slower we might make fewer mistakes but not get as much done. There are a lot of differences in the kinds of strategies people use to help with task management in these sorts of situations. This study investigates how these task management strategies are influenced by practice with some experimental tasks, of two kinds: (1) paper-folding tasks (which involve making copies of a model paper object); and (2) computer tasks (involving entering numbers in a spreadsheet program).

Appendix J.

Counterbalanced Orders of Task Materials for Study 2.

Order 1:

Session 1:

Phase 1 - paper-folding task (canoe)

Phase 2 - easy computer task (materials set C)

Phase 3 - paper-folding (canoe)

Phase 4 - difficult computer task (materials set A)

Phase 5 - paper-folding (canoe)

Phase 6 - difficult computer task (materials set A)

Session 2:

Phase 1 - difficult computer task (materials set B)

Phase 2 - paper-folding task (sailboat)

Phase 3 - easy computer task (materials set D)

Phase 4 - paper-folding (sailboat)

Phase 5 - difficult computer task (materials set B)

Phase 6 - paper-folding (sailboat)

Order 2:

Session 1:

Phase 1 - difficult computer task (materials set B)

Phase 2 - paper-folding task (sailboat)

Phase 3 - easy computer task (materials set D)

Phase 4 - paper-folding (sailboat)

Phase 5 - difficult computer task (materials set B)

Phase 6 - paper-folding (sailboat)

Session 2:

Phase 1 - paper-folding task (canoe)

Phase 2 - difficult computer task (materials set A)

Phase 3 - paper-folding (canoe)

Phase 4 - difficult computer task (materials set A)

Phase 5 - paper-folding (canoe)

Phase 6 - easy computer task (materials set C)

Order 3

Session 1:

Phase 1 - paper-folding task (sailboat)

Phase 2 - difficult computer task (materials set A)

Phase 3 - paper-folding (sailboat)

Phase 4 - difficult computer task (materials set A)

Phase 5 - paper-folding (sailboat)

Phase 6 - easy computer task (materials set D)

Session 2:

Phase 1 - difficult computer task (materials set B)

Phase 2 - paper-folding task (canoe)

Phase 3 - easy computer task (materials set C)

Phase 4 - paper-folding (canoe)

Phase 5 - difficult computer task (materials set B)

Phase 6 - paper-folding (canoe)

Order 4

Session 1:

Phase 1 - difficult computer task (materials set B)

Phase 2 - paper-folding task (canoe)

Phase 3 - easy computer task (materials set C)

Phase 4 - paper-folding (canoe)

Phase 5 - difficult computer task (materials set B)

Phase 6 - paper-folding (canoe)

Session 2:

Phase 1 - paper-folding task (sailboat)

Phase 2 - easy computer task (materials set D)

Phase 3 - paper-folding (sailboat)

Phase 4 - difficult computer task (materials set A)

Phase 5 - paper-folding (sailboat)

Phase 6 - difficult computer task (materials set A)

Appendix K.

Example Transcript from Study 2.

The numbers in brackets following the semantic content of each utterance are the codes for the various speech classifications: semantic self-regulation, speech preceding action, incomprehensible speech, and for the difficult computer tasks, psychological predication as well (in that order). For each code, 1 indicates negative and 2 indicates positive.

