

## **INNER SPEECH**

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This entry reviews the definitions, theories, measures, development, characteristics, neuroanatomy, and functions of inner speech, as well as the maladaptive impact of negative self-talk. Inner speech is involved in self-regulation, working memory language functions, and self-awareness. Most assessment tools are introspective (e.g., thought sampling) or retrospective (e.g., questionnaires). Children's private speech constitutes the best available objective manifestation of inner speech. Inner speech is social in origin, it is preceded by private speech, and once internalized, it becomes abbreviated and predicative. Inner speech production activates the left inferior frontal gyrus. Distorted self-talk is associated with psychological disorders like anxiety and depression.

### **Overview**

#### Definition

Inner speech is the activity of talking to oneself in silence. It is often equated with the phonological loop portion of short-term memory, which gets recruited when one needs to hold auditory information in an active state for a short period of time. However, inner speech does much more, as it plays a central role in self-regulation (e.g., planning, problem-solving, self-motivating), normal language functions such as reading and writing, task switching performance, remembering the goals of action, rehearsing person-to-person communicative encounters, and self-awareness, which includes mental time travel into the past and the future. People report that around one-fourth of their conscious waking life consists of inner speech, indicating that it most certainly constitutes a significant human mental activity.

#### Related terms and manifestations

Typical expressions used to designate inner speech are self-talk, self-directed speech, subvocal, covert, or acommunicative speech, auditory imagery, speech-for-self, propositional thought, self-verbalizations, internal dialogue or monologue, subvocalizations, self-statements, and silent verbal thinking. Jean Piaget used the term egocentric speech when discussing self-talk produced aloud by children in social situations. He proposed that egocentric speech served no function at all and was the manifestation of children's cognitive immaturity. Lev Vygotsky insisted rather that egocentric (private) speech served an important self-regulatory function. In Vygotsky's view, speech-for-self emitted out loud by children reflected intellectual development, not egocentrism.

Young children engage in echolalia when they repeat others' words in an automatic manner for language learning purposes or for the simple pleasure of using words. They emit crib speech when producing soliloquies before falling asleep. The idiom embedded private speech refers to adults' use of private speech during public talks in order to restructure the lecture or to self-regulate (e.g., OK, let's now move on to the next point). Inner speech writings represent hastily recorded memos for self in notebooks, personal journals, on shopping lists, etc. These messages may consist in single words or phrases, or full paragraphs written in a very condensed and often obscure style meaningful only to the self.

### **Theoretical Themes**

#### Thought and language

There exist two main views on the connection between thought and language (which includes inner speech): language basically is thought, and thought can exist without language. Plato, an advocate of the first position, wrote that "When the mind is thinking, it is simply talking

to itself, asking questions and answering them.” Following John Watson’s lead, behaviorists also held that thought is identical to inner speech. Charles Darwin seemed to agree with this theory when he proposed that “A long and complex train of thought cannot be carried on without the aid of words, whether spoken or silent, than a long calculation without the use of figures or algebra.” Vygotsky concurred and suggested that thought is not expressed in words—it comes into existence through them. An alternative formulation of this first position is the Sapir-Whorf hypothesis, which suggests that the use of vocabulary that is unique to one’s native language shapes one’s view of the world. To illustrate, color terms within a language influence color perception. Present work shows that using interrogative language (e.g., Will I?) as opposed to declarative speech (I will) increases motivation and goal-directed behavior.

The Wurzburg’s school of thought founded by Oswald Kulpe in the late 1800s was a major proponent of the second theory: pure thought can exist without language (or inner speech); thought can be wordless. Experiments tentatively supporting this position were conducted by Karl Buhler at the beginning of the twentieth century. Participants listened to a proverb and then were asked to press on a button once they understood it. Most volunteers claimed that the button pressing was not accompanied by verbal thoughts or images, suggesting that understanding (i.e., thought) precedes language.

None of these two extreme views are embraced by modern cognitive scientists and linguists. Instead of asking if language creates thought or if thought causes language, the question being currently examined is: how does language affect thought processes?

