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Los Angeles

Characterizing streams-of-consciousness as a lens into intrapersonal communication

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of
Philosophy in Communication

by

Constance Bainbridge

2026

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ABSTRACT OF THE DISSERTATION

Characterizing streams-of-consciousness as a lens into intrapersonal communication

by

Constance Bainbridge

Doctor of Philosophy in Communication

University of California, Los Angeles, 2026

Professor Greg Bryant, Chair

Intrapersonal communication examines how individuals interact with themselves from a communication perspective. We engage in self-talk, imagine interactions, generate internalized media such as visualizations, and so on, yet a unified study of these phenomena is missing. This dissertation aims to revive the study of intrapersonal communication by describing what it is through a literature review of related subjects and presenting frameworks for how it can be studied. Empirical work is then presented demonstrating a multidimensional approach to studying one example of intrapersonal communication – overt linguistic streams-of-consciousness. In a series of three studies, participants provide their typed or spoken streams-of-consciousness, aiming to report their thoughts continuously and spontaneously. The first study prompts participants to think about life before or during the COVID-19 pandemic to see how their thoughts about the future may shift through psychological momentum. From analyzing the language in the future-directed thoughts alone, it is possible to predict the temporal priming of prior thoughts. The second study then explores how typing versus speaking thoughts may impact how thoughts unfold. Typing enhanced lexical diversity as well as proportions of

emotional language usage. When Large Language Models generated comparable thoughts, emotion language was reduced relative to humans. Finally, the third study manipulates the environment under which spoken thoughts are generated to see how darkness or the presence of a mirror may shift language and the delivery of our voices. Darkness and a mirror led to exploration of different language spaces, and speaking in the dark attenuated vocal intensity while boosting roughness. Together these studies show that the conditions under which we deliver our thoughts to ourselves can shape what we think about and how.

The dissertation of Constance May Bainbridge is approved.

Rick Dale

Clark Barrett

Anne Warlaumont

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2026

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VITA

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Chapter 1 - Revisiting intrapersonal communication through an interdisciplinary lens

(The published version of this chapter can be viewed [here](#))

1 - Introduction

As you begin your day, you may first think through a to-do list of action items. Perhaps you have a meeting and find yourself imagining an interaction you expect to have there, rehearsing possibilities and considering how your words may be interpreted. Or you may simply imagine a sequence of viable conversational topics. Whether this sequence has an imaginary listener or not may be irrelevant—you are merely brainstorming to yourself. You may have many ideas that you can sense, but they fail to take form until you express them internally with language. These mindful moments, and perhaps other behaviors and experiences, have at times been referred to as *intrapersonal communication*. In intrapersonal communication, we engage in information exchange within ourselves in ways that may influence our own actions or thoughts. This concept applies communication theories to processes that unfold within a single individual. A simple and provisional definition is that it involves information generation and transmission such that sender and receiver are the same cognitive agent.

The study of *interpersonal* communication has long been influenced by the sender-receiver, or code model (Shannon, 1948). This familiar formulation frames communication as a sender transmitting a message to a receiver through a noisy channel. The sender has the intention of influencing a receiver of this message to provoke some understanding or action, the receiver decodes the message, and from there communication continues (e.g., Schramm, 1954). Later formulations included various features that might impact communicative action, including social context, emotions of the participants, and different modalities working

together. There have long been challenges to this paradigm across many disciplines influenced by the sender-receiver model, including basic questions such as whether animal signals have inherent meaning, or to what extent language explicitly encodes speaker meaning (e.g., Gernert, 2006; Rendall et al., 2009; Sperber and Wilson, 1996). Despite these challenges, Shannon's multiparty format, with separate senders and receivers, comprises the defining criteria of the term “communication” across a wide variety of disciplines.

Intrapersonal communication seems like an *edge case* for the general concept of communication, because it challenges Shannon's multiparty distinction. Debates about how to define communication generally can be framed using edge cases that go beyond conventional domains of study (e.g., Cushman and Whiting, 1972; Craig, 1999). An example edge case is whether we should include communication with the self as consistent with a definition of communication. Outside of social interactions, we often experience a process akin to communication: we engage in verbal thought, speak aloud in isolation, write in journals, and so on. While many of us can relate to self-directed communicative behavior, the literature on the topic remains sparse and largely disjointed. Indeed, there is no unifying standard to encapsulate these behaviors (though see Vocate, 1994), and attempts at establishing a field of intrapersonal communication have been met with resistance (Cunningham, 1992; Hardy, 2006).

Whether intrapersonal “communication” is suitably named, this definitional problem has not otherwise been solved. There is a long-standing discussion to define communication as a general concept to underpin an emerging scientific enterprise. Over 75 years ago, (Platt 1955) asked “what do we mean, ‘communication’?”, seeking a general formulation for teaching and research in an emerging discipline. The result of this exercise was abstract and complex, because “communication” can connote a wide variety of senders, receivers, mediums and underlying

features of each (Platt, 1955). Decades after Platt, (Andersen 1991) and (Motley 1991) still debated over whether communication should be so broadly defined that it is almost impossible *not* to communicate across any kind of mutual social observation (e.g., communicating one's culture with attire, one's desires by movements, etc.).

The concept of intrapersonal communication can also be found in these early debates. (Barker and Wiseman 1966) proposed a model of intrapersonal communication along an internalized vs. externalized dimension. In a subsequent exchange with (Cunningham 1992), they argued that intrapersonal processes should be part of our understanding of communication, whether we call it communication or something else (Barker and Barker, 1992). Many models in communication consider intrapersonal cognitive processes as key ingredients to our participation in communication, even in media consumption, such as the intrapersonal components proposed by Cho et al. (2009). Further evidence for this comes from the growing landscape of computational modeling in communication science in which models are explicitly formulated with underlying intrapersonal processes (e.g., Gong et al., 2023).

Here, our general aim is to make a case for what (Barker and Wiseman 1966) implied long ago: self-directed processes can be classified as a form of communication. Because it challenges the influential multiparty format, it may seem like an unintuitive and bold thesis. Nevertheless, this very concept has been adopted by many researchers across many disciplines, including communication, psychology, child development and more [Ruesch and Bateson, 1951; see discussion in Macke (2008)]. However, we will not revisit prior debates about a general definition of communication. Instead, we will demonstrate that diverse disciplines may inspire reconsidering at least some intrapersonal processes as justifiably included among other forms of communication. Importantly, the case of mindfulness presents opportunity to highlight the utility

for a unified study of intrapersonal communication, given the way it is employed toward a myriad of sensations and modalities, such as affecting experience of pain or offloading verbal thoughts through perspective shifts.

In the next section, we offer a discussion of varied literature surrounding intrapersonal communication as a construct, and then share a series of empirical and theoretical observations that frame an understanding of intrapersonal communication as an adaptive category of behaviors. These will include the psychological and emotional functions of intrapersonal communication, its emergence and psychological development, and uses in day-to-day life. We end on some general theoretical reflections for this process, including how it related to concepts of consciousness and mindfulness.

2 - Background: a varied literature

We begin with a provisional definition: intrapersonal communication is the generation and transmission of information in which sender and receiver are the same cognitive agent. This fairly general definition leaves open important discussions to eventually better define boundaries between intrapersonal communication and other phenomena, such as consciousness and cognition. Consciousness, for example, may be more specific to the feeling of experience, while intrapersonal communication focuses specifically on the information flow that may or may not be volitionally attended to. We discuss one possible framework for determining boundaries in Section 6.2.

One testament to the persistence of the *intrapersonal* communication concept is the many terms associated with it, and the theoretical frameworks it has shaped across many disciplines. In some work, a signaler and receiver contained in one individual or entity is termed

autocommunication (Broms and Gahmberg, 1983). Autocommunication may describe individuals or organizations, and is used as a way to update the ideal state of self or “produce the information necessary to maintain itself” (Christensen, 1997, p. 200). Autocommunication was proposed by Yuri Lotman as part of a theory of general semiotics (Kull, 2015), and may be considered present even in heterocommunication, or communication between separate individuals (i.e., the traditional model of communication as social).

Research in *intrapersonal communication* takes a similar approach, but while autocommunication tends to appear in culturally specific contexts such as marketing (Christensen, 1997) or the workplace (Morsing, 2006), intrapersonal communication focuses on individual communication and relies less on institutional influences. Intrapersonal communication may also encompass a wider range of behaviors, potentially including dreaming and biofeedback training, for example (Jandt and Beaver, 1973). One major component of intrapersonal communication is imagined interactions, where individuals rehearse potential social communication. In a study by Honeycutt (2019), individuals shared anecdotes of imagined interactions they had. These individuals highlighted the use of intrapersonal communication in rehearsing highly relevant social relationships, such as romantic relationships and conflict.

Many scholars have criticized the notion of treating these processes as “communicative.” In a review and critique, Cunningham (1992) posed a summary view of intrapersonal communication as a field of study and raised several conceptual challenges to its inclusion within communication. First, it was noted that in intrapersonal communication an individual is treated as a plurality, and suggested rather that intrapersonal communication lacks “a community of at least two persons,” (p. 605) as well as other features such as the sharing or transfer of meaningful or informative messages. Second, Cunningham also criticized empirical methodologies of

intrapersonal communication, and pushed back against the inclusion of inner processes, such as physiological influences. But he suggested that any externalization, such as language used to talk overtly to oneself, “[disqualifies] itself as an inner, self-contained exchange” (Cunningham, 1992, p. 608).

Cunningham's critique is clear and incisive, but these two main points of his criticism can be addressed. Consider, for example, the concern about individuals treated as a plurality. There are many studies in cognitive and neural science suggesting internal processes do have this quality. For example, binocular rivalry studies in which different images are shown separately to left and right eyes have shown that information can be available to some but not all subsystems in the brain (Lau, 2022). Relatedly, split brain research has shown the many fascinating ways that low and high level information can become disjointed internally by multiple, often non-interacting systems in the left and right hemispheres (for a review see Gazzaniga, 2005). At a higher level, separate mental mechanisms may interact across subsystems of our wider cognitive architecture (Kurzban and Aktipis, 2007). In a recent study, a computer model with simulated agents that have “multiple selves” may help explain aspects of complex decision-making (Dulberg et al., 2023). Indeed, it would be surprising if mechanisms used to deliberate with the self do not have any function, such as potentially unifying information across domains.

Consider the second of Cunningham's criticisms, that studying “internal” processes is somehow disqualifying. While certainly some modalities of self-communicative behaviors are inaccessible to current research methods, language does provide opportunities to understand how we perceive our own intrapersonal communication, such as hinting at various hidden individual differences (cf. Lupyan et al., 2023). In fact, understanding the aspects of intrapersonal

communication that remain elusive will be informative to interpersonal communication itself. As we communicate with others, we are mostly aware of what we are communicating, we monitor how it may be interpreted, and how it represents us—we are not completely unaware to the influence of our own utterances (Giles, 2016). Aspects of mental traits or states can trickle into linguistic styles and other dynamics may be informative, as we will discuss in Section 6.2.

Intrapersonal communication may in fact unify several concepts that are immensely meaningful to everyday experience. These concepts have been widely discussed by philosophers of mind, who take interest in the potential division between internal (mental) and external (social, situational) processes for understanding how human experience emerges and evolves. Yoshimi (2012) summarized this philosophical debate, and offered an alternative theoretical perspective that unifies them: conscious experience is a coupled function of intrinsic (mental) dynamics and the impacts of external social and situational domains. In such debates, intrapersonal communication would be valuable to develop as a systematic empirical study. It can be integrated with this and many disciplines as a distinctive contribution of communication research which seeks to understand the exchange and influence of information across many sorts of acts of communication and many distinct kinds of parties involved. Cunningham's important criticisms provide valuable launching points for revisiting and further developing this broader area of intrapersonal communication research. From here, this range of behaviors may be better situated in the communication landscape.

The National Communication Association changed the name of “The Commission on Intrapersonal Communication Processes” to “The Communication and Social Cognition Division” in 2001 (National Communication Association, 2023). This decision framed social cognition as a dimension of broader intrapersonal communication and may have been aimed at

opening new avenues of investigation that link cognition and communication. Presently, the International Communication Association does not have a clear division where research relating to intrapersonal communication could be reported. It could be argued that these disciplinary structures are meant to isolate social cognition as a specific *aspect* of communication and not necessarily a phenomenon of communication itself. Still, these decisions abandon a wider understanding of a complicated yet widely recognized inner mental ecosystem, favoring proximate description at the total expense of ultimate explanations.

There are many terms that appear best unified under intrapersonal communication, with varying descriptors across relevant literatures including autocommunication, imagined interactions, inner speech, private speech, self-talk, and more. Different terms appear more common in certain domains, such as “private speech” examined in studies of young children's intrapersonal communication (Alarcón-Rubio et al., 2014). In general terms, these various concepts can be subsumed under one notion: our personal thoughts can have the appearance of internalized communication. They may be overt, subdued, or covert vocalizations produced in isolation, written forms such as journaling and thought-listing, and more. As such, intrapersonal communication will be defined here as communicative behaviors or processes where the sender and receiver are contained within an individual (cf. Ruesch and Bateson, 1951).