Participant 49, Session 1, Order 1 - Tape 28, 1:04:30

Phase 1 - begins 1:05:32 (duration = 4:16) - Paper-Folding Task

1:06:57 - [semantic content cannot be understood] {1, 1, 2}

1:08:28 - [cannot be understood] {1, 1, 2}

Phase 2 - begins 1:10:13 (duration = 4:03) - Easy Computer Task

1:10:28 - 5 {2, 1, 1}

1:10:37 - [cannot be understood] {1, 1, 2}

1:11:47 - 6, 4, 5 {2, 1, 1}

1:11:53 - 5, 6, 4, 5 {2, 1, 1}

1:12:11 - 6 {2, 1, 1}

1:12:27 - 5 {2, 1, 1}

1:12:45 - [cannot be understood] {1, 1, 2}

1:12:50 - [cannot be understood] {1, 1, 2}

1:13:16 - [cannot be understood] {1, 1, 2}

1:13:36 - 2 {2, 1, 1}

1:13:43 - 4, 2 {2, 2, 1}

Phase 3 - begins 1:14:40 (duration = 4:31) - Paper-Folding Task

1:17:26 - [cannot be understood] {1, 1, 2}

Phase 4 - begins 1:19:29 (duration = 4:03) - Difficult Computer Task

1:19:55 - [cannot be understood] {1, 1, 2, 1}

1:20:08 - AJ {2, 1, 1, 2}

1:20:20 - AJ [followed by speech that cannot be understood] {2, 1, 1, 1}

1:20:42 - S2 [cannot be understood] {2, 1, 1, 1}

1:21:14 - [cannot be understood] {1, 1, 2, 1}

1:21:34 - X196 {2, 1, 1, 2}

1:21:47 - [cannot be understood] {1, 1, 2, 1}

1:21:52 - [cannot be understood] {1, 1, 2, 1}

1:21:58 - [cannot be understood] {1, 1, 2, 1}

1:22:12 - AS15 {2, 1, 1, 2}

1:22:42 - K19 {2, 1, 1, 2}

1:22:50 - [cannot be understood] {1, 1, 2, 1}

1:23:00 - [cannot be understood] {1, 1, 2, 1}

1:23:30 - Q58 {2, 1, 1, 2}

Phase 5 - begins 1:23:45 (duration = 4:38) - Paper-Folding Task

No speech.

Phase 6 - begins 1:29:10 (duration = 4:24) - Difficult Computer Task

1:29:16 - F2 {2, 1, 1, 2}

1:29:45 - AJ86 {2, 1, 1, 2}

1:30:40 - oh finally {1, 1, 1, 1}

1:30:57 - [cannot be understood] {1, 1, 2, 1}

1:31:19 - [cannot be understood] {1, 1, 2, 1}

1:31:50 - [cannot be understood] {1, 1, 2, 1}

1:32:17 - AS [cannot be understood] 15 {2, 1, 1, 1}

1:32:32 - K19 {2, 1, 1, 2}

1:32:43 - [cannot be understood] {1, 1, 2, 1}

1:32:52 - [cannot be understood] {1, 1, 2, 1}

1:33:17 - [cannot be understood] {1, 1, 2, 1}

Session 2 - Tape 45, 32:00

Phase 1 - begins 32:34 (duration = 4:17) - Difficult Computer Task

32:40 - [cannot be understood] {1, 1, 2, 1}

33:17 - A214 {2, 2, 1, 2}

33:36 - [cannot be understood] {1, 1, 2, 1}

34:06 - [cannot be understood] {1, 1, 2, 1}

34:50 - AL300 {2, 1, 1, 2}

35:13 - [cannot be understood] {1, 1, 2, 1}

35:53 - [cannot be understood] {1, 1, 2, 1}

36:27 - J76 {2, 2, 1, 2}

36:47 - AG219 {2, 1, 1, 2}

Phase 2 - begins 37:09 (duration = 4:44) - Paper-Folding Task

39:19 - [cannot be understood] {1, 1, 2}

Phase 3 - begins 42:19 (duration = 5:06) - Easy Computer Task

43:27 - [cannot be understood] {1, 1, 2}

43:44 - 4, 2, 5 {2, 2, 1}

43:49 - what? {1, 1, 1}

43:54 - 5 {2, 2, 1}

44:00 - 2, 4 {2, 1, 1}

44:07 - 3, 7, 1, 2 {2, 1, 1}

44:14 - [cannot be understood] {1, 1, 2}

44:49 - [cannot be understood] {1, 1, 2}

44:52 - 8, 2, 2 {2, 1, 1}

44:59 - [cannot be understood] {1, 1, 2}

45:37 - 3 {2, 1, 1}

45:57 - [cannot be understood] {1, 1, 2}

46:13 - [cannot be understood] {1, 1, 2}

46:29 - [cannot be understood] {1, 1, 2}

Phase 4 - begins 47:46 (duration = 4:23) - Paper-Folding Task

No speech.