#### Vygotsky’s position

Numerous theories of inner speech have been formulated. Vygotsky’s theory, which emphasizes culture, language, and internalization, arguably represents the most complete, original, and coherent view available. In Vygotsky’s system, children’s cognitive development is affected by culture in two ways. First, children acquire most of their knowledge (the contents of thought) through culture. In addition, not only does culture teach children what to think—it teaches them how to think. Intellectual growth emerges out of a dialectical process in which problem-solving experiences are shared with parents, teachers, siblings, peers, etc. Children can solve some problems by themselves, yet other more challenging problems require help from social agents. Vygotsky named the difference between what children can and can’t do by themselves the zone of proximal development. He insisted that not respecting this zone, either by helping children on tasks they can complete on their own, or by not helping enough on difficult tasks, impedes cognitive development. Ideally, people interacting with children initially should guide most of the problem-solving process, and eventually transfer this responsibility to the child. Language represents the core type of interaction which allows social agents to convey information to children. Gradually, children’s own language becomes their principal tool of intellectual growth, first as speech-for-self emitted aloud (private speech) to guide and control their own actions, and eventually as silent self-talk (inner speech). Vygotsky called this internalization—the process of using an instrument of thought (inner speech) that was at first located outside children (social speech). Much of Vygotsky’s theorizing has led to empirical predictions and most have received support.

#### **Methodology of Research**

Like other internal cognitive processes, inner speech cannot be directly observed but only indirectly inferred. Not surprisingly, early efforts aimed at assessing inner speech were based on introspection. Alfred Binet for instance, would have his two daughters work on various tasks and would ask them what strategies they employed. He noted that the daughters often reported thoughts such as “I told myself this. . .” or “I said to myself that. . .”. From these observations Binet deduced that most thinking recruits inner speech.

### Private speech

Vygotsky held that studying the spontaneous production of private speech in children was the most reliable way to tap into inner speech. Although they both are not identical, private speech nonetheless retains some characteristics that inner speech is postulated to possess, and importantly, it is objectively measurable and quantifiable. Indeed, private speech has been extensively studied in natural settings (e.g., in the classroom) and in more controlled environments in numerous situations (e.g., with others vs. alone). Private speech is typically measured by calculating the total number of raw utterances, the number of verbalizations per minute, or the ratio of social to private speech. Private speech units are coded and classified into different categories. Typical categories are task-irrelevant private speech (e.g., word play, emotional release, conversations with imaginary others), task-relevant private speech (e.g., vocalizations about the task or the child's current or future task-related actions), and partly internalized private speech consisting of inaudible muttering, whispers, and silent lip movements. The frequency and content of private speech are then correlated with behavior or performance.

Only children's private speech has been used as a window into inner speech. Adults also engage in private speech, but only when alone and thus much less frequently than children. However, adults' private writing has been investigated. Private writing (also called introspective or inner speech writing) refers to scribbling people write on a piece of paper (e.g., a grocery list) or on the margins of a book, as well as in a notebook (e.g., a writer's thoughts). Private writing is consistently condensed (like inner speech) and cryptic to others because it is uniquely addressed to the self.

### Production methods

Production (or self-revelation) methods usually entail the externalization of ongoing inner speech as a task is being performed; most are thus introspective, as opposed to retrospective. With the think out loud technique, recordings of adults' verbalizations are made as they are working on a given task; volunteers are clearly encouraged to vocalize their thoughts. It is assumed that the collected speech will mirror genuine inner speech, or at any rate will supply a representative sample of it. To reduce the likelihood of having participants produce a biased or unnatural sample, instructions explicitly specify not to edit thoughts or to worry about being understood. The videotape reconstruction method consists in showing participants video recordings of their behavior in precise situations (e.g., during task performance) and asking them to recall (reconstruct) inner speech content. A variation of this technique is the interview immediately following the execution of a given task, where volunteers are probed for inner speech use during task completion. With the thought listing technique participants are asked to list their subvocal activity once a task has been completed. The thought-sampling method intends to collect a representative sample of people's inner speech in natural settings. Subjects wear a beeping apparatus that produces audio signals at random intervals throughout the day. Volunteers are asked to report the content of their inner speech upon hearing the beep. All measurement techniques reviewed above include coding and classification of inner speech units into different categories that are then correlated with behavior or task performance.