A casual search across various literatures yields many instances of these concepts. While a systematic review permits certain search criteria and hypotheses in advance, our initial survey of this concept across various literatures led to clear challenges to this approach. For example, the very terms associated with intrapersonal communication, its effects or covariates and so on, are all quite varied across these literatures. For this reason, we engaged in an exploration of related concepts across these literatures and organized these observations in the present review.

Indeed, with these findings in hand, it may be possible to conduct a more systematic inquiry scanning the journals and topics summarized in Table 1. Despite these wide ranging concepts, they rarely appear in communication journals. A search in the Web of Science, for example, revealed that communication journals rarely published work related to concepts like inner speech, private speech, or self-talk, despite their conceptual relatedness to intrapersonal communication (Table 1). Here, we have selected a few of the concepts that appear in the literature and have clear connections to communication given their linguistic nature—certainly, several other concepts that may be considered intrapersonal communication could show interesting patterns in where they are or are not published. However, we suspect if even self-talk and inner speech are underrepresented in the field of communication, it is unlikely that other concepts such as mindfulness would be more prominently featured.

Table 1 – Top ten journal topics per search term

	Intrapersonal communication	Inner speech	Private speech	Self-talk
1st	Education Educational Research	Neurosciences	Psychology Developmental	Sport Sciences
2nd	Communication	Psychology Experimental	Education Educational Research	Psychology Applied
3rd	Psychology Multidisciplinary	Psychiatry	Linguistics	Hospitality Leisure Sport Tourism
4th	Public Environmental Occupational Health	Psychology Multidisciplinary	Psychology Experimental	Psychology
5th	Psychology Clinical	Psychology	Psychology Multidisciplinary	Psychology Multidisciplinary
6th	Social Sciences Interdisciplinary	Linguistics	Language Linguistics	Psychology Clinical

7th	Health Care Sciences Services	Philosophy	Psychology Educational	Education Educational Research
8th	Family Studies	Psychology Developmental	Psychology	Psychology Experimental
9th	Psychology Social	Education Educational Research	Rehabilitation	Psychiatry * (tied with Psychology Experimental)
10th	Health Policy Services	Clinical Neurology	Law	Psychology Social

The top 10 publication areas represented by articles listed on the Web of Science as of April 2024, based on search term. While communication appears as a top publication category for intrapersonal communication which may be simply because the word “communication” is present - inner speech, private speech, and self-talk all do not show communication as a main topic at all. Even for intrapersonal communication, communication is secondary to educational research.

Regardless of these varied notions across disciplines, so many potential manifestations of intrapersonal communication suggest they could play an important role in our social cognition, communication, and beyond. Here, we will cover a wide range of intrapersonal communication concepts, most often studied independently from one another, across different disciplines, and without much consideration of the *communication* aspects in particular. We will explore different contributions to intrapersonal communication from these various fields, in an effort to highlight how a unified study could combine existing work to most effectively build on further investigations. Inspired by the broad array of disciplines in Table 1, this review develops an interdisciplinary approach, integrating research from multiple fields to gain insight into any such unified phenomenon. In the following section, we first suggest that evolutionary and developmental evidence supports the idea of intrapersonal communication as a valuable adaptation, one that may even guide our understanding of human consciousness.

3 - Functions of intrapersonal communication

Several high-level cognitive processes are likely important to human functioning, such as metacognition (our ability to think about thinking) and our capacity for theory of mind (to reason about the mental states of others) (Baron-Cohen, 1999). It may be that intrapersonal communication itself serves related adaptive functions. What use would we have for intrapersonal communication processes? In this section, we present an evolutionary inspired survey on why intrapersonal communication is a viable concept by considering its potential functions.

3.1 - Information search

One highly relevant domain of study in cognitive science is internal foraging or search (Todd and Hills, 2020). We engage in mental foraging routinely, looking for concepts or ideas to formulate our thoughts and communications. For instance, if asked to list all the animals one can in a limited amount of time, individuals may internally search across various topics, from farm animals to a new category such as common household pets. When people do these cognitive tasks, their behavior tends to have many statistical features of a physical foraging process (Todd and Hills, 2020). Just as we engage in exploitation of resource rich environmental patches, and explore when seeking more resources (such as when a patch has been depleted), we engage in similar patterns exploring mental space. Given these similarities between external and internal foraging, self-awareness may have its origins as a mechanism for distinguishing mental and external foraging. Hills and Butterfill (2015) proposed that it was adaptively advantageous to distinguish resource foraging thoughts from the real external environment, resulting in the evolution of self-awareness or “the capacity that allows adult humans to mentally represent to become aware of their protracted existence across subjective time” [quoted from Wheeler et al.

(1997) in Markowitsch (2003), p. 181]. Tooby and Cosmides (2001) took a similar approach to the construction of fictional worlds where reality and fiction must be effectively distinguished, and people are able to move effortlessly between such representations with minimal confusion.

The possibilities introduced by intrapersonal communication would be limited only by the imagination of the self-communicator. Creating a kind of internalized fiction allows imaginative possibilities to be explored and may benefit the maintenance and development of mental processes much like exercise works the body, or choosing a habitat works the external world (Tooby and Cosmides, 2001). This capacity, rather than being explicitly socially oriented, benefits the individual in all domains in which decisions shape outcome payoffs. With greater abilities to volitionally forage creatively in the mind, such as through language, the possibility space can be quite large.

3.2 - Imagined interactions and versions of the self

The adaptive benefits of imagined interactions (IIs) may be easy to recognize. These rehearsed social engagements could constitute a major aspect of intrapersonal communication. For example, imagined interactions allow for the processing of norm violations (Berkos et al., 2001). In one study, students encountered one of three instances of teachers violating norms (i.e., being incompetent, offensive, or indolent) and were asked to report IIs with the target teacher as well as the likelihood they would actually engage in said interaction. First, when asked about general use of IIs to cope with norm violations, students significantly used IIs relative to a theoretical mean. When using IIs to process the norm violations presented in the study, they used them in the place of real-life interactions. As such, the imagination can facilitate both exploration and avoidance of possible interactions.

This socially guided processing can be applied to the self as well. IIs may also involve different versions of the self. The dialogical self, proposed by Hermans (2002), involves internal dialogues or conversations, considering models (such as real-life social partners, or fictional or distant others) to shape one's internal interlocutors. The dialogical self-perspective is necessarily social in nature, and generally extends to representations of society, culture, and history in seemingly infinite internal selves (Hermans, 2002, 2003). The interlocutors within the dialogical self may include specific roles, such as Faithful Friend, Ambivalent Parent, Proud Rival, and Calm Optimist (Puchalska-Wasyl, 2015). Such techniques of separating out aspects of the self have proven valuable in the clinical realm, supporting the notion there may be distinct functions for intrapersonal communication, particularly self-talk (Schwartz, 2013).

Self-talk also appears to feature a variety of interpersonal styles employed under different affective states (Lefebvre et al., 2022). Some self-talk may serve self-management, self-critical, self-managing, and self-assessing functions (Brinthaupt et al., 2015). It may serve performance as well, such as motivational and instructional self-talk, considered especially in sports psychology (Hatzigeorgiadis et al., 2004) and addressed further in Section 5.2.

Connections of self-talk to clinical psychology go back to Freud (Lapsley and Stey, 2011). The ego includes unconscious monitoring and suppression of the self, which logically extends to self-deception. Von Hippel and Trivers (2011) suggested that self-deception may facilitate social advancement by allowing for deceptive self-inflation. Similarly, Goffman (2004) posed the self as performative, where we engage in behaviors specifically to modulate others' perception of us. Intrusive thoughts provide an interesting example of dissonance within the self—while we may recognize these thoughts as generated from ourselves, we do not necessarily volitionally send these thoughts out, and we often do not wish to identify with them. However,

suppression is associated with increased intrusiveness, and leads to increased levels of distress (Marcks and Woods, 2005). Cognitive dissonance provides a similar example of tension within the self, where we make a change to our beliefs or behaviors to resolve the discomfort of such inner conflict (Festinger, 1957). The existence of self-deception, intrusive thoughts, and cognitive dissonance regulation strategies all imply the existence of a disjointed self and a suite of mechanisms that helps balance different streams of information about the self.

3.3 - Neural functions

Neurological data could potentially provide insights into psychological functions of intrapersonal communication. In neuroimaging, the network of activity occurring when not performing a task may be associated with a default state of mind-wandering (Bar et al., 2007). This default mode network (DMN) may work in conjunction with a frontal-parietal network (FPN) to generate our streams-of-consciousness (Smallwood et al., 2012). As suggested by Smallwood et al. (2012), this pairing of the DMN with a control network such as the FPN permits spontaneous trains of thought to occur. The DMN may also connect thoughts to different mental health conditions. Major depressive disorder, particularly the tendency toward rumination and brooding, is associated with patterns of higher rest-state connectivity (i.e., the DMN: Berman et al., 2011). Understanding the relationship between the DMN activations and intrapersonal communication activities, content, and outcomes may further reveal functions for this internal process. We can consider these internal brain dynamics as a kind of intrinsic intrapersonal process (Stacks and Andersen, 1989).

Verbal intrapersonal communication may link to other social and emotional neural systems. For example, the labeling of emotional faces has been shown to reduce activation in the

amygdala and other parts of the limbic system, suggesting diminished emotional reactivity (Lieberman et al., 2007). Different language-associated regions of the brain may also reflect the different roles of sender and receiver within one individual. As noted by Gibson and Foster (2007), the left frontal cortex tends to be associated with language production, while regions in the left temporal cortex are often associated with comprehension and monitoring of language and self-talk. Research findings with schizophrenic patients who experience auditory verbal hallucinations are consistent with these brain activity patterns. Thoughts also do not necessarily rely on language as evidenced through neuroimaging of individuals with global aphasia who have limited verbal skills (Fedorenko and Varley, 2016).

Our understanding of how different intrapersonal communication methods and modalities operate may also be influenced by what model of brain function is applied. In functionally specialized models of cognition, domain-specificity may support the notion of independent internal entities that could benefit from intrapersonal communication and regulation. However, many of the mechanisms likely to enable intrapersonal communication require higher-level cognitive abilities that integrate and organize multiple lower-level mechanisms. Barrett (2005) proposed an enzymatic computation model where outputs from lower-level systems can be pooled, and then interpreted in specific ways if they match the input criteria for a given “cogzyme,” or cognitive device that operates using a “lock-and-key” style of computation, comparable to enzymes. By this model, there is a dynamic co-existence between functional mechanisms and integrative connections between them, giving rise to a powerfully flexible, and specialized architecture. These cogzymes can be potentially activated by stimuli that satisfy input conditions even if somewhat different from the set of features the device is designed to process (also described as a difference between actual and proper domains of a mechanism) (Sperber,

1994). This plasticity could be by design as a strategy to manage different kinds of perceptual errors (e.g., snake detectors have liberal criteria creating a greater chance of a false alarm than a miss). Intrapersonal communication may be designed to generate such keys to exploit the input conditions of different cognitive mechanisms, allowing the mind to practice responses beyond what is available in the immediate external environment. Given that intrapersonal communication engages imagination, such as mentally traveling through time, space, and abstract possibilities, it may then model real-like experience to tap into mechanisms like social bonding, reward and punishment, and so on.

3.4 - Cross-cultural variation

When considering the functions of intrapersonal communication, it is also valuable to recognize how it may manifest variably across cultures. A study using Brinthaup's US-based Self-Talk Scale (Brinthaup and Dove, 2012) with a Chinese sample found reliability in self-talk being employed for self-criticism, self-reinforcement, self-management, and social assessment (Ren et al., 2016). While the functions and characteristics of self-talk may share commonalities across cultures, it will likely vary as a function of cultural norms of expression. In a study comparing the IIs used by young adults in the US, Thailand, and Japan, some differences were found. First, Americans were found to exhibit more self-dominance, or dominating of conversations in IIs (McCann and Honeycutt, 2006). Valence, frequency, and variety of IIs was also found to vary across these three cultures. However, it is important to note that each of these samples were comprised primarily of urban student populations. Variation in imagined interactions, and likely other self-talk phenomena, should be expected both between and within cultures as the utility of self-talk will be adaptive to the needs of the individual in the contexts they occupy. Even in cases

of psychosis-related acoustic hallucinations, cross-cultural differences have been found (Luhmann et al., 2015), suggesting that a range of intrapersonal communication behaviors and processes should be examined with a wider cultural lens.

Different forms of intrapersonal communication appear across cultures as well. For example, the Shuar of the Amazon sing *anent*, which are used with the intention of influencing outcomes in the world in some form (Rubenstein, 2012). While *anent* can be shared with others (with certain limitations), they need not be explicitly communicative toward others in nature and are not understood by those who have not been taught that specific *anent*. Prayer, a cross-culturally robust phenomenon, may also have connections to intrapersonal communication. While prayer may include the implication of an external communication partner, it generally does not play out with the same turn-taking dynamics of interpersonal communication. No difference in stress levels was found in a study comparing prayer and self-talk, suggesting both may serve similar intrapersonal functions (Belding et al., 2010).

Cultural norms likely shape the strategies for communicating with oneself in ways that may impact functional outcomes. An important trajectory for intrapersonal communication studies is in recognizing what variation is present, as well as where universalities may hint at deeper functions of self-directed communications. Some variation is only just being investigated, even in how different individuals experience their own thoughts (such as a reported lack of inner voice—see Nedergaard and Lupyan, 2024; see also Fernyhough and Borghi, 2023 for some discussion). Through necessary cross-cultural work, a deeper understanding of the possibility space of our self-communications may be possible.