Phase 5 - begins 52:28 (duration = 4:23) - Difficult Computer Task

52:56 - [cannot be understood] {1, 1, 2, 1}

53:28 - [cannot be understood] {1, 1, 2, 1}

53:33 - [cannot be understood] {1, 1, 2, 1}

53:46 - [cannot be understood] {1, 1, 2, 1}

53:59 - [cannot be understood] {1, 1, 2, 1}

55:50 - A1 {2, 1, 1, 2}

56:21 - Q170 {2, 1, 1, 2}

56:38 - [cannot be understood] {1, 1, 2, 1}

Phase 6 - begins 57:12 (duration = 4:39) - Paper-Folding Task

No speech.

Appendix L.

Instruction Page for Study 3.

Instructions

There is a different folder for each of the 8 phases, on the front right corner of the table. For each phase, first read the instructions inside the folder, then set the timer for 4 minutes and begin the task. The timer goes in the cardboard box on the chair on the other side of the room. When the timer goes off at the end of the phase, read the instructions inside the folder for the next phase. Please do not do any writing except as instructed.

Procedure:

Read the instructions inside the folder for Phase 1, then set the timer and begin the task.

Phase 1 - Block Patterns A

When the timer goes off, read the instructions inside the folder for Phase 2.

Phase 2 - Scrambled Words A

When the timer goes off, read the instructions inside the folder for Phase 3.

Phase 3 - Arithmetic Word Problems A

When the timer goes off, read the instructions inside the folder for Phase 4.

Phase 4 - Scrambled Words B

When the timer goes off, read the instructions inside the folder for Phase 5.

Phase 5 - Paper-Folding A

When the timer goes off, read the instructions inside the folder for Phase 6.

Phase 6 - Arithmetic Word Problems B

When the timer goes off, read the instructions inside the folder for Phase 7.

Phase 7 - Paper-Folding B

When the timer goes off, read the instructions inside the folder for Phase 8.

Phase 8 - Block Patterns B

When the timer goes off, go and get Rob in room 4290.

Appendix M.

Arithmetic Word Problems from Study 3.

Easy:

If you have $18.00 and you spend $7.50, how much will you have left?

solution: _____

A family coming home from their summer vacation drove 250 miles in 5 hours. What was their average speed?

solution: _____

Bill is going to ride his bicycle between two towns. The distance between the towns is 60 miles, and Bill will be riding at an average speed of 20 miles per hour. How long will it take for Bill to ride between the towns?

solution: _____

Scott has been collecting stamps for 12 years, at an average rate of 1,000 stamps per year. How many stamps are in Scott's collection?

solution: _____

The price of raisins from the supermarket's bulk bin is $3.00 for a kilogram. How

much will 4 kilograms of raisins cost?

solution: _____

Christmas tree ornaments take 15 minutes each to make. Noel is going to make 4 of these ornaments. How long will Noel need to work on them?

solution: _____

A liquid soap dispenser holds 200 cubic centimetres of soap, and dispenses half a cubic centimetre each time the lever is pulled. The soap dispenser has just been completely filled. How many times must the lever be pulled before the soap dispenser will be completely empty?

solution: _____

Wendy's dog eats half a kilogram of dog food every day. How much dog food will Wendy need to last 8 days?

solution: _____

A dozen oranges cost $3.00. How much do 2.5 dozen oranges cost?

solution: _____

A gardener is going to plant a flower bed with petunias. The nursery recommends that these petunias should be planted at a density of 2 per square foot. The total area of the flower bed is 10 square feet. How many petunias will the gardener need, to plant the flower bed at the recommended density?

solution: _____

A piece of furniture is priced at $600.00. If it is paid for in monthly installments of $30.00, with no interest charges, how many months will it be before the piece of furniture is completely paid for?

solution: _____

A maple tree grows 8 centimetres every year. How much will a maple tree grow in 5 years?

solution: _____

A man who weighs 180 pounds wants to reduce his weight to 160 pounds. If he lost 2 pounds a week, how many weeks would it take for him to reach his goal?