### Self-reports

The most frequently used instrument to assess inner speech is questionnaires made up of self-statements along a variety of domains—e.g., anxious vs. non-anxious (This is so stressful; I will make it), positive vs. negative (I feel fine; I just want to die), or social phobia ('People don't find me interesting). Participants are invited to rate the frequency of their self-talk using a Likert-scale. The main advantage of questionnaires is that they can easily and quickly be administered to large groups of people. Conversely, because these scales consist of pre-made self-verbalizations, they significantly restrict the scope of natural inner speech that volunteers could otherwise describe. Q-methodology is also used to estimate the content and/or functions of inner speech. Participants are invited to sort out cards that depict inner speech units according to

extent of agreement. Another approach, called the cued recall technique, consists of eliciting self-reports of inner speech use by presenting cards containing cue words to participants.

More ecologically valid methods exist. Researchers may use an open format question to gather spontaneously occurring inner speech in people's natural environments (e.g., When you talk to yourself, what do you typically say to yourself?). Compared to the random sampling method, the open ended format approach suffers from being retrospective (and thus potentially unreliable) but is not as limiting as the questionnaire. Slightly less retrospective is the use of diaries (or first-person narratives), which can also produce rich inner speech content.

#### Electromyographic recordings

Alexander Sokolov wrote an entire book on the use of electromyographic recordings of movements of the lips and tongue to assess inner speech incidence during problem-solving tasks. Electromyography allows one to evaluate and record physiological characteristics of muscles. This is done with an electromyograph that measures the electrical potential created by muscle cells when these cells contract and are at rest. Movements of the lips and tongue observed during overt speech are also produced (with much less intensity) during covert speech. These movements represent an objective external expression of subvocal speech activity. Suction electrodes placed on the tongue, sublingual horseshoe electrodes located under the tongue, or surface electrodes attached to the lower lip are used to record the target articulatory movements. It is thus possible to infer inner speech activity (but not content) during completion of various cognitive tasks such as mental calculation, silent reading, listening to speech, recall of verbal material, and manipulation of graphic-visual information.

#### Articulatory suppression

As seen above, articulatory movements accompany inner speech. Logically, interfering with those movements (articulatory suppression) will lead to inner speech interruption. In a typical experiment participants are invited to complete a task while concurrently reciting verses or mentally counting backward from 100. The forced articulation produced by the recitation or counting blocks any other articulation that would be otherwise required when spontaneously engaging in inner speech. Performance deterioration implies that the task normally benefits from inner speech use, although some argue that the deterioration could be due merely to the extra attentional demands. Articulatory suppression clearly does not assess inner speech per se but nonetheless informs the researcher as to what types of cognitive work cannot be accomplished without inner speech.

#### Brain-imaging

Recent advances in brain-imaging techniques such as positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) make it possible to record brain activity of participants performing various cognitive tasks. Activation of the left inferior frontal gyrus (LIFG) can be taken as evidence of inner speech activity during task completion because the LIFG is reliably recruited during the silent generation of words or sentences (see Neuroanatomy section below). It will be possible in the near future to identify what mental activities rely on inner speech, as well as to dress a list of those which do not or, partially do so. To illustrate, preliminary work examining self-referential activity suggests that focusing on one's personality traits or remembering personal past episodes engage inner speech, whereas recognizing one's face on a photograph does much less so. The latest brain-imaging tool that has been developed is repetitive transcranial magnetic stimulation (rTMS), which temporarily interrupts normal cortical activity. Current experiments are looking at the effects of applying rTSM on the LIFG. Brain-imaging techniques do not allow access into the content of inner speech—only its presence or absence is being objectified.

### Summary

Each measurement technique described above presents specific advantages and disadvantages. Ultimately it is the type of problem being studied that should determine what method to select. For instance, in a preliminary stage of an investigation, it would be reasonable to employ an open-format or thought sampling approach to collect self-generated statements from depressed patients. In a second part of the study, a validated questionnaire could be created based on these vocalizations and administered to larger clinical and non-clinical samples. Several assessment techniques should be used in order to aim for convergent validity. For example, in three independent studies on inner speech in anxious people, one could use diaries (thus collecting self-generated content), the videotape reconstruction procedure following anxiety-producing social interactions, and a questionnaire administered to anxious and non-anxious participants. Results would then be integrated into one broader research report.