3.5 - Summary

The functions of intrapersonal communication can be consciously engaged, such as searching our memory for information or ideas. It can also be subtle, such as the intrinsic dynamics of the brain while it is not pre-occupied with a task. Cultural variation suggests that self-talk may be a blend of deliberate self-regulation along with possibly unconscious influences of one's cultural context. The functions of intrapersonal communication likely have both conscious and unconscious elements, allowing one to adapt to ecological and social environments. We will consider how these conscious or unconscious elements may help to categorize intrapersonal communication in Section 6.2.

4 - Development of intrapersonal communication

If the functions described above characterize a core psychological contribution of intrapersonal communication, then we may see them emerge systematically during childhood learning, including in the development of various modes of intrapersonal communication.

4.1 - Early development

At birth, intrapersonal communication does not have verbal language as a medium for expression. However, as skills build early in life, different vehicles of intrapersonal communication may unfold. A study with preverbal children aged 14, 16, and 18 months of age found self-regulatory private gestures used during play activity, possibly representing precursors to private speech (Basilio and Rodríguez, 2017). Even newborn infants engage in imitation of body movements, that may be reflective of an initial implicit consciousness enabling subsequent explicit consciousness-related behaviors (Lewis, 2003), such as intrapersonal communication or

self-talk. Mechanisms such as imitation or recognition of the self in mirrors show the capacity for parsing the self from others.

Intrapersonal communication in children typically transforms into private speech (Stanley, 2011), which initially involves vocalizing verbally and overtly to oneself with no intention for an external audience to receive any messages. Infants as young as 5-months-old may also be engaging in deliberate vocal play when alone. In a study by Shimada (2012), infants vocalized for longer durations when left alone by the parent(s), and used significantly more acoustic phrase repetitions. Interestingly, in a condition where the infant vocalizations were amplified in real-time, infants prolonged their vocalizations, altogether suggesting the goal was specifically vocal play rather than elicitation of parental attention (cf. Oller et al., 2013).

4.2 - Debate on developmental trajectories

The nature of early self-talk such as private speech has provoked differing perspectives on the connections to social communication. A Vygotskian perspective on development suggests that self-talk starts in the social realm, moving to internal mental processes afterwards to enable self-regulation (Winsler, 2003). This may be reflected in the tendency for overt (external) private speech to accelerate starting around 3 years of age before withdrawing internally around age 7 (Stanley, 2011). In the transition to internalized intrapersonal communication, partially internalized private speech occurs, with whispered or mouthed speech patterns. This partially internalized speech may have a self-regulatory as opposed to a social function (Alarcón-Rubio et al., 2014).

However, variation in the overtness of private speech may be dependent on context. A recent study using three separate tasks involving delayed sequential memory, selective attention,

and a Tower of London test, found differing degrees of overt speech based on the task (Doebel and Munakata, 2022). For example, age effects (from 5- to 7-year-olds) were only found for frequency of self-directed speech on the selective attention task. A Piagetian perspective, in contrast to a Vygotskian one, argues that children rarely take a social perspective, instead making use of egocentric speech with social speech emerging as a product of developing logical thought (Stanley, 2011). This suggests equating intrapersonal communication to social cognition in communication may be premature or incomplete.

Interestingly, despite burgeoning use of private speech in the preschool years, it is unclear how or when awareness of internal thoughts or streams-of-consciousness develops in childhood. In a task evaluating willingness to attribute active mental states to others, or even themselves, younger children appear to perceive waiting periods as moments where no thoughts are happening (Flavell et al., 1993). In a task eliciting volitional streams-of-consciousness, kindergartners struggled with production compared to fifth graders (Kipp and Pope, 1997). However, pretend play, or pretense, appears during the second year of life, if not earlier, in the form of pretend gestures (Fein, 1981), showcasing that regardless of metacognitively generated self-reports, young children are able to generate fictionalized explorations independently in communication with the self. Evidence suggests the ability to attribute mental states to others emerges by 3–4 years of age or quite earlier (e.g., 13 months) when tasks are not based on verbal measures (Surian et al., 2007), and as such it may be more precise to consider intrapersonal communication as early emerging yet variable as various cognitive capacities unfold (Lewis, 2003).

Understanding variation in intrapersonal communication capacity, for example in volitional control due to self-regulation abilities, may inform future discussion of what counts as

consciousness, what distinguishes human consciousness from potential forms in other species, and how consciousness changes throughout the human lifespan.

4.3 - Emergence of emotional and other functions

Both Vygotsky and Piaget considered self-regulation as a key mechanism relating to the self. While both considered self-regulation from an intellectual perspective, Piaget also highlighted the self-regulation of emotion (Fox and Riconscente, 2008). Research on the private speech of children used in a frustration task showed differences in self-talk usage in relation to emotional valence and regulation strategy (Day and Smith, 2013). For example, even when controlling for regulation strategies, negatively valenced task-relevant private speech, along with higher levels of social speech, predicted higher levels of sadness. Task-relevant self-talk appears to have both positive and negative effects on task performance, depending on various factors.

Greater frequency of overt task-relevant speech may be associated with lower inhibitory control and executive function issues (Thibodeaux et al., 2019). However, task-relevant private speech may be beneficial in cases where the task is neither too simple nor too difficult for the child (Fernyhough and Fradley, 2005). In another study examining the task-relevance of private speech, Mulvihill et al. (2021) found in both a Duplo construction task (i.e., replicating a specific Lego® structure) and a card sort task a high frequency of performance-related content, such as self-instruction, attention focusing, and observational statements. Task performance was particularly influenced negatively by task-irrelevant content. Forethought content, such as motivational language or future planning, was associated with improvements in task performance in some cases.

4.4 - Family and social systems

Given the social nature of language learning, it is unsurprising that the nature of children's self-talk will also be influenced by experiences with parents and other significant individuals in early life. Overall, children who perceive the people in their lives as speaking to them positively use more positive self-talk and less negative self-talk, with the opposite pattern emerging when they perceive others using more negative talk toward them, although sex differences may suggest differing social pressures based on gender norms (Burnett, 1994).

Similarities have also been found in child and parent narratives about traumatic events, even when sampled separately from one another (Alisic et al., 2016). These similarities include length/elaboration, rates of anxiety words, and rates of cognitive words. The makeup of a family may also influence self-talk: the frequency of self-talk, especially self-critical talk, was found to be higher for adults who grew up as only children compared to having siblings (Brinthaup and Dove, 2012). Interestingly, this study also reported a higher frequency of self-talk in adults who had imaginary companions as children. This self-talk also included significantly more self-reinforcing and self-managing self-talk than those who did not have imaginary companions growing up, and suggests positive benefits to imagination that may play a functional role for intrapersonal communication.

4.5 - Summary

Developmental research on intrapersonal communication supports the idea that it is self-regulatory in nature. But there remain a number of intriguing questions about the developmental ordering and origins of the process, as the earliest speech can occur privately, but with potential systematic effects of the child's social environment.

5 - Intrapersonal communication in everyday life

As described above, various functions of intrapersonal communication can be identified in the experiences and behaviors of young children. As a broad repertoire for engaging the self, it should also be flexible under various factors and conditions. This flexibility may derive, in part, from the capacity for intrapersonal communication to manifest itself in both conscious and unconscious processes. Below we cover some exemplars in day-to-day life where this flexibility is present.

5.1 - Cognitive factors and distancing

Self-talk relies on language production and is thus likely to be constrained by priming that directs the flow of thoughts. This mental process can sometimes be very rapid and unconscious. For example, syntactic priming research demonstrates how the processing of one utterance's form influences the processing of subsequent utterances (Pickering and Branigan, 1999). The framing of thoughts in different times, spaces, and perspectives also has implications for the construction of self-talk. In a review by Trope and Liberman (2010), times, spaces, and perspectives that are considered more distal from the here and now and one's identity led to more abstract mental construals. Observations regarding framing are central in construal-level theory. Increased abstraction appears to influence self-talk depending on context. One way psychological distance is achieved is through the use of first- vs. second- or third-person pronouns, and this may impact performance on tasks. For example, when asked to give advice after imagining a specific scenario, individuals who were primed to give advice in the second-person (i.e., using “you” instead of “I”) performed better on an anagram task (Dolcos and

Albarracin, 2014). Distanced self-talk may also enable more rational thought, with a third-person perspective of the self leading to better gains in strategic games (Gainsburg and Kross, 2020).

There is evidence that this distancing factor relates to aspects of health-related feelings and outcomes (Kross et al., 2017; Furman et al., 2020; Oliver et al., 2016; Orvell et al., 2021). For example, third-person self-talk may be a low-effort technique for emotion regulation, with reduced event-related potentials (ERPs) in a marker associated with self-referential emotional reactivity despite no enhancement in an ERP marker of cognitive control (Moser et al., 2017). Third-person self-talk also appears to more strongly influence self-conceptualization than adopting the perspective of a close friend or thinking of the self in first-person, leading to more abstract language (Gainsburg and Kross, 2020).

Distanced self-talk can also occur beyond personal pronoun anchoring. In work on decentering, de-identifying the self with certain aspects of an experience is used in some mental health interventions. Rather than construing oneself as “being sad,” for example, they may instead “have sadness,” minimizing the hold the feelings have on the individual (Bernstein et al., 2019). Temporal framing of thoughts may trend toward the past being associated with depression and the future being associated with anxiety (Pomerantz and Rose, 2014). Circumstances may also matter, such as the life-altering effects of COVID-19, and may shift how temporal framing influences future thoughts (Bainbridge and Dale, 2023). Additionally, the effectiveness of temporal framing as a deliberate intervention may depend case-by-case based on individuals' attachment styles, which could be proxies for baseline tendencies toward proximal or distal psychological distances (Wang et al., 2012). Low-avoidant individuals show less negative emotion and more positive emotion using psychological distancing after reading a threat-inducing scenario, while high-avoidant individuals (i.e., those with psychologically

distanced tendencies) showed no meaningful benefits. While avoidance may be associated with a tendency for further psychological distances, anxiety may lead to closer than average distancing. Both low and high anxiety participants were able to lessen negative emotion through distancing, although only those with low anxiety increased positive emotion through distancing.

5.2 - Contextual variation

Distancing is only one way self-talk can be employed to guide outcomes. As we have seen with research on private speech in children, task-related language can be beneficial, depending on varying details of the context. In the domain of sports psychology research, evidence suggests instructional self-talk may increase precision on tasks, while motivational self-talk may benefit strength and endurance (Hatzigeorgiadis et al., 2004). Motivational self-talk of athletes using a stationary exercise bicycle was shown to reduce time to exhaustion as well as reducing ratings of perceived exertion when partway through this physically exerting activity, permitting greater endurance (Blanchfield et al., 2014). This suggests self-talk is guided by context. Being in an autonomy-supportive environment (e.g., giving rationale, validating the participant's perspective) lead to greater use of positive emotion words, fewer negative words, and fewer first-person references in a think-aloud task compared to being in a more controlled environment (Oliver et al., 2008).

Our streams-of-consciousness may also be constrained by cognitive load. For example, when exposed to stimuli at a faster rate, or with greater short-term memory loads, task-irrelevant thinking and visual imagery are lower, hinting at limitations to mental foraging when cognition is tied up elsewhere (Antrobus et al., 1966). The common experience of mind-wandering may relate to intrapersonal communication, and it is also influenced by working-memory load

(Soemer and Schiefele, 2020). Tip-of-the-tongue phenomenon, where problems accessing a specific word is subjectively felt, also presents an example of where streams-of-consciousness may become disrupted, particularly when verbally guided. Tip-of-the-tongue has signatures of greater cognitive load, with greater pupil dilation during failures to retrieve a tip-of-the-tongue answer (Ryals et al., 2021). While mind-wandering might not be inherently bad, it seems to be best served when other processing is not necessary. Similarly, when other tasks demand cognitive power, mind-wandering may be particularly disruptive (see also Jones and Langford, 1987; Soemer and Schiefele, 2020).

Intriguingly, the growing practice of mindfulness may relate to intrapersonal communication. Mindfulness does not necessitate language, and indeed often recommends avoidance of verbal mind-wandering by transferring focus elsewhere (Creswell, 2017). Mindfulness often applies attention to in-the-moment sensations and experiences (both internal and external), which can include the observation of verbal thoughts but aims to anchor against the streams-of-consciousness. The focus on physical sensations in mindfulness practices appears as one way to shift intrapersonal communication from uncontrolled verbal streams to interoceptive or exteroceptive (i.e., external) awareness. Interoceptive awareness, or the awareness and evaluation of the body's physiological workings and state, appears higher for those who are also high in dispositional mindfulness (Hanley et al., 2017). It may therefore be possible to adapt one's self-communicative mindfulness willfully. Deliberately observing physical sensations can help tune dispositional mindfulness, which in turn can improve benefits of using other modalities of intrapersonal communication, such as writing to the self (Quaglia et al., 2016).

5.3 - Summary

As suggested by the function and development of intrapersonal communication, cognitive features also reveal a variety of mechanisms that may support it. An unconscious process like linguistic priming may shift and guide intrapersonal thinking, while active and deliberate engagement may help people shape their own internal processes.