solution: _____

Tulip bulbs cost 50 cents each. How much will it cost for a dozen tulip bulbs?

solution: _____

Green widgets take 45 minutes to produce, and blue widgets take 30 minutes to produce. How long will it take, altogether, to produce 2 green widgets and 4 blue widgets?

solution: _____

If you buy $6.00 worth of gasoline and pay for it with a 10 dollar bill, how much change should you get back?

solution: _____

Raffle tickets cost 25 cents each. How much would it cost to buy 6 tickets?

solution: _____

Two friends are going for a 12-day backpacking trip. They will need a total of 2 pounds of food each day, between the two of them. How many pounds of food will they need to be carrying, altogether, at the beginning of the trip?

solution: _____

Soft drinks are sold 6 cans to a package. If you want 36 cans, how many packages

must you buy?

solution: _____

The price of apples is 2 for 31 cents. What is the price of 1 dozen apples?

solution: _____

How long will it take a person to walk 24 miles at the rate of 3 miles an hour?

solution: _____

Difficult:

A bicycle courier is going to ride a circuit from the dispatch office to two stops and back to the office again. The first stop is 4 miles from the office, the second stop is 5 miles from the first stop, and the office is 2 miles from the second stop. The courier will travel at an average speed of 16 miles per hour on the first and last legs of the trip (that is, between the office and the first stop, and between the second stop and the office). Between the first stop and the second stop, the courier will travel at an average speed of only 10 miles per hour, because the route passes through a part of town where the traffic is very heavy. If the courier spends 5 minutes at each stop, how long will the complete circuit take?

solution: _____

Two brands of peanut butter are on sale at a local supermarket. A 20-ounce jar of Brand A costs $1.90. A 15-ounce jar of Brand B costs $1.15. Which is the more economical buy?

solution: _____

If 8 machines are needed to finish a job in 6 days, how many machines would be needed to finish the job in one-half day?

solution: _____

Sparky's Rent-A-Car charges $24.00 per day plus 20 cents per mile for rental of a compact car. Mrs. Garcia rented a compact car for a day. She received a bill for $59.00, not including sales tax. How many miles did she drive?

solution: _____

John is 4 inches taller than his brother, Peter. If Peter grows 3 inches a year and John grows 2 inches a year, how soon will Peter and John be the same height?

solution: _____

A taxi ride costs $1.00 for the first one-ninth of a mile and 20 cents for each additional one-ninth. There is a charge of 20 cents for each minute of waiting time. What would a two and two-ninths mile ride cost if there are 5 minutes of waiting time?

solution: _____

Sharon bought a box of apples for $5.00. She sold them at a football game for 20 cents each. After the game she had 8 apples left. If she made a profit of $3.00, how many apples were in the box at the beginning?

solution: _____

Monica's outboard motorboat will go 10 miles an hour. She wants to go up the river 4 miles to visit a friend and then come back home. The current in the river flows 2 miles an hour. What is the least amount of time Monica will spend travelling to see her friend and then returning home?

solution: _____

Dave is walking to the convenience store. The store is half a mile away, and Dave walks 4 miles per hour. Along the route there are 3 traffic lights, and Dave will have to wait for an average of 20 seconds at each light. Assuming he spends 3 minutes in the store, how long will Dave's trip to the store and back take?

solution: _____

In the supermarket's bulk bin section, peanuts cost $2.50 per kilogram, almonds cost $5.50 per kilogram, and cashews cost $7.00 per kilogram. What is the total cost for 5 kilograms of peanuts, 2.5 kilograms of cashews, and 1.5 kilograms of almonds?

solution: _____

A coat that normally sells for $60.00 is reduced by 15 percent during a sale. What

is the price of the coat during the sale?

solution: _____

Appendix N.

Example Scrambled Word Problems.