### **Development of Inner Speech**

#### Social origins

Vygotsky postulated that inner speech grows out of one's social environment. This hypothesis is supported by the fact that there exist high positive correlations between rates of social interaction and private speech in children. Children immersed in cognitively and linguistically stimulating environments (situations more frequently observed in higher socioeconomic status families) start using and internalizing private speech faster than children from less fortunate backgrounds. Indeed, children raised in environments characterized by low verbal and social exchanges exhibit delays in private speech development.

#### Development of private speech

Cross-sectional and longitudinal studies support Vygotsky's original view that the frequency of children's private speech follows an inverted-U relation with age. Private speech use peaks at 3–4 years of age, decreases at 6–7 years of age, and gradually fades out to be mostly internalized by age ten. As private speech diminishes, one can observe more and more frequent whispering and inaudible muttering—typical manifestations of partially internalized inner speech. Intellectually gifted children tend to internalize private speech into inner speech earlier than their average counterpart, and girls usually show a faster private speech development than boys. Before the age of four children are largely unaware of engaging in private speech. The above trends seem to be universal and not sensitive to cultural differences. One study examined private speech in British and Saudi Arabian children and found no differences in frequency of private speech.

Vygotsky suggested that fully internalized inner speech does not re-emerge as private speech. This assertion has recently been challenged. Healthy adults have been observed to engage in external speech for self when alone for self-regulatory purposes, as well as for spatial navigation and search, concentration, and emotional discharge and control. Ninety-six percent of all adults report sometimes talking to themselves aloud.

#### Verbal self-control

Alexander Luria conducted a set of experiments on verbal mediation, aimed at determining the extent to which both social and self-generated speech effectively control children's behavior. Participants were instructed to press a rubber bulb as they were told by the investigator to start, stop, or synchronize presses with a flashing light and with his own speech. At 1½ to 2½ years, the instigating function of speech by the adult (start) was successful but not the inhibiting function (stop). Self-initiating and inhibiting functions of speech at that age were lacking. At 3 to 4 years, both the initiating and inhibiting functions of the experimenter's speech and the initiating function of the child's own verbal activity were objectified, but not the self-inhibiting function. The complete regulating function of the child's own speech was observed at 4½ years.

The investigation of natural self-regulatory private speech in children shows that it first follows behavior, then it accompanies action, and finally it precedes it. Use of private speech for

self-regulatory purposes significantly increases between 3 and 4 years of age. Social agents who actively include children in a collaborative effort to solve problems facilitate the development of self-regulatory private speech. Joint work on common problems helps children to internalize coping strategies and produce individualized vocalizations adapted to solving problems encountered when alone.

#### The private speech transition

A significant shift in children's spontaneous use of private speech occurs between the ages of 3 and 4. Three-year-old children emit self-talk across a very large array of situations (e.g., goal-directed and unfocused activities), whereas 4-year-olds' private speech tends to be observed almost exclusively during self-selected but focused, sustained, goal-directed activity. This indicates that 4-year-old children start engaging in private speech in situations in which it is mostly required for self-regulatory purposes.

#### **Characteristics of Inner Speech**

Fully internalized private speech transforms into inner speech, and it takes a life of its own with distinctive characteristics that differ from those of social speech. The semantic aspect of speech becomes most prominent as its syntactic and phonological dimensions move to the background. Unlike social speech, inner speech is predicative: it is syntactically compressed, condensed, abbreviated. The context of speech being always known to the self-talker, there is no need to explicitly identify the subject of a thought. In inner speech sense prevails over meaning. The private significance of words becomes more salient than their conventional meanings. Agglutination refers to the creation of hybrid words that constitute complex and uniquely personal concepts. The predicative nature of inner speech explains why it is experienced as a series of fragmented units—not as a smooth sequence of fully developed verbal images. This actually accounts for the observation that the rate of inner speech is significantly faster than that of overt speech.