6 - Discussion

Intrapersonal communication represents a collection of rich phenomena, developing systematically, varying cross-culturally, and subject to conscious and unconscious cognitive processes. Some research illustrates functionality in intrapersonal communication, which can be valuable when considering how these behaviors may be adaptive (and indeed, future work may consider these functions when exploring non-human animal behaviors that may serve similar purposes). Information search and mental foraging could reflect adaptations for navigating complex external environments. Social mechanisms moved internal might function to manage aspects of the self and interface with external norms, such as through imagined interactions. When inner selves come in conflict, cognitive dissonance and self-deception may emerge. Neuroimaging work might provide insights into how intrapersonal communication can be neurally implemented, with some promise in looking at the default mode network, as well as emotion and language relevant regions. Current and future cross-cultural work will provide important insight into what should be considered intrapersonal communication, and where possible boundaries should be drawn.

The early emergence of private speech, and even private gestures in preverbal children, suggests the importance of intrapersonal communication during development. Intrapersonal

communication connects to task performance and emotional regulation in children. As work in the development of intrapersonal communication diversifies across modalities, interesting implications for future mental health and behavioral outcomes may emerge. Performance and endurance in sports and other physical activities can be influenced by self-talk and other mindfulness practices, but how does our adult intrapersonal communication landscape manifest or become constrained by our early-life experiences?

We argue that the appearance of so many behaviors and capacities resembling intrapersonal communication suggests it is a viable concept to be studied as part of communication science. But to bring further coherence to the concept, there are at least two important next steps in this enterprise. First, the approach is theoretical in nature, such as how we situate intrapersonal among other forms of communication, and systematically relate these concepts across academic disciplines. The second step is methodological, integrating research into a well-understood toolkit to measure intrapersonal communication. We consider these two puzzles of integration in the next sections.

6.1 - Integrating theory

Theoretical approaches to communication such as information theory (Shannon, 1948) provide an initial perspective on how intrapersonal communication might operate. In some of our self-directed communication, we are deliberately sending and receiving the messages of our thoughts. For example, imagining social interactions or deliberating with yourself to conclude your opinion on a topic may appear similar to interpersonal communication. There may even be strong modality effects, such as imagining the tone of your inner voice, as it tells you how you might feel about current events. Perhaps the noise in this internal channel is made up of other

voices or ideas popping up, interrupting your thoughts. Actively attending to thoughts allows one to receive some potentially coherent message, allowing for desired behavioral or information-state changes. Some intrapersonal communication may involve less awareness, however. To better understand the variation of behaviors that may be classified as self-communicative, researchers should consider conscious involvement in various aspects of the sending and receiving of messages with the self. While total lack of conscious involvement may constitute mere cognition, active engagement in sending, receiving, or completing a full communication chain could be distinct enough to qualify as intrapersonal communication.

Theorists should also consider why and how intrapersonal communication is even possible. This includes considerations from the previous sections, as well as how novel information may be possible to generate and communicate with the self. Under the stochastic generation of information, it is possible to derive novel combinations of ideas, processing, and reevaluation (see Coutanche et al., 2020 for a review). But the level by which the self-communicating entities are defined also matter. These levels can be defined at the micro scale (such as neuronal communication) but also, at least theoretically, between multiple “selves.” While communication-like processes do occur between individual neurons, this level may not be especially meaningful on its own for representations of self-hood or other major cognitive or behavioral outcomes. Instead, at a higher level, it is likely more aggregate, emergent cognitive phenomena that underlie this capacity to “inform the self” through internal dynamics.

Future models will be able to present this capacity across levels of entities, such that neuron to neuron, brain region to region, self-representation to alternate selves, and even interpersonal systems, may all be linked. Questions of this nature may initially be beyond the scope of intrapersonal communication as a discipline of empirical study, but this does not

necessarily rule out multiple levels or conceptions of selves that communicate intrapersonally. Rather, certain levels should be considered the primary thresholds necessary to constitute communication with the self (as opposed to being the mere raw ingredients affording intrapersonal communication). Theories of intrapersonal communication thus would benefit from considering theories of self and identity (McAdams and Cox, 2010) to determine meaningful categorical boundaries.

6.2 - Active/inactive sender-receiver model

To better understand how different modes of intrapersonal communication might operate, an adapted model of communication should clarify how a sender and receiver exist within the self. Here, we propose a preliminary framework that enables the self to be engaged as sender and receiver. As mentioned earlier, the sending and receiving can be differentially conscious or “active,” in that the process may be one involving active awareness and effort. In some situations, we become particularly tuned into signals we observe within, taking on a more actively engaged role as the receiver to these messages. Other times, we deliberately formulate signals of information with the intention to have influence on the self—for example, through journaling or production of overt speech. These sender and receiver roles constrain how intrapersonal communication influences behavior or reveals inner psychological or mental states. Similar approaches to traditional, interpersonal communication have been explored to understand sender- vs. receiver-focused perspectives (Andersen, 1991). This includes exploring instances where the sender may be intentionally or unintentionally sending signals, or a receiver being receptive, incidentally receptive, or non-receptive. Is communication dependent on someone receiving an intentionally sent message (e.g., Scott-Phillips, 2008)? If so, it suggests

intrapersonal communication should also be considered communication. Examples of behaviors that represent different self-directed sender and receiver activations are presented in Table 2.

Table 2 – A matrix of self-communicative behaviors where the individual may take active or inactive sender and receiver roles.

		Receiver	
		Active	Inactive
Sender	Active	Imagined interactions, simulations, conscious sensory imagery (including visualization, aural imagery, interoception, etc.), overt self-talk (e.g., spoken, written), lucid dreaming	Spontaneous thoughts that are not appraised or attended to (but one could become aware of by activating the receiver role).
	Inactive	Dream recall, hallucinations, intrusive thoughts, emotional appraisal	Dreams not recalled, cognition, intangible thoughts such as implicit associations, biases, or unattended emotional responses

This matrix is analogous to Fig. 1 in Andersen (1991) explaining communication that is intentionally versus unintentionally transmitted or successfully versus unsuccessfully received. Like interpersonal communication, intrapersonal communication may vary in nuanced ways based on the effect it can have on the sender and/or receiver contained within the singular individual.

Active sender/active receiver represents the most involved model, where communication within the self is explicit and intentional. Imagined interactions represent a fairly even distribution of focus as the sender and receiver, as the interaction plays out dynamically with consideration of potential interpretations a receiver of the signal may have, as well as how this then feeds back into the subsequent turn of the original sender. Overt intrapersonal communication, whether spoken or typed, also likely constitutes an active sender and active receiver model, as the act of making intrapersonal communication tangible forces the self to receive the message.

While the self can still be influenced by the behaviors listed as active sender/inactive receiver, the role of receiver is inactive and lucid interpretation is not engaged. This category may be the least distinct, as the act of sending a message with awareness likely activates the receiving role more so than other inactive positionings. However, thoughts can often be generated without engaging reappraisal, leaving the role of receiver limited as it is not then taking a subsequent turn as sender in a hypothetical internal interaction. Indeed, one may become active as receiver after the fact, becoming retroactively aware of a thought that had already been generated. While the matrix in Table 2 represents a simplified sender-receiver model, the feedback relationship between partners in traditional, dyadic communication interactions is likely to play out in intrapersonal communication as well. If we indeed are able to influence ourselves via intrapersonal communication, the model is interactive.

In some cases, one may deliberately shift these roles into active positions. For example, mindfulness meditation draws on existing active signals of sensation within the body and activate the sender role by using thought to shift the experience of those sensations. Other strategies of mindfulness may activate the receiver role, such as by calling attention to sensations that have been otherwise undetected—vibration sensations in the hands or feet, for example. Varying the activation of these sender and receiver roles may provide different benefits based on the functions of an intrapersonal communication act. Mindfulness can also exploit other modalities—generating visualizations such as rivers or dissipating clouds to observe the flow or releasing of thoughts. Of course, this also includes self-talk, such as assessing and discussing our pain with ourselves (cf. cognitive appraisal: Ramírez-Maestre et al., 2008).

While most of the literature connecting to intrapersonal communication focuses on self-talk, better integration with the study of mindfulness is a valuable first step toward clarifying

the boundaries of our self-directed communication and factoring in the richer possibilities multiple modalities provide. Indeed, the preliminary taxonomy in Table 2 may suggest ways of organizing different sorts of cultural experiences around mindfulness. Prayer, for example, can represent an active-sender model while opening dialogue or reflection with objects of religious experience or belief. This activity has cognitive implications. For example, Schille-Hudson et al. (2024) investigated five cultures in their prayer experiences and found that increased prayer engagement altered various cognitive, perceptual and other experiential reports. This sort of work suggests that mindfulness-related activities has broad applications in day-to-day activities across cultures. Other cultural practices invoke specialized institutions or roles. Hove et al. (2015) showed that an expert Shaman experience may involve a distinct perceptual *decoupling* from external stimulation through active focus with a rhythmic stimulus. This suggests a relatively active-recipient form that has as its attentional focus a single source of stimulus energy.

The framework in Table 2 offers a way of conceptualizing mindfulness and related experiences as a kind of intrapersonal communication where knowledge of the self (or *through* the self) has differential active/inactive forms. Overall, mindfulness may work to shift or enhance the level of active engagement in intrapersonal communication, and future work could directly apply mindfulness interventions in varying modalities or to target varying information streams within the self to assess where self-communication might be more or less effective. For example, mindfulness has shown some promise for regulating mind wandering across several studies including both behavioral and physiological methodologies (Feruglio et al., 2021). Mindfulness could be particularly valuable as a method for shifting information across the framework's quadrants (e.g., from inactive sender and receiver to active sender and receiver). Previous perspectives on mindfulness have noted its value toward self-processing and phenomenological

connection, contributing toward the maintenance of one's self-schema (Vago and Silbersweig, 2012). Dispositional mindfulness has been shown to boost psychological wellbeing through enhancing self-concept clarity (Hanley and Garland, 2017). Mindfulness therefore may provide important tuning to enable intrapersonal communication to occur successfully.

Just as strategies can be employed to make *interpersonal* communication clearer (i.e., reduce entropy by providing the information necessary in a minimally noisy channel), mindfulness may be a primary methodology for doing the same with endogenous signals. It is worth noting that intrapersonal communication does not guarantee successful self-regulation, just as interpersonal communication is not guaranteed to achieve either the sender's or receiver's communicative goals. However, engaging actively in the sender and receiver roles likely provides more potential control over the self compared to not. Future work should explore the role of active/inactive engagement as the sender and receiver of internal messages, as well as how other features such as modality and vividness of the messages can impact the outcomes of our intrapersonal communication behaviors.

6.3 - Integrating methodologies

To assess all these underlying factors, various methodologies can be integrated into a general study of intrapersonal communication. One of Cunningham's (1992) prominent critiques regarded the difficulty in devising methodologies to study such internal processes. But there are techniques available for such an enterprise, even considering the rich array of studies from evolutionary adaptiveness to everyday functioning that we considered above. As observed in the context of neural capacities for intrapersonal communication (e.g., the default-mode network), indirect measures may be informative such as with brain imaging. Cunningham (1992)

reasonably resists pain perception as intrapersonal communication, but with physiological measurements and deliberate practices such as mindfulness meditation, this rejection of modalities beyond language could miss important nuances. It is likely that the active thoughts across and within individuals spans modalities, and indeed some report a total lack of inner speech (Nedergaard and Lupyan, 2024), making a more holistic view of this self-directed communication landscape necessary. A rough portrait of the potential complexity and multimodality of intrapersonal communication is depicted in Figure 1.

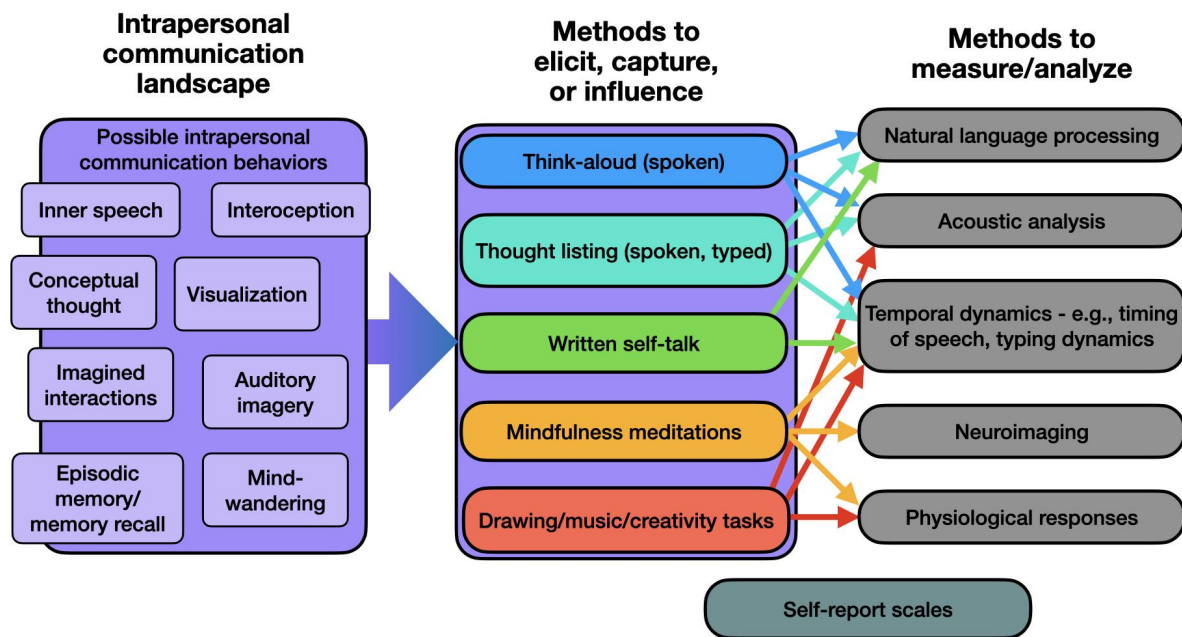


Figure 1. A rough portrait of a methodological approach to intrapersonal communication. We likely self-communicate through a myriad of modalities, which could be elicited or collected in various formats. From there, methodological options for analysis of these communication acts may be applied, sometimes in multiple manners such as the combination of natural language processing with analyses of temporal dynamics.