Easy:

ujts _ _ _ _

bmo _ _ _

idm _ _ _

uceb _ _ _ _

isk _ _ _

eojk _ _ _ _

kiml _ _ _ _

nin _ _ _

lsde _ _ _ _

epi _ _ _

lotl _ _ _ _

emt _ _ _

vone _ _ _ _

anyv _ _ _ _

ozo _ _ _

gagn _ _ _ _

arg _ _ _

rsi ___

leyl ____

avn ___

nkwo ____

pho ___

nari ____

upt ___

ohem ____

Difficult:

eedacd ______

rsseei ______

graic _____

uyngrh ______

zdhraa ______

orrnec ______

pciot _____

uqnee _____

onusic ______

vreir _____

nrchoa ______

uesma _ _ _ _ _

ctsne _ _ _ _ _

eecin _ _ _ _ _

fefico _ _ _ _ _ _

aergon _ _ _ _ _ _

uwrrob _ _ _ _ _ _

inmrfou _ _ _ _ _ _ _

urecis _ _ _ _ _ _

hrsiev _ _ _ _ _ _

eraveb _ _ _ _ _ _

dnseud _ _ _ _ _ _

ieson _ _ _ _ _

tsrvane _ _ _ _ _ _ _

ubnar _ _ _ _ _

awlsloh _ _ _ _ _ _ _

Appendix O.

Task Instructions for Study 3.

Scrambled Words

Each of the strings of letters can be re-ordered to form a word. (None of them are impossible.) Solve each item by re-ordering the letters to form the word, without writing anywhere, except for writing your solution in the spaces indicated to the right of each letter string. Try to go through the list at a reasonable pace: take your time (don't rush), but at the same time don't spend a really long time on any one item. If you get through all the items before the 4 minutes is finished, start at the beginning again with the items you didn't solve the first time through. It is extremely important that you do not do any other writing at all, except for writing your solutions in the appropriate spaces. Do not make any extra notes or write any rough work. This is an extremely important part of the task.

Set the timer for 4 minutes and begin the task. When the timer goes off, put this folder at the bottom of the pile, and read the instructions inside the folder for the next phase.

Arithmetic Word Problems

Solve each problem and write your solution in the space indicated, without doing any other writing. If you get through all the problems before the 4 minutes is finished, start at the beginning again with any problems you didn't solve the first

time through, or if you solved them all then double-check your solutions. It is extremely important that you do not do any other writing at all, except for writing your solutions in the appropriate spaces. Do not make any extra notes or write any rough work. This is an extremely important part of the task.

Set the timer for 4 minutes and begin the task. When the timer goes off, put this folder at the bottom of the pile, and read the instructions inside the folder for the next phase.

Block Patterns

Copy each pattern, in the sequence in which they are arranged in the folder. Use the black-and-white blocks for the black-and-white patterns, and the red-and-white blocks for the red-and-white patterns. Be sure to mix up or scramble the set of blocks, between patterns. If you get through all the patterns before the 4 minutes is finished, start at the beginning and go through the sequence of patterns again.

Set the timer for 4 minutes and begin the task. When the timer goes off, put this folder at the bottom of the pile, and read the instructions inside the folder for the next phase.

Easy Paper Folding

Make copies of each of the paper objects on the back left corner of the table, using the paper in this folder. For each of the objects, there is also a piece of paper on

the table showing the folds involved in making it, which you might find helpful. Go clockwise through the set of objects, beginning with the object on the left end of the back row (that is, the object in the extreme back left corner). If you finish your copies of all 8 objects before the 4 minutes is finished, begin again with the object in the back left corner, and go through the sequence again, making another copy of each object, using a new piece of paper for each one.

Set the timer for 4 minutes and begin the task. When the timer goes off, put this folder at the bottom of the pile, and read the instructions inside the folder for the next phase. Please put your finished copies on the chair by the timer.

Difficult Paper Folding

Make a copy of the paper object on the back right corner of the table, using the paper in this folder. On the table there is also a piece of paper showing the folds involved in making it, which you might find helpful. If you finish your copy before the 4 minutes is finished, start again with a new piece of paper and make another copy.

Set the timer for 4 minutes and begin the task. When the timer goes off, put this folder at the bottom of the pile, and read the instructions inside the folder for the next phase. Please put your finished copies on the chair by the timer.

Appendix P.