Inner speech often exhibits a dialogic quality because it grows out of social speech, itself being mostly a dialogue between two persons. Inner speech is regularly experienced as including a speaking self (the inner voice) and a self talked to (the inner ear). Indeed, inner speech frequently adopts a format that approximates social verbal interactions, with a series of alternating lines, questions and answers. Various acoustic qualities of overt speech perception (e.g., sex, loudness, accent, and language) are not reported during internal speech.

#### **Neuroanatomy**

Experiments employing PET and fMRI scans show that the LIFG is more active during inner speech production elicited by tasks such as silently articulating sentences or single words. The LIFG is also recruited when subjects undertake working memory tasks involving covert repetition of verbal material. The LIFG corresponds to Broca's area, which constitutes the neurological foundation of both overt and inner speech generation. The LIFG is also referred to as the left ventrolateral prefrontal cortex or left frontal operculum; it encompasses Broadmann's areas 44, 45, 46, and 47. Additional brain areas are activated during inner speech use, including Wernicke's area, supplementary motor area, insula, and superior parietal lobe on the left side, as well as right posterior cerebellar cortex.

Neuropsychological findings are consistent with brain-imaging studies: accidental damage to the LIFG disrupts inner speech. rTMS applied to the LIFG interferes with internal speech. rTMS applied to the motor cortex of the left hemisphere, which is known to control mouth and tongue muscles, also inhibits inner speech—an observation in line with the view that covert speech necessitates articulation. The LIFG is not uniquely activated during inner speech production. Its activation can also be recorded during cognitive control (the orchestration of thoughts and actions in accordance with internal goals), working memory (temporary storage and manipulation of information), selection among competing alternatives to guide response, and interpretation of others' behavior. Note that naturally occurring inner speech, with its condensed and dialogic

qualities, has never been imaged; what has been measured so far is inner speech defined as mental recitation.

## **Functions**

### Self-Regulation

#### *Overview*

Fundamental human activities such as setting immediate and distant goals, problem-solving, planning, and decision-making, are all part of a more global capacity called self-regulation. Private speech in children and inner speech in adults have been shown to be of critical importance for effective self-regulation. Not surprisingly, the expression verbal self-guidance is often used to designate self-regulation. Self-talk significantly increases performance on tasks that entail the creation of complex behavioral sequences and the concurrent judgment of multiple behavioral choices. Four main groups of effective self-verbalizations during problem-solving tasks have been documented: (1) a clear definition of the problem; (2) an efficient approach to the problem; (3) sustained concentration on the problem; and (4) regular assessment of progress that includes self-encouragement or strategic refocusing.

#### *Private speech*

Private speech use in children gradually increases as tasks become more challenging. It is most often observed when participants work on tasks that require executive control in the absence of regulation offered by adults. Representative tasks found in research reports are puzzles, memory tasks, picture classification and discrimination, and sequencing tasks. The following situations increase the likelihood of private speech use for self-regulatory purposes: (1) completion of goal-directed, academic, or problem-solving tasks as opposed to free play or other activities; (2) working on difficult yet achievable problem-solving tasks instead of easy tasks; (3) being either alone or with peers in contrast to being with a verbally regulating adult; (4) working with an encouraging as opposed to highly controlling adult. This is referred to as scaffolding, which consists in adult assistance only on those tasks that are beyond children's skills.

That private speech use increases with task difficulty does not automatically imply that it actually improves performance. Two factors that need to be considered are task complexity and concurrent versus future performance. Private speech will most likely impede performance if the task is too difficult. It will enhance performance if the task is within the child's zone of proximal development—that is, if it is within the child's ability range. Also, private speech use is more beneficial on the long term (future) than on the short term (concurrent). Increased performance following private speech use is delayed (diachronic) instead of instantaneous (synchronic). Better performance is typically observed during task sessions following the time at which private speech was produced.