Below we discuss in more depth some of the existing overt measures that help to index and characterize intrapersonal processes, with an understanding that methodology can and should expand beyond these under the guidance of a unified study of intrapersonal communication.

6.3.1 - Natural language processing

While language may not tap into the rawest form of intrapersonal communication occurring internally in the form of thoughts, it can provide immense value in revealing information about our minds. Natural language processing (NLP) methodology continues to develop as computational tools increase in power and application (Jackson et al., 2022). NLP allows for the quantification of language through varying methods, including sentiment analysis, topic modeling, and more.

Among the simplest but most widely applied NLP techniques, Linguistic Inquiry and Word Count (LIWC) is a frequency-based word categorization library (Tausczik and Pennebaker, 2010). For the past few decades, LIWC has provided a method to study a wide range of linguistic functions, including negative and positive affective tone, temporal focus, and over a hundred other meaningful categories that have expanded with newer iterations. One study employing LIWC on recounts of trauma, told as though unfolding in real-time, found use of death-related words associated with more severe PTSD and depression, and poorer social adjustment after the traumatic event (Alvarez-Conrad et al., 2001). While these associations do not speak to causality, they showcase how word categories used in narratives, and other forms of verbal intrapersonal communication, can reveal mental-state information about the signaler.

LIWC can also analyze dynamics in the form of narrative arcs, such as how text flows across cognitive tension, staging, and plot progression. These measures reveal trends in different linguistic contexts, with unique signatures found for TED talks, newspaper articles, Supreme Court opinions, and narrative media (Boyd et al., 2020). These signatures of intrapersonal communication remain largely untapped, and will likely vary depending on whether the method

of communicating involves unaltered streams-of-consciousness vs. more structured and edited journaling. On a much smaller scale, micro-features of real-time typing keystrokes may be meaningful as well. In a review of studies on typing dynamics and emotion detection, Maalej and Kallel (2020) reported that slower typing and higher error rates appeared to indicate negative emotions and stress. Linguistic work may also draw from mathematical concepts such as control theory, where desired behavior is achieved through a feedback loop that reduces discrepancies between a present state and desired state (Carver and Scheier, 1982).

Much of this work focuses on affective computing in the realm of human computer interaction (HCI), and with how much interpersonal communication now relies on digital formats, applications for computer-moderated intrapersonal communication may be just as fruitful.

6.3.2 - Spoken language

In cases where written or transcribed intrapersonal communication is available, NLP techniques can be immensely revealing. However, when intrapersonal communication is spoken, the additional signal provided by the voice itself can also provide valuable information, some of which may be unavailable or cumbersome to convey through typed language alone. Although often coded into data manually, partially internalized private speech is often whispered (Alarcón-Rubio et al., 2014), with whispers exhibiting both lower intensity and a lack of vocal fold vibration (Jovičić and Šarić, 2008). Some of this vocal information is likely the product of physiological influences that shapes vocal features by altering respiration or other production components (Scherer, 2003). High arousal emotions, such as anger, are likely to increase certain acoustic features, including intensity and fundamental frequency mean, variability, and range. In

a study where nurses and nursing school students evaluated mock patient voice recordings, when the content of speech exhibited valence that was dissonant to the voice's tone (e.g., positive content with negative tone), the negative valence more strongly influenced perception and emotional responses (Yogo et al., 2000).

This finding suggests that analyses of content alone, such as transcriptions of speech, will not fully capture the emotional experience of spoken self-communicative instances. What specific features are necessary to infer emotion is unclear. Vocal and facial expressions can communicate a wealth of emotional information, including in contexts devoid of speech or other sources of semantic information (Bryant and Fox Tree, 2005; Laukka et al., 2013). Much of the work on vocal acoustics of emotions makes use of actors, which can call into question ecological validity of true emotional expressions as more variation is introduced through cultural influences (Bryant, 2021). However, in the case of intrapersonal communication, there could be benefits to understanding what features can be deliberately generated to volitionally signal favorable emotional states to achieve positive outcomes of overt spoken self-talk.

It might be the case that task performance and emotional regulation will benefit from different modalities or intrapersonal communication techniques, given the added emotional information accessible via overt private speech. A study looking at published essays from major figures and persuasive spoken public addresses found that the oral modality involved more personal references, more first and second person pronouns, and other features of word patterns and lengths (Einhorn, 1978). If persuasion techniques are different across modalities, it could be the case that self-persuasion operates differently orally vs. written as well.

6.3.3 Think-aloud paradigm

One existing method for studying thoughts presented vocally is the think-aloud paradigm. Often used in the testing of computerized user interfaces, think-aloud involves speaking one's thought process aloud, typically as one performs a task such as navigating a website. Some scholars debate the validity of using such paradigms, often assuming the speech process disrupts the main task of interest, such as website navigation and perception (Cooke and Cuddihy, 2005).

Despite these concerns, think-aloud as a standalone paradigm might provide an informative window into intrapersonal communication. An association between negative, past-oriented, self-focused language, and rumination tendencies in spoken language (Raffaelli et al., 2021) appears to match similar findings in typed paradigms, which link “I-talk,” or self-focused language, to depression (Berry-Blunt et al., 2021). Some research also suggests overt vs. covert self-talk are equally beneficial for performance on tasks, although in a sample of patients with rheumatoid arthritis, written disclosure showed more potential influence than spoken disclosure (Lumley et al., 2011). Related research has used experience sampling in which a participant is prompted at regular intervals throughout a day to provide data (Van Raalte et al., 2019). This could help to evaluate mind-wandering tendencies (Stawarczyk et al., 2011). Different paradigms for eliciting self-talk may thus result in different styles of intrapersonal communication as well.

6.3.4 - Survey-based research

To understand the nature of intrapersonal communication, several questionnaire-based scales have been developed and tested. Some questionnaires examine the content of self-talk such as the Inner Speech Report, where one self-reports a list of as many topics of their self-talk as they can (Uttl et al., 2011). The Inner Speech Report parallels the thought-listing technique, which

involves listing out all thoughts relating to some constraint, such as during a specific duration of time (e.g., “list all the thoughts you had while completing this past task”), and can include additional evaluations, such as reviewing one's own thoughts and tagging them for valence or other attributes (Cacioppo et al., 1997).

Other self-talk measures involve rating scales in response to targeted questions that provide context such as the Self-Talk Inventory, which presents imagined scenarios and asks how likely they would use different kinds of self-talk phrases (Uttl et al., 2011; Calvete et al., 2005). Uttl et al., for example, compared a collection of such self-report measures, finding internal consistency yet minimal evidence for validity across scales. Using such retroactive report style scales or paradigms are arguably indirect representations of more naturalistic and spontaneously occurring intrapersonal communication.

6.3.5 Strengths and weakness of methodologies

A major barrier to establishing the phenomena of intrapersonal communication in research has been the wide-ranging collection of examples that potentially qualify. This problem is exacerbated by the limitations of methodologies as well. Currently, most related research appears focused on language, but the process of converting whatever endogenous communication is present into overt verbal communication could filter or otherwise alter the form. While spontaneously spoken thoughts used in think-aloud tasks might aim to reduce this conversion, it constrains thoughts into this particular modality and may force a linear trajectory onto thoughts that is not organic. Thought-listing can eliminate the linear trajectory by allowing any and all thoughts be shared (even if they may have co-occurred), the retrospective aspect may lose accuracy of reports, and the act of listing these thoughts in itself represents a stream of

information, where new ideas could falsely be included. Even if these limitations are set aside, the use of natural language processing techniques to infer function within form, such as assigning positive or negative sentiment, assume generalizability. To study something as complex as our inner communication landscape, it is necessary to better integrate a wider range of methods, one of the benefits that could emerge from a dedicated study of intrapersonal communication.

In addition to the methods described above, new empirical insights could be gained through dynamic measurements, such as neuroimaging, physiological measurements, eye-tracking, body-tracking, and more. These dynamic techniques could be used in conjunction with most of the methods reviewed above. Though it is outside the scope of the present review, interested readers can consult theoretical and methodological reviews of such continuous measures in Spivey and Dale (2004), Spivey (2008), and Favela (2020).

7 - Concluding remarks

By taking a multi-dimensional approach to intrapersonal communication, more can be understood about the dynamics of self-awareness in human experience. Future work would benefit from fleshing out the space intrapersonal communication encompasses, considering a wider spectrum of conscious and unconscious variations. This work would build on themes such as context (Brinthaup et al., 2015), content, and modality, while identifying possible dimensions that determine how our self-influence plays out, such as awareness, attention, or perhaps vividness of the endogenous experience. By incorporating work on mindfulness with an intrapersonal communication framework, a unified study could then investigate the ways active and inactive sender and receiver roles within the self shape our experiences with differing levels of success or salience. Methods, theories, and findings from different relevant fields could be

leveraged by each other to delve deep into the potential that various intrapersonal communication behaviors can have on things such as education and mental wellbeing.

As raised by Cunningham (1992), intrapersonal communication as an area of study risks an extreme hypothetical perspective that requires a private language for inner experiences, or at another extreme include the entirety of information within an individual, making the distinction between intrapersonal communication and cognition unclear. The greatest challenge for this area of study remains the defining of meaningful boundaries. The proposed active/inactive sender-receiver framework provides one approach to boundaries by characterizing the active involvement in the internal messages as the defining dimension. The process of activating any communication role within the self may be enough to qualify a signal as intrapersonal communication. However, the case of the self as both inactive sender and inactive receiver leaves ambiguities unaddressed: How should basic cognition be factored into definitions of intrapersonal communication, if at all? Other frameworks may also privilege other criteria over active engagement in these sender and receiver roles. If an internal signal is perceivable but volitional control is limited or nearly inaccessible, such as with auditory hallucinations or dreams without lucidity, then this boundary could remain debatable. However, many of the limitations for the proposed framework are similar to those shared across all communication frameworks.

In intrapersonal communication, we must first consider the scope that defines the “personal” or meaningful entity that this communication occurs internal to. From there, we can focus on intrapersonal communication in the domain of human individuals, though future work should certainly extend beyond humans, considering non-human animals and artificial intelligences. To better understand intrapersonal communication and the forms and functions that occur, frameworks such as the proposed active/inactive sender-receiver model can guide

categorization and inform possible boundaries or limitations. Other possible frameworks could consider characterizing a hierarchy of intrapersonal communications along dimensions such as unconscious-conscious levels, intended-unintended, vividness, and so on. From there, clarification of these mechanisms, their functional potential, and the boundaries around what is and is not intrapersonal communication, may become possible.

Chapter 2 - Thinking about life in COVID-19: An exploratory study on the influence of temporal framing on streams-of-consciousness

(The published version of this chapter can be viewed [here](#))

Introduction

What is the semantic structure of free-flowing thought? How do meanings come up in our thoughts, and how are they linked over time? Human experience is filled with this structure, while we stand in line for our groceries, wait in line at the bus station or even in a moment of mind wandering while conversing with a friend. In this paper, we explore recent events surrounding COVID as a domain to tap into this semantic structure. We devised a “stream-of-consciousness” task in which participants imagined the future beyond COVID, and quantified how their free-flowing thought varied as a function of how they were prompted before this writing. We find that if participants are prompted with the present COVID situation vs. the pre-COVID times, their structure of thought changes. Our exploratory analyses suggest language from the future-oriented responses reflects its temporal priming, i.e., the pre-pandemic vs. during the pandemic prompt that came before. These results offer hints at the semantic patterns that characterize these self-reflections, and how context is central to the forms they take. We end by arguing that a generalized notion of “self-communication” may organize phenomena such as these in intriguing ways.

Background

When the COVID-19 global pandemic spread rapidly in late 2019 and early 2020, major life impacts reverberated globally. These effects were felt across many aspects of everyday life, from direct health impacts to more indirect effects on the economy and social life. People began

referring to life before the pandemic colloquially as the “before times,” and there was a sense of a new normal. These effects were also significant in the lives of younger individuals, such as students, with virtual schooling, diminished social interaction, and limited hands-on learning (e.g., Schlossberg, 2020). Evidence suggests an alarming impact of the pandemic on the mental health of college students, including increased stress moderated by self-regulation efficacy (von Keyserlingk et al., 2022), increased depression and anxiety (Wang et al., 2020), and negative changes to student relationships (Dotson et al., 2022). The effect of perceived threat of COVID-19 on mental well-being appears to be mediated by future anxiety as well, showing the potential to impact mental health in the long run as decisions about the future may be impacted (Paredes et al., 2021). The pandemic thus provides a unique opportunity to study how major events influence perceptions of life and mental health, and their relationship to other dimensions.