Debriefing for Study 3.

Thank you very much for taking part in this study. We really appreciate your time and effort. This study investigates the relationship between speech, and problem-solving - it's a study about how people use self-directed speech (or, speech which isn't directed toward anyone but themselves) as a tool for problem-solving, and as a means for planning and organizing their actions.

We were making audiovideo recordings of the sessions. I really want to apologize for not telling you about that beforehand, but what we're interested in with this study is what people say to themselves when they're working on these tasks, and we felt pretty sure that if we did tell people about the recording ahead of time, this would affect their speech. Probably it would mean a lot of people wouldn't say anything at all, and there wouldn't be any point running the study. We would have liked to have been able to avoid running the study this way, and we did think a lot about other possibilities, but in the end there really just didn't seem to be any alternative. There's strong social pressure against talking to yourself - people sometimes think other people who talk to themselves are maybe a little odd. There's stigmatization about talking to yourself, and a lot of social pressure against it, even though many completely normal people do it quite a lot. So we believed that if people knew they were being videotaped, in a psychology

experiment, they probably wouldn't speak out loud very much - maybe not at all. It's very likely that if we didn't withhold information about the recordings until the end of the study, it wouldn't be feasible to do this kind of research at all. And we believe this research is important, because the findings could have very far-reaching implications for theories about human thinking, based on the idea that thinking is closely related to speech. And this seems to be the only way of getting at this kind of information. So we decided to do the study anyway, despite these complications.

Again, I want to apologize for not telling you beforehand about the recording. You have the opportunity now to withhold consent for the use of the data from your sessions, if you want to.

This kind of speech has been studied quite a lot in children, and the use of this kind of self-directed speech by adults has been pretty much overlooked by researchers. Young children talk to themselves a lot, in a lot of different situations. For example, if you watch a five-year-old doing a jigsaw puzzle, you'll probably find that they talk to themselves quite a lot. According to the original thoery, children stop doing that when they're about eight years old. The idea is that at that age, they internalize that self-directed speech, and after that they do it internally, and not externally. So from that point of view, the use of this kind of self-directed speech is a developmental stage, ending at around eight years. I don't

belive that's the case, so with this research I'm challenging that claim.

One finding that's come up consistently in research with children is that they talk to themselves a lot more when they're working on a difficult task, compared to an easier task - which does seem to support the idea that this kind of speech is related to thinking. In this study, we used easy and difficult versions of each of the tasks, and we're hoping to extend that finding about task difficulty to the adult population.

And a study I did last term suggested that adults use a lot more self-directed speech when they're working on verbal tasks, which involve language a lot, compared to nonverbal tasks, which don't involve language. So in this study, we're comparing speech while working on verbal tasks (scrambled words and arithmetic problems) with speech on nonverbal tasks (paper folding and block patterns).

Appendix Q.

Consent Forms for Study 3.

Consent Form

I have read the information letter describing the purposes and the tasks involved in participation in a study on performance on block-copying tasks, paper-folding tasks, arithmetic word problems, and scrambled word tasks, which is being conducted by Robert Duncan and Dr. A. Cheyne of the department of Psychology at the University of Waterloo. I further understand that should the information I provide be used in publications, my identity will be protected. I acknowledge that I may withdraw my consent to participate at any time.

This study has been reviewed by, and has received ethics clearance through, the Office of Human research at the University of Waterloo. This Office will receive any complaints or concerns with regard to your involvement in this study.

Participant's Name: (please print) _____

Participant's Signature: _____

Witness's Signature: _____

Date: ____/____/____

D M Y

Post-Debriefing Consent Form

I have read the debriefing letter describing the purposes of the study on adults' self-directed speech while they work on block-copying tasks, paper-folding tasks, arithmetic word problems, and scrambled word tasks, which is being conducted by Robert Duncan and Dr. A. Cheyne of the department of Psychology at the University of Waterloo, and also describing the audiovisual recording during the study and the reason for withholding full information about this aspect of the study until after the session was finished. I further understand that should the information I provide be used in publications, my identity will be protected. I acknowledge that I may withdraw my consent for use of the data from the session in which I participated.