#### *Self-talk use in sports*

Numerous studies have examined the self-regulatory use of self-talk in athletes while training and competing during sporting activities such as water-polo, skating, golf, gymnastics, wrestling, and basketball. Self-verbalizations have been shown to be superior to other mental strategies (e.g., mental imagery) in enhancing sport performance. Dimensions of self-talk that are usually measured or manipulated in studies are valence, overtness, self-determination, self-instruction, self-motivation, and frequency. Valence refers to the emotional content of self-statements. While negative self-talk is associated with poorer performance, positive self-talk does not significantly increase it. Positive self-verbalizations are defined as those that help to concentrate on the present, not on past errors or in a remote future. Negative self-statements constitute inappropriate, irrational, counterproductive, or anxiety-producing thoughts. Another quality of self-talk is overtness, as opposed to covertness. It has been suggested that overt self-talk is more effective at improving performance because it allows the athlete to reproduce situations where his or her coach verbally guides performance aloud. Self-determined (i.e., self-selected) self-talk is postulated to possess more motivational power than pre-formulated self-talk

assigned by a trainer. How-to-perform self-talk is called self-instructional talk and is especially effective in practice situations, whereas I-can-do-it talk represents motivational self-talk and is more appropriate in competitive settings. Frequency of self-talk often increases across various periods of a sporting season and is linked to superior performance, although extreme frequency (called paralysis by analysis) worsens it.

### Language

Inner speech underlies basic language functions such as reading, writing, speaking, and calculating. Deterioration of inner speech caused by brain injury consistently produces language disorders like aphasia, agraphia, alexia, acalculia, as well as reduced verbal short-term memory. Current studies indicate that speakers monitor their own subvocal speech to identify and correct phonological, lexical, or grammatical mistakes before they are spoken. Inner speech and crib speech are often recruited when one spontaneously practices pronunciation and thinks about grammatical correctness. Significant lip movements are observed during silent reading, and patients with frontotemporal dementia and Gilles de la Tourette's syndrome, who exhibit a loss of control over inner speech which manifests itself in coprolalia (emitting unwanted vocalizations in social situations) also cannot read in silence. These two lines of evidence strongly suggest that inner speech and silent reading are deeply associated.

### *Links between inner, oral and written speech, reading, and composing*

As seen earlier, because inner speech is solely addressed to the self, it is telegraphic, densely meaningful, fluid, dynamic, idiomatic, agglutinative, elliptic, and predicative. Written speech however, is produced for others and thus is fully expanded, maximally elaborated, and orthographically explicit. Composing refers to the process of putting ideas and words onto paper; inner speech allows the writer to engage in mental rehearsal, or planning, to determine what to write. Oral speech lies in between inner and written speech—it is more spontaneous and involuntary than written speech, it requires an interlocutor, like inner speech it is dialogic, and it is made up of actual sounds. Social speech develops first, followed by inner speech, then both written speech and reading. But relationships between inner and written speech are bidirectional. On one hand, inner speech serves as an internal rough draft for oral and written speech. On the other hand, the very structure of written language forces an analytic (metalinguistic) stance on inner speech. The sophisticated, elaborated qualities of written speech encourage a less spontaneous and involuntary use of inner speech. Not only does inner speech constitute the basis of written speech—it also underlies reading. In contrast with inner speech, writing and reading require much more voluntary attention to the phonological, syntactic, and semantic aspects of speech.

### *Language without inner speech?*

One scientific article describes the case of a patient who retained normal language functions despite being incapable of inner speech. This evidence seems to contradict the claim that language functions require inner speech. However, careful neuropsychological assessment showed that the patient was using mental imagery to compensate for the absence of inner speech. That is, instead of verbalizing words to himself, the patient could create clear images of words when talking to himself—thus engaging in inner imaging as opposed to inner speech. Apparently, this visual communication with oneself effectively replaced inner speech and other language functions such as reading and calculating.

### *Do deaf people talk to themselves?*

Individuals born deaf never experience hearing sounds and thus do not develop normal language skills, including inner speech. Simply put, since deaf people never heard spoken words they cannot speak with or think in words. Can they nonetheless engage in a form of wordless self-talk? The answer is yes, with sign language. Use of sign language in deaf individuals activates

the LIFG—the brain area known to sustain inner speech. As seen before, articulatory suppression interferes with performance on tasks that benefit from inner speech use in orally proficient individuals. A comparable deterioration in task performance is obtained in sign users by having signers hold objects firmly in their hands, which inhibits self-sign language use. Also, deaf individuals tend to wave hands when working on difficult tasks—the non-verbal equivalent of private speech.