To study these perceptions, we investigate how student participants construct a narrative text about their lives. Our approach is inspired by methods used in essay writing and journaling (Pennebaker et al., 2003), self-talk (Vocate, 2012), and think-aloud (Rafaelli et al., 2021). These domains suggest that when we speak to ourselves, ruminate, or reflect on aspects of our lives, our linguistic styles and strategies may be a signature for underlying mental or emotional states and processes. Intriguingly, such intrapersonal communication has been frequently the topic of discussion, yet remains largely an understudied construct. Self-communication occurs when both sender and receiver of a communicative instance are contained within a single individual, such as in dialogical self-talk (Vocate, 2012), and can include transcending across time and space (Hermans et al., 1992). Here we use this process as a source of data about these life perceptions.

While not all aspects of intrapersonal communication may be easily accessible for study, such as the seemingly endless streams-of-consciousness we engage in every day, various

methods have been employed to tap into self-talk through writing or speech. Raffaelli et al. (2021) used a think-aloud paradigm in which individuals are instructed to speak aloud their thoughts. Negative valence in the words used correlated with a narrowing of conceptual scope, such that thoughts became more semantically similar when they were more negative. Social context may play a role, too. Oliver et al. (2008) used a think-aloud task to study mental health outcomes. Changing social context to more supportive environments led to greater use of positive emotion words, fewer negative emotion words, fewer swear words, and fewer first-person references compared to a control condition that lacked emotional recognition or meaningful rationale. Recent work has shown that self-talk also links to mental health outcomes during COVID-19. In a questionnaire study conducted on an Iranian sample, there were significant relationships found between self-talk, death anxiety, obsessive-compulsive disorder, and coping strategies in relation to the pandemic (Damirchi et al., 2020).

As noted above, the onset of COVID for some may present a distinct point in time at which everyday life changed. This temporal effect of COVID may alter the way we contextualize and think about events before, during, and after this distinct transition. Changing the temporal framing of one's thoughts or self-talk may have an influence on the language that we use. For example, construal-level theory hypothesizes that increased psychological distances are linked to increased abstractness of hypotheticals (Trope & Liberman, 2010). The further away something is in time, space, or relatability (e.g., feeling similar to or different from an individual), the further the perceived psychological distance and the less concrete related thoughts become. Similarly, increasing concreteness, such as through writing about a given event, may decrease psychological distance to that event in time (Mrkva et al., 2018). High-level construals, or higher abstractions when mentally representing objects or concepts, may better facilitate self-control,

such as attenuating the impact of future discounting on economic decision making (Fujita, 2008). Following the September 11, 2001 attacks on the United States, entries in an online journaling platform used increasingly psychologically distant language in their daily writings, suggesting major events can impact our relationships with time (Cohn et al., 2001). However, prior work suggests that writing about emotional experiences such as trauma may provide benefits for both mental and physical health (Pennebaker, 1997).

Considering these findings, one might expect that writing about “the before times,” pre-pandemic, would influence how one perceives their future, perhaps with increased abstraction leading to greater possibilities and allowing distance from such a troubling and disruptive event. Relatedly, a focus on life during the pandemic may have negative impacts on one’s perceptions of their future after the pandemic, with lower levels of construal leading to ruminative tendencies.

To test this idea, we collect and analyze a text-based “stream-of-consciousness” dataset. Participants carried out this open-ended response task online, typing in their thoughts about COVID-19 life under different temporal conditions. The task was designed to elicit a naturalistic and uninterrupted flow of thought. Participants were first told to consider and write about life either before or during the pandemic. This prompt (before vs. during) served as a frame for a subsequent writing prompt, where participants were instructed to share their thoughts about a post-pandemic life. This future-oriented prompt is the same for all participants and is the focus of our analysis, and participants only differed in which writing prompt preceded this one (before vs. during the pandemic). This open-ended writing task generates a large and rich dataset of text. We thus took a preliminary, exploratory approach to investigate the influence of this temporal framing on their responses. In the *Analyses* section, we consider prior research that frames some

factors guiding our exploratory analysis, and we introduce the ways in which these texts can be measured and analyzed.

Methods

Data collection was conducted during two separate college quarters: in the first quarter (fall, 2021), classes were hybrid (both in-person and online), with students returning to campus for the first time since the pandemic began. This research was approved by the UCLA North General Institutional Review Board. 134 undergraduate students (female = 95, male = 38, other = 0) contributed data to this first phase of sampling. The second phase of sampling occurred the following quarter (winter, 2022), which had returned to online-only for the first four weeks due to the rapid spread of a particularly contagious strain of the virus, labeled “omicron.” In this phase, 91 undergraduate students (female = 70, male = 19, other = 2) contributed data. The students completed the study online for course credit in an introductory communication course. The goal of the study was to collect a rich dataset for exploratory analyses, and several aspects of the data were not included for analysis. Because of the pandemic-related constraints participants encountered at the start of the winter quarter, we first use this second phase dataset for our main analyses. We then use the fall dataset for exploratory comparison.

The experiment was built using jsPsych (de Leeuw, 2015) in conjunction with <https://cognition.run> to store the data. First, participants encountered a consent page, then click to continue only if they agree to consent to participate in the study. After the initial consent page, participants selected on a slider where in the COVID-19 timeline they considered the current moment to be. For the main portion of the study, participants wrote in a stream-of-consciousness style manner for ten minutes per prompt, responding to three total writing prompts. The first

prompt asked participants to write either as if it is before the pandemic, or as if during the pandemic. Following the initial prompt, participants responded to a similar prompt asking to write as though it is after the pandemic. The final prompt included whichever temporal framing was not responded to in the first prompt. This resulted in two possible conditions: before-after-during the pandemic, or during-after-before the pandemic. Our focus here is on how the before vs. during prompt, chosen randomly as the first temporal framing, influences the way participants write about the future, after the pandemic.

During all writing prompts, a countdown timer was visible on the screen during writing, and on multiple pages throughout the study, mental health resources were provided. After completion of the three prompts, participants responded to questions about demographics, COVID-19 experiences, journaling experience, as well as three individual difference measures: a rumination scale (Treynor et al., 2003), an 18-item adaptation of the need-for-cognition scale (Cacioppo & Petty, 1982), and a social connectedness and belonging scale (Lee & Robbins, 1995).

Measures and analyses

In the analyses that follow we focus on document-wide features, taking an exploratory approach. Linguistic Inquiry and Word Count (LIWC) (Boyd et al., 2022) categorizes the words in a text based on a range of concepts, including emotions, cognitive tension words, causal words. LIWC provides one methodological tool for enabling indirect inferences about mental states. The most recent version of LIWC at the time of analysis features over 100 word categories, capturing a large variable space. This version of LIWC was tested and validated using a “Test Kitchen Corpus” of around 31 million words pooled from a wide range of corpora, including blogs,

emails, movie dialogues, transcribed speech, natural conversations, social media posts, and more (Boyd et al., 2022). Analysis of language data can be challenging due to the complexities at play. However, LIWC has been successful at predicting a variety of psychological and social measurements from language usage. For example, course performance has been generally predicted based on the written self-introductions of undergraduate students (Robinson et al., 2013).

Several of the specific LIWC word categories also map neatly onto well-studied and meaningful dimensions of language. LIWC includes several sentiment related categories, including positive and negative emotion and tone, as well as several discrete emotions, such as sadness, anger, and anxiety. Sentiment of language may provide hints at wellbeing. In one pair of studies, improvements in physical health were linked to a greater use of positive emotion words and a moderate number of negative emotion words (neither very high nor very low), as well as increased use in both causal and insight words throughout a writing task (Pennebaker et al., 1997). Pronoun usage may also hint at different psychological processes. Greater use of first person singular pronouns is associated with interpersonal distress (Zimmermann, 2013), as well as depressive symptoms and negative emotions (Berry-Blunt et al., 2021). LIWC additionally includes categories relating to time, such as a past or future focus, and health categories, all concepts highly relevant for the topics of interest in this dataset. Content words (e.g., nouns, regular verbs, and various adjectives and adverbs) and function words (e.g., pronouns, prepositions, articles, conjunctions, and so on) are also detectable using LIWC, and may reveal information about one's social inclination — the use of function words often requires understanding shared knowledge between interlocutors, for example (Tausczik & Pennebaker, 2010).

For each future-oriented text produced by participants, LIWC generates a set of semantic category measures that reflect the percentage of these categories represented in that text. This can be understood as a multivariate vector of measurements of how positive, negative, etc., a text is based on a calculation of the percentage of words that fall under these categories. To evaluate the influence of temporal framing (i.e., writing about pre-pandemic or during pandemic life in the first prompt) on writing about life after the pandemic, we evaluated the LIWC features present in the post-pandemic documents (the LIWC data for all documents and the analyses script are available at https://github.com/conbainbridge/covid_thoughts). Because LIWC has over 100 of these categories, we face the challenge of multivariate analysis without simply deploying an analysis pipeline on each of the 100 separate dimensions. To conduct a more global analysis of LIWC features, we used principal components analysis (PCA) to determine components that best predict the temporal framing condition. PCA permits the analysis of many intercorrelated variables, characterizing the structure of both the observations in the dataset and the variables themselves (for a detailed explanation, see (Abdi & Williams, 2010)). PCA has been used successfully in prior work to reduce LIWC dimensions (Robinson et al., 2013; Kramer & Rodden, 2008; Baggott et al., 2015)).

PCA thus extracts a conceptual space across all LIWC dimensions, but at a lower dimensionality. Another way to think of this process is that PCA reveals this lower dimensionality based on how normalized LIWC scores cluster across students' writing. For example, instead of the three LIWC features "positive tone," "negative tone," and "emotion," the PCA model may infer that these three features load onto just one principal component (PC). This example is intuitive, but finding clusters across texts and many features yields subtler and more complex patterns of correlation. Our main test is whether these lower-dimensional PCs

distinguish temporal prompts at all. This analysis is done based solely on the post-pandemic-oriented texts, to see how the framing of a preceding prompt may echo into thoughts about the future. Put simply: It would show that participants primed by the past or present (pre- and during pandemic) alter the way they think (or write about) the future.

Results

The PCA recovers as many PCs as there are variables, ranked by the strongest component to the weakest. In cases where the number of participants is less than the number of variables, the number of PCs is limited to match this sample size. Because the winter dataset's sample size ($n = 91$) is less than the total LIWC variables (117), the PCA yields 91 total PCs. The LIWC features cluster across texts as we found a nonlinear rise in PC strength, expressed through cumulative proportion of variance accounted for (Fig. 1). The first 20 PCs account for almost 70% of the cumulative variance in the dataset.

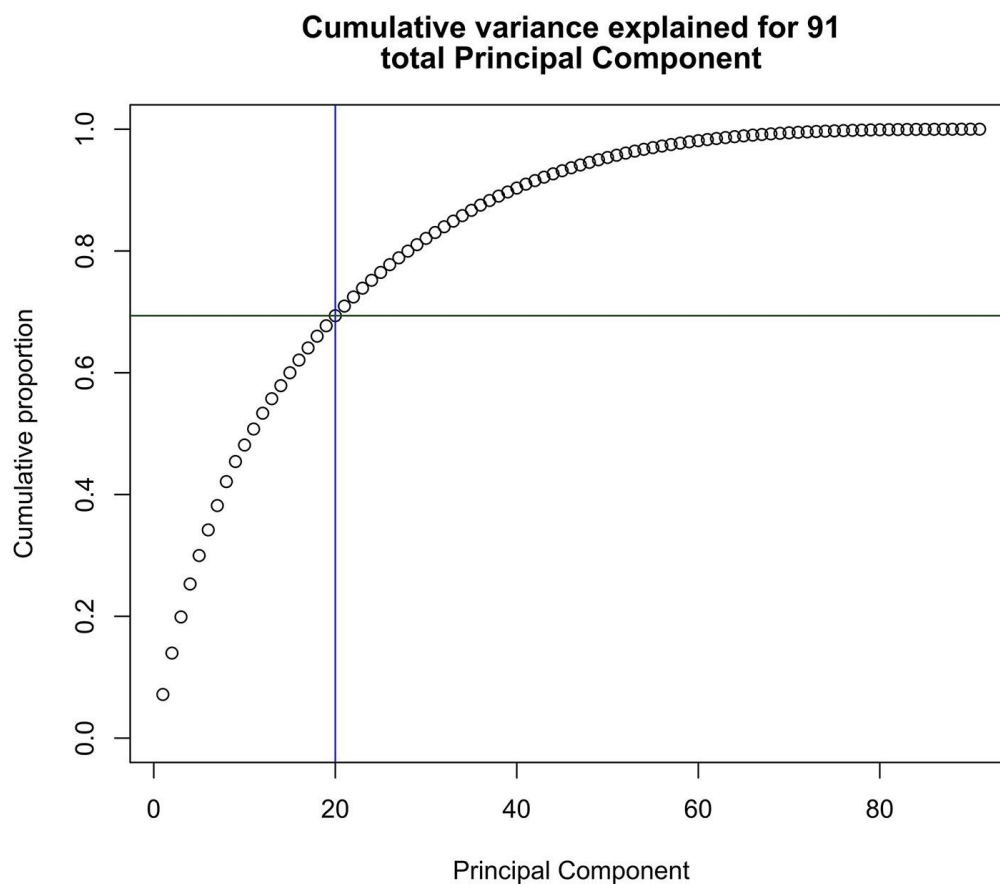


Figure 1: Cumulative variance of the principal components. Of the 91 total PCs, a subset of 20 accounting for approximately 69% of the cumulative variance was taken to determine the most significant PCs.