This study has been reviewed by, and has received ethics clearance through, the Office of Human research at the University of Waterloo. This Office will receive any complaints or concerns with regard to your involvement in this study.

Consent for use of data: YES _____ NO _____

Participant's Name: (please print) _____

Participant's Signature: _____

Witness's Signature: _____

Date: ____/____/____

D M Y

Appendix R.

Cover Story for Study 3.

This study investigates task management strategies, with 4 different kinds of tasks. Sometimes on a task there's a trade-off between speed and accuracy: if we go fast we might get more done but we tend to make more mistakes, and if we go slower we might make fewer mistakes but not get as much done. And there are a lot of differences in the kinds of strategies people use to help with task management in these sorts of situations.

This study investigates how these task management strategies differ between different kinds of tasks.

Appendix S.

Counterbalanced Orders of Task Materials for Study 3.

Order 1

Phase 1 - Difficult Scrambled Words

Phase 2 - Difficult Paper-Folding

Phase 3 - Difficult Arithmetic Word Problems

Phase 4 - Easy Block Patterns

Phase 5 - Easy Scrambled Words

Phase 6 - Easy Arithmetic Word Problems

Phase 7 - Difficult Block Patterns

Phase 8 - Easy Paper-Folding

Order 2

Phase 1 - Easy Paper-Folding

Phase 2 - Difficult Scrambled Words

Phase 3 - Easy Arithmetic Word Problems

Phase 4 - Easy Block Patterns

Phase 5 - Difficult Arithmetic Word Problems

Phase 6 - Difficult Block Patterns

Phase 7 - Easy Scrambled Words

Phase 8 - Difficult Paper-Folding

Order 3

Phase 1 - Difficult Block Patterns

Phase 2 - Easy Scrambled Words

Phase 3 - Easy Arithmetic Word Problems

Phase 4 - Difficult Scrambled Words

Phase 5 - Difficult Paper-Folding

Phase 6 - Difficult Arithmetic Word Problems

Phase 7 - Easy Paper-Folding

Phase 8 - Easy Block Patterns

Appendix T.

Example Transcript from Study 3.

The two numbers following the time of each utterance are the codes for the speech classifications, speech preceding action and reading. For the first code, 1 indicates 'speech not preceding action' and 2 indicates 'speech preceding action;' for the second code, 1 indicates 'not reading,' 2 indicates 'ambiguous,' and 3 indicates 'reading.'

Participant 26, Order 3 - Tape 18, 0:00

Phase 1 - begins 0:41 (duration = 4:18)

0:44 - 1, 1

1:04 - 1, 1

1:22 - 1, 1

1:50 - 1, 1

2:31 - 1, 1

3:03 - 1, 1

Phase 2 - begins 5:47 (duration = 4:25)

6:03 - 1, 2

6:18 - 1, 1

7:04 - 1, 1

7:21 - 1, 1

7:27 - 1, 1

9:12 - 1, 1

Phase 3 - begins 10:51 (duration = 4:26)

11:10 - 1, 1

11:23 - 1, 1

12:17 - 1, 2

14:11 - 1, 2

14:23 - 1, 2

Phase 4 - begins 16:01 (duration = 4:38)

16.07 - 1, 2

16:33 - 1, 2

Phase 5 - begins 21:28 (duration = 4:37)

21:41 - 1, 1

22:42 - 1, 1

23:07 - 1, 1

24:23 - 1, 1

25:10 - 1, 1

Phase 6 - begins 26:49 (duration = 4:18)

27:03 - 1, 2

27:14 - 1, 2

27:48 - 1, 2

27:58 - 1, 1

28:08 - 1, 2

28:28 - 1, 2

28:42 - 2, 1

28:56 - 1, 1

29:37 - 1, 2

30:29 - 2, 1

30:42 - 1, 1

30:58 - 1, 1

Phase 7 - begins 31:46 (duration = 4:32)

34:30 - 1, 1

35:50 - 1, 1

Phase 8 - begins 36:58 (duration = 4:35)

39:33 - 1, 1