### Memory

#### *Working memory*

Inner speech plays an important role in memory functions, particularly in working memory. Working memory allows one to keep a small quantity of information in an active state for a short period of time. It is involved in numerous complex cognitive abilities that include reasoning, decision making, problem solving, and language understanding. Verbal and spatial information are manipulated differently in autonomous neuroanatomical systems. Each system is made up of three functional parts with unique neural correlates. One component stores information, another one rehearses—reactivates, refreshes—it, and a third component (the executive one) controls the overall processing of information in working memory. Inner speech is synonymous with the rehearsal component, at work for example when one mentally repeats a phone number to assist later recall.

#### *Autobiographical memory in bilinguals*

Inner speech has also been shown to be involved in autobiography, the memory of one's own past. Phenomenological inspection makes it clear that images are often used when we store and recall personally-relevant events. However, a recent study suggests that autobiographical information is also encoded and retrieved in words, or in narrative form. A related issue is: in what inner language do bilinguals recall their past? One cross-cultural study assessed inner speech of autobiographical memory in Polish people who emigrated to Denmark 30 years ago. Participants indicated retrieving personal memories in Polish for the decades prior to immigration and in Danish after immigration. This observation thus suggests that autobiographical material stored in one language is more easily retrieved in the same language. All immigrants spent 30 years in Denmark, but early immigrants (on average 24 years old at the time of immigration) indicated using more Danish inner speech, while late immigrants (about 34 years old at the time of immigration) reported more Polish inner speech use.

### Self-awareness

It is becoming increasingly evident that fully developed human self-awareness depends on inner speech use. Self-awareness refers to the ability to analyze the self and to build a self-concept. It includes focus on private and public self aspects, and consists in self-definition, self-recognition, self-evaluation, self-esteem, mental time travel, and death awareness, to name a few self-referential processes. Inner speech allows one to identify and label various self-aspects—it makes it possible for a person to represent internal states and to reflect on them. There is considerable empirical support for the notion of inner speech participation in self-awareness. Multiple validated questionnaires measuring frequency of self-focus and use of inner speech strongly correlate. Healthy participants claim to rely significantly on inner speech while thinking about their future. Brain imaging studies of self-referential processing often report activation of the LIFG and thus, most probably, inner speech use. Brain injuries that produce a loss of inner speech are associated with self-awareness deficits. The development of Theory-of-Mind, which consists in thinking about others' mental states, is linked to private speech use in preschoolers.

### Additional functions

Inner speech does not uniquely play a role in self-regulation, language, memory, and self-awareness. It is also involved in task-switching performance, the ability to switch back and forth between two cognitive operations like multiplying and dividing numbers. Children learn to

differentiate their own voice from those of others by repeatedly hearing their own voice through private speech use. People also talk to themselves when mentally preparing an upcoming social encounter. Inner speech is also activated when one focuses attention on a given target, forms concepts, remembers the goals of actions, or expresses emotions such as anger. Some have proposed that praying engages inner speech.

### **Dysfunctional inner speech**

#### Overview

Ruminative inner speech that focuses on real or imagined negative self-aspects may amplify pre-existing morbid conditions such as test anxiety, bulimia, anorexia, lack of assertiveness, insomnia, social anxiety, agoraphobia, sexual dysfunctions, low self-esteem, and depression. Inner speech may also accompany less severe and temporary negative states like worry, guilt, and shame. The content-specificity hypothesis suggests that the aforementioned maladaptive conditions underlie negative self-talk associated with specific dysfunctional topics. To illustrate, anorexia triggers inner speech revolving around weight and physical appearances issues (e.g., I must lose weight), and low self-esteem is linked to self-worth cognition (e.g., I'm insignificant). Accordingly, compulsive gamblers have irrational thoughts about control of the game, for instance, I'm going to bet on those rows again, this is a good game.