As noted above, we tested whether these LIWC PCA components from the future-oriented prompt relate to the temporal frame of the prior prompt (before vs. during the pandemic). With a logistic regression predicting prior condition from these 20 components, we found seven PCs that were significant or approached significance. We chose a liberal initial threshold of $p = 0.1$ to ensure we captured a wide range of possible semantic structures in the future-oriented writing. In a secondary generalized linear model, six of these remained

significant (PCs 1, 4, 5, 10, 11, and 13). We also included the seventh (PC18) in our selected components because it trended towards significance in that follow-up model alone. Note that these results reflect coefficients from a single regression model – not independent tests.

The *p*-values for each PC in the model, and the top ten most influential LIWC features per PC (i.e., highest absolute values in loading scores, ordered from most to least influential) are in Table 1. LIWC categories in bold, italic font feature positive loading scores, indicating their tendency to characterize the *during*-pandemic framing, while negative (normal font) loading scores characterize the *pre*-pandemic framing. Loading scores are available in the *Supplementary Materials* section. For details on what the different LIWC categories entail, see (Boyd et al., 2022).

	P-value	Top 10 most influential LIWC features
PC1	* 0.021	<i>Health, Illness, Analytic, Neg. tone, Article, Physical</i> , Pronoun, Social refs, Social, Personal Pronoun
PC4	* 0.027	<i>Space, Aux. Verb, Perception, Allure</i> , Fulfill, Prosocial, Exclamation, I, Insight, Social behavior
PC5	** 0.009	<i>Pos. Tone, Want, Tone, Discrepancy, Pos. Emotion, Emotion, Lack</i> , Past focus, Authentic, Personal pronoun
PC10	* 0.085	<i>Conjunctions, Acquire, Swear, Risk</i> , Communication, Impersonal pronoun, Memory, Sad emotion, Leisure, Lifestyle
PC11	* 0.047	<i>You, Male, Space</i> , Achieve, Death, Work, Cognition, Lifestyle, Q mark, Certitude
PC13	* 0.041	<i>Cause, Time, Future focus, Conjunctions, She/he, Need</i> , Mental, Visual, Perception, Past focus
PC18	0.111	<i>Moral, Impersonal pronoun, Certitude, Motion, Words per sentence, Affect</i> , Need, You, Personal pronoun, Apostrophes

Table 1: The top ten most influential LIWC features for each selected component. The top ten LIWC features for each PC, ordered from most-to-least influential (i.e., highest absolute loading scores), clustered by the condition they characterize. Features in bold, italic font have positive loading scores and characterize the during-pandemic condition, while the features in normal font have negative loading scores and characterize the pre-pandemic condition. Loading scores for these LIWC features are available in the *Supplementary Materials*.

PC5 is the most significant component of the selected components from the generalized linear model. By itself, it is able to predict which temporal framing preceded the post-pandemic prompt, based solely on the linguistic characteristics in that post-pandemic prompt ($p = .011$, Fig. 2). PC5 shows that positive emotion, tone, want, and discrepancy are found more in post-pandemic contemplations when they are preceded by reflections about *during* the pandemic. Conversely, when prompted with *before* the pandemic, PC5 shows focus on the past and use of personal pronouns. Interpreting LIWC loadings may be subjectively influenced, and interpretive assessment must be done with caution. In this particular case, PC5 indicates that thoughts about experience during the pandemic prompt positivity (i.e., the presence of the “positive tone” and “positive emotion” LIWC categories) that is desired (“want”, “tone,” “emotion,” and “discrepancy” – which includes words like would, can, and want). On the other hand, the pre-pandemic priming may focus on what was lacking (“lack”) in the past (“past focus”) and may be expressing themselves more spontaneously (“authenticity”).

An interpretation of PC1 could indicate people think more negatively (“negative tone”) and analytically (“analytic”) about health (“health”) as a result of thinking about the experience of the pandemic (e.g., “illness” and “article”, perhaps the result of noting “*the* pandemic”). Other

PCs may hint at pre-pandemic priming leading to thinking enthusiastically about social life (PC4 – “fulfill,” “prosocial,” “exclamation,” “social behavior”), expressing sadness over remembering one’s lifestyle from the past (PC 10 – “memory,” sad emotion,” “leisure,” “lifestyle,”), or perhaps more episodically inspired thoughts guiding future projections (PC13 – “mental,” “visual,” “perception,” “past focus”). The during pandemic priming may lead to frustration (PC10 – “risk” and “swear”) and one’s needs and their justifications (PC13 – “Cause,” inclusive of words like how, because, and why, and “Need”). Importantly, participants were *not* prompted to contrast the future and the present/past; the temporal prompt simply alters the semantic patterns in their writing, revealed by the PCs shown in Table 1.

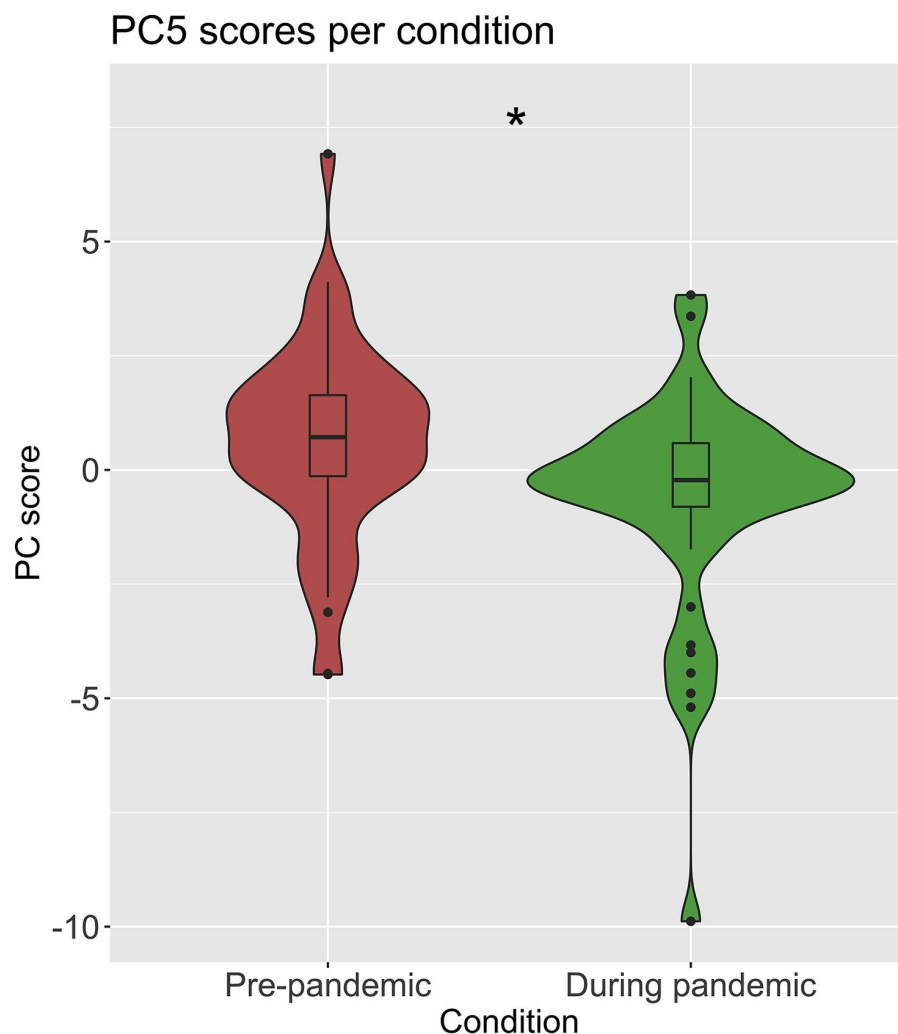


Figure 2: Comparison of pre-pandemic vs. during pandemic priming of future-oriented writing, as distinguished by PC5. The temporal framing of during-pandemic represents the reference condition in green, while the pre-pandemic condition is in red. The difference in explanatory power for PC5 between the two conditions is significant at $p = .011$

One way to quantify these overall linguistic trends is to assess them using network analysis (Hills et al., 2008; Ferrer-i-Cancho, 2005; Teixeira et al., 2021). This method takes the PCs and visualizes the relationships among the LIWC categories. These more visual, geometric relationships among the dimensions may help to interpret the overall shift taking place in participant writing after the prompts. We built a network model using the “igraph” R package to explore which LIWC features are shared across the selected principal components (Fig. 3). The nodes represent the top 50 most influential LIWC features across the selected components (i.e., PCs 1, 4, 5, 10, 11, 13, 18). Edges are formed as the result of shared presence of the linked LIWC features across components, suggesting recurring themes in distinguishing the conditions. The color represents the level of influence that feature has in distinguishing conditions, such that the lighter the purple, the greater the influence across these components. This influence is calculated as the sum of the loading score absolute values for a given LIWC feature across components, and rather than being specific to the condition captures that feature’s overall distinguishing influence.

Therefore, the lighter purple nodes represent features that are more influential across the semantic landscape. The manner in which features cluster may then represent the distinctive set of semantic factors that are combined during our particular task. For example, positive emotion, positive tone, want, tone, emotion, and discrepancy, all features found to characterize the

during-pandemic condition in PC5, cluster together even across these components and appear to hint at longing for better times. Other clusters suggest livelihood elements (work, tech, lifestyle, culture), health (health, illness, physical), and sociality (she/he, friend, affiliation). When a feature within a cluster also exhibits a lighter tone, it may be the case that feature is particularly unifying of the cluster's concepts (e.g., "perception" being linked to "visual" as well as "motion"), although the feature itself may merely have more influence independently. Because semantic graphs of this kind can represent how one "moves" through meaning space (cf. Thompson & Kello, 2014), a potential future application of this network-based technique is to visualize and characterize the set of potential semantic paths induced by a given prompt or frame of mind (Stella et al., 2022). In our case, thoughts about COVID induce particular sorts of ideas, such as health and social connection. When we prompt participants with a prior temporal frame (i.e., pre-pandemic or during), they appear to take different paths on this network. Such methods may facilitate characterization of the streams-of-consciousness and internal thought processes that open this paper. Importantly though, any such graph structure should be compared to a baseline to ensure that we are not interpreting a chance outcome.

To test whether this network was structured meaningfully relative to a baseline, we extracted some measures and performed a permutation. We analyzed the mean degree (number of adjacent edges), mean betweenness (number of shortest paths going through a vertex or edge), and clustering coefficient (probability that adjacent vertices of a vertex are also connected) of the network. The mean degree is 1.92, mean betweenness 29.02, and transitivity 0.49. We then ran the same network analyses on 10,000 random permutations of the normalized LIWC data to see where the original data falls on this random distribution. This is to confirm whether such semantic structure arises specifically as a result of condition, as opposed to random clustering.

The probability of the mean degree in the permutations distribution is .038, .185 for mean betweenness, and .004 for the clustering coefficient. Given both the mean degree and clustering coefficient are outside a 95% confidence interval, this suggests structure meaningfully departs from what would be expected by chance.

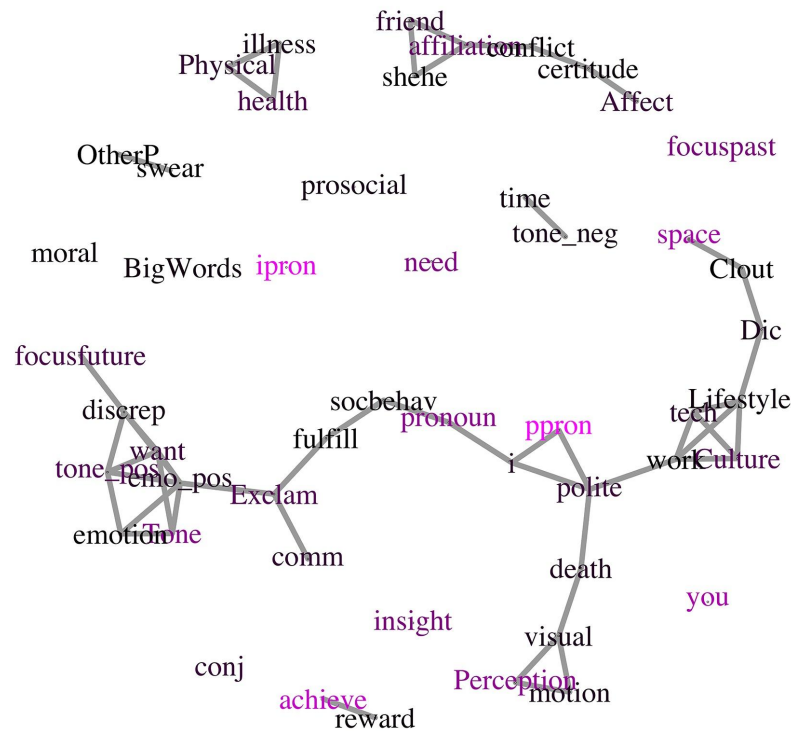


Figure 3: Network of LIWC features shared across PCs. LIWC features are plotted such that an edge is drawn if the features are shared across principal components 1-50. The brighter color the node is, the more influential the feature is in the loading scores of the main selected components (PCs 1, 4, 5, 10, 11, 13, 18).