#### Asymmetry between positive and negative self-verbalizations

There exists an important and counterintuitive asymmetry between positive and negative self-statements. Negative inner speech has a significantly more dysfunctional influence than positive self-talk on coping. Simply put, imagining the worst through pessimistic inner speech (e.g., failing an exam) has more negative impact than thinking positively (passing an exam). This fact clearly goes against the fashionable belief of positive thinking and suggests that eradicating negative verbalizations might be more efficient than formulating positive ones. Healthy functioning is associated with a 1.7 to 1 ratio of positive to negative self-verbalizations; maladaptive thinking is characterized by a 1 to 1 ratio. Studies that measure cognitive change following psychotherapy confirm that negative thoughts tend to decline while positive thoughts do not increase. Negative verbalizations (e.g., disfigurement) increase heart rate, yet positive ones (e.g., harmony) have no significant effect.

#### The rebound effect

Also perplexing is the observation that trying to suppress undesirable thoughts in inner speech (e.g., I must stop thinking about this) makes the thoughts more accessible (they are experienced more often) and leads to increased anxiety, depressed mood, and lower self-esteem. This paradoxical phenomenon is called the rebound effect.

#### Hearing voices in schizophrenia

The most plausible explanation for auditory verbal hallucinations in schizophrenic patients is that they can't properly monitor their own self-generated inner speech. There is little doubt that the voices are the result of patients' own subvocal activity. Indeed, the LIFG is active when schizophrenic patients are experiencing verbal auditory hallucinations, suggesting inner speech production. The precise underlying mechanism is unknown, but one view implicates a verbal self-monitoring deficit. Speech production in normal individuals generates a corollary discharge that sends a message to the left temporal lobe where verbal thoughts are identified. Basically, the message tells the brain that it just produced speech and thus the voice heard is one's own inner speech. This communication between the frontal and temporal lobes is postulated to be deficient in schizophrenic patients. Brain imaging studies support this hypothesis: patients with auditory hallucinations show activity in the LIFG when engaging in inner speech but fail to exhibit activity in the left temporal cortex. That verbal hallucinations would be caused by an inner speech dysfunction per se is improbable. Performance on short-term memory tasks that require inner speech use is normal in patients experiencing severe auditory hallucinations.

### Hyperactivity

Initial explanations of hyperactivity in children involved the notion of insufficient self-regulatory private (and inner) speech causing poor self-control. Cognitive-behavioral psychologists designed various techniques to increase the use of verbal self-guidance. A typical approach consisted of gradual stages producing the internalization of self-regulatory speech—e.g., modeling, overt external guidance, overt self-guidance, faded overt self-guidance, and covert self-guidance. This method has recently been re-evaluated and most agree that it actually is ineffective. First, the aforementioned approach focuses on short-term results that apply to precise tasks; what would be needed is a technique leading to long-term gains that would generalize to broad academic and interpersonal behaviors. What used to be taught was self-control (i.e., copying adults' commands) instead of authentic self-regulation (i.e., self-generating flexible plans for action). Second, in point of fact, hyperactive kids produce adequate self-regulatory private speech. The nature of the deficit doesn't lie in lack of verbal self-guidance—it most likely is neurobiological.

### **Conclusion**

Inner speech constitutes a fundamental cognitive activity not limited to working memory (the phonological loop) but including self-regulation (initiating, shaping, guiding, and controlling behavior), language functions, self-awareness (e.g., autobiographical memory, mental time travel), emotional release, task-switching, preparation for upcoming social encounters, and more. Various methods exist to measure inner speech, some easy to administer but limiting (e.g., questionnaires) and others more ecologically valid but time consuming (e.g., thought sampling). The general agreement is that inner speech is social in origin, it is preceded by private speech, and once internalized, it becomes mostly abbreviated and predicative. Although various brain regions underlie inner speech production, the LIFG seems to represent the most important area. Inner speech resembles a double-edged sword—on one hand it is associated with positive consequences such as self-regulation, yet on the other hand negative and ruminative self-talk may lead to or maintain psychological disorders like anxiety and depression. Inner speech nonetheless remains neglected compared to other important psychological concepts. To illustrate, what people actually talk to themselves about is largely unknown and current work is precisely aiming at answering that and other exciting research questions.

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