We next conducted a PCA on the fall (first phase) dataset. Our initial focus on the winter dataset was because we expect a more intensive response from participants – students who just had another disruption to their class activities during more lock down. To match the winter

dataset, we ran a generalized linear model on the first 20 components, which account for 66% of the cumulative variance. Of these 20 components, only PC4 is significant ($p = .008$). The top ten loading scores for LIWC features characterizing PC4 are word count (-0.205), positive tone (0.182), impersonal pronouns (-0.181), death (-0.179), conversation (-0.17), conflict (-0.169), social references (-0.168), anger (-0.161), social (-0.157), and technology (-0.156), with each associated with the past-primed condition with the exception of positive tone. Because there is only one significant PC, we did not conduct network analysis on this dataset. In general, there are some small effects in the fall dataset but far less pronounced than the structure we find in the winter. We return to this below.

Conclusions and Discussion

These exploratory analyses showcase the influence of temporal framing on college students as they envision their post-pandemic lives. Based only on what participants wrote when imagining their post-pandemic lives, LIWC features reduced into principal components can predict which temporal framing participants received. A few significant components hint at different categories of words that aid in making these distinctions. A tentative interpretation suggests that there is an extra focus on health (PC1) and a longing for better times (PC5) when primed by pandemic life, and more socially-oriented thinking (PC4) when primed by pre-pandemic life. In a network analysis, a semantic structure appears to arise, particularly in comparison to a distribution of random permutations of the original LIWC data. Interpretive assessment of the semantic network confirms the results on individual components. This visualization also reinforces the idea that the temporal framing leading into a stream-of-consciousness might shape the conceptual structures that participants work with. These explorations offer an initial foundation for understanding the

influence of temporal thinking, and in this particular study on construing imagined futures after a major global crisis. While interpretations of the components are speculative, the LIWC categories may inform deeper studies into the specific ways COVID-19 has shaped the content of students' imagined futures. Regardless of the meaning behind these semantic spaces, this work highlights that shifts in life triggered by COVID-19 can have an impact on immediate thoughts about the future. With this in mind, interventions may be developed to explore how re-framing thoughts, such as temporally, can encourage shifts where future thoughts may be more hopeful and positive, and less dire or pessimistic.

When conducting PCA on the comparison fall dataset, we find only one component is significant. This could suggest that the winter dataset induced more complex semantics due to the emotional experiences associated with the constricted context, when students returned to remote learning due to the pandemic. Indeed this was our expectation, and motivated our initial focus on that winter data set. However, there are several factors that limit any strong conclusions. First, such environmental contextual influences need to be studied in more depth in future work. These represent just two time points, and a wider sample of data from multiple timepoints may suggest these differences were due to noise. Second, the datasets do have slightly different properties. While the winter dataset had a limited sample size, constraining the total components in the PCA, the fall dataset had a larger sample size, enabling the number of components to match the number of LIWC variables. Because of limited prior work using such methods, we did not have strong priors for an optimal sample size, which may additionally limit power in these analyses. Given our analyses were exploratory in nature, future work will benefit from taking insights gained here to formulate a priori hypotheses and planned analyses.

Priming participants to write in a stream-of-consciousness style seems less common in the literature in favor of journal paradigms, where more editing and refining of language may limit inferences about inner psychological and emotional processes, perhaps especially their dynamics. Nevertheless there are some important limitations to our own design that should be acknowledged. One limitation of the data collection using this paradigm was the online context of the study, which may include extraneous variables that would be valuable to measure and control for in future work. For example, this could include aspects of their state in the moment (e.g., exhaustion, mood), ease of technology use, and the environment when completing the task (such as presence of others in the room). Participants may also have still performed some editing, or struggled to understand or adhere to a free-flowing style of writing. To overcome these issues, it may be useful to integrate content analysis like this with typing dynamics (e.g., Brizan et al., 2015). Indeed, we collected individual keypresses and timings, including the use of the delete key. It may thus be possible to reconstruct some deleted content, and give a full portrait of the stream-of-consciousness exercise. These typing data may also be used to validate and refine this paradigm to study finer-grained psychological events.

Dynamic typing data may also reveal memory search, rumination through recurrent themes or word sequences. These data may also reveal document-wide typing rates that signal cognitive signatures that relate to global features such as overall sentiment and mood. In addition to word categories such as the LIWC dictionaries, other natural language processing techniques and analyses may reveal further insights. LIWC-22 also includes a measure called “narrative arc.” Narrative arc includes proposed stages of composition such as staging, plot progression, and cognitive tension, and appears to follow different patterns depending on text or transcription formats, such as fictional-style writing versus *New York Times* science articles (Boyd et al.,

2020). Whether journalistic or stream-of-consciousness writing follows certain narrative arc patterns, or varies depending on the topic, sentiment, or other features, remains an open question. Topic modeling or recurrence analyses can explore how possibilities become constrained (or not) by temporal framing (Chen et al., 2016; Dale et al., 2018). Further explorations into associations across LIWC categories could also contribute to understanding meaningful differences caused by temporal framings.

Individual differences in the experience of COVID-19 life would seem to be a critical ingredient here that we do not yet explore. Future analyses may consider such differences in more detail, such as comparing the framing texts to the post-pandemic texts. If an individual writes particularly optimistically about their life *during* the pandemic, they may be more likely to then write positively about the future, while greater negativity may similarly bleed into perceptions of the future. A rumination scale (Treynor et al., 2003), a need-for-cognition scale (Cacioppo & Petty, 1982), and a social connectedness and belonging scale (Lee & Robbins, 1995) were included in data collection, though these measures were not factored into the present exploratory analyses. First-person singular pronoun use is increased in the self-focused attention typical of rumination (Zimmermann et al., 2017), and thus may have potential for predicting rumination levels based on streams-of-consciousness. The interplay between language and rumination may result in, for example, pervasive use of such pronouns in future-oriented texts regardless of temporal framing. The need-for-cognition scale may also predict how much semantic space one covered in their streams-of-consciousness to begin with, and may inform language-oriented interventions if one temporal framing or the other encouraged greater cognitive exploration. Aside from the social connectedness and belonging measure, we asked questions about actual social experience during COVID-19. Taken together, these measures may

explain some of the semantic space that the PCA revealed (e.g., PC4, which included the LIWC categories of “prosocial” and “social behavior” characterizing the pre-pandemic condition).

Given that this dataset was a college sample, factors such as age or other demographics remain open for study as they relate to global crises. For example, experiences of age-related change appear to influence perceptions of the future, and in turn mental health (Brothers et al., 2016). Age also appears to be a factor in influencing in-the-moment perceptions of COVID-19, although it may not have had as much influence on perceptions of the future (Ceccato et al., 2021). While the pandemic marked a sudden major lifestyle shift globally, it will be valuable to evaluate similarities and differences to other health concerns experienced personally, such as chronic health issues, injury, or a terminal illness diagnosis. Whether the global, collective experience of COVID-19, or concern about one’s own experiences drive differences in future projections remains an open question. Understanding the relationships between personal health, global health, and how perceptions of their impact on the future change across the lifespan may clarify how different kinds of interventions may perform better or worse for different health profiles.

This study examines the effects of temporal framing on perception of the future, all within individuals; however, undoubtedly many external factors will also shape how individuals have experienced the COVID-19 pandemic. The media landscape and how the pandemic has been framed to different audiences will certainly have some influence. Indeed, psychological distance has been found to influence the evolution of misinformation regarding COVID-19 when the threats appear more distant (Kwon et al., 2022). Future work may examine the effects of the media on self-talk relating to global crises. Additionally, COVID-19 panned out to be a highly politically polarizing event. Political affiliation and intensity of an individual’s antagonistic

views will shape how this global event influences thoughts of a post-pandemic life. Social media usage and the makeup of one's social network both on- and off-line likely moderate perceptions of pandemic life. The language of social media posts across different styles of platforms and through different media (e.g., written such as in a tweet versus video, such as on TikTok) may show differences in socially oriented communication, which may then turn inwards when engaging in self-talk. How inter- and intra-personal communication are linked appears to be a ripe area for research (Vocate, 2012; Turkle, 2016).

Our findings suggest that streams-of-consciousness could have rich dynamic properties. In broader terms, the contexts of a person's present thoughts offer a kind of momentum, propelling them into the next stream-of-consciousness. In the language of dynamical systems, there is *hysteresis*, when "the subject remains longer in the initially perceived interpretation" (Rączaszek et al., 1999, p. 373). This hysteresis property characterizes psychological dwell time in many domains, from motor control to categorization (Tuller et al., 1994). Even high levels of cognitive complexity, like streams-of-consciousness, may be given to these properties of complex, dynamic systems. The results here suggest this hysteresis occurs in temporal framings. When participants engage in thought about the past vs. the present, it may set their mind on a given trajectory, giving it some momentum and remaining longer in the initial perceived interpretation. Importantly though, the effects of such framings are confounded with the psychological boundary of a major global event. How context and psychological distance in the temporal domain interact or differently influence hysteresis could be the subject of future work. The global nature of COVID-19 may provide a valuable comparison point to other world events or disasters, such as the findings from Cohn, Mehl, and Pennebaker (2001) of language shifts after the September 11, 2001 attacks on the United States. Future stream-of-consciousness

prompts may also explore open-ended thoughts rather than anchoring on a specific event, to further clarify the temporal element alone, instead manipulating how far back or forward in time one is projecting their thoughts.

In the particular study presented here, we took an exploratory step into how streams-of-consciousness may color our views as we look towards the future. Our conscious thoughts, once expressed, are not divorced from measurable effects of thoughts that came before. The words we write and the things we think of before considering the future have a non-trivial influence on the way we frame that future to ourselves, and this can be seen even when considering a global crisis that has shaken our worlds as we knew them.

Chapter 3 - Spoken versus typed streams-of-consciousness

1 - Introduction

Speaking and writing provide tangible forms for our otherwise intangible thoughts – however, much like the psychological momentum from one thought may influence subsequent thoughts, differences in the modality used may impact how we explore ideas or what we choose to verbalize. When we speak our thoughts aloud, they are generally delivered with spontaneity, and prosody can add information the words need not explicate. When we write or type, we may erase or edit, and thoughts unfold at a slower rate as every letter must be scribed rather than voicing syllables. But how might these differences shape the unfolding of our thoughts?

Writing about one's feelings has been shown to guide positive outcomes including even physical health benefits (Pennebaker, 1997), and the use of overt private speech, such as in early childhood or during cognitive behavioral therapy, suggests both approaches can be valuable tools in regulating wellbeing. Some features may instead be indicative of maladaptive thought – in a study using think-aloud, an association between negative, past-oriented, self-focused language, and rumination tendencies was found (Raffaelli et al., 2021). These findings are comparable to those in writing tasks, where first-person, singular pronoun usage and self-focused language has been linked to depression (Berry-Blunt, Holtzman, Donnellan, & Mehl, 2021). Self-talk also is used to enhance performance on tasks, as evidenced by an extensive literature in sports psychology (see Hatzigeorgiadis et al., 2011). A study of mathematical reasoning found that students expressing problem solving through writing were able to perform better compared to speaking their logical process out loud (Pugalee, 2004), hinting at differing benefits based on the goals of the self-communicative behavior. Together these could suggest different goals may shape whether the modality used matters or not.

Differences in language usage may explain some modality differences. When comparing audio-recorded versus written dream diaries, audio-recorded accounts appeared to evoke more visual and auditory imagery, bizarreness, discontinuities, and overall generation of words, even when filtering for content-only words (Casagrande & Cortini, 2008). Variations natural to the modality, such as the unplanned versus planned nature of speaking versus writing, respectively, can lead to differing degrees of integratedness and fragmentation (Redeker, 1984) – although this work had participants engage in writing and speaking tasks in the presence of a silent but responsive researcher, adding social influence that may interact with these mode-specific findings. When social presentation is explicitly involved, differences in language appear to arise (see Einhorn, 1978). But when engaging in communication alone, with the self, are such differences preserved?

Some language differences could be detected in lexical diversity shown through the ratio of unique words, or types, over total words, or tokens. This relationship of types-to-tokens is expected to fit a power-law function, so-called Heaps' Law (Chacoma & Zanette, 2020). Work on how this slope may shift as a result of various features is limited, though changes in temperature settings for a Large Language Model have the potential to disrupt this fit (Mikhaylovskiy, 2025). Hapax richness provides another possibility for understanding lexical differences, giving a proportion of words used only once over the total words. Hapax richness may contribute to identification of authorship, reflecting styles related to periods of time (Smith & Kelly, 2002), though differences expected under different modalities remain unknown.

Here, we explore how a stream-of-consciousness (SoC) produced in a room alone may differ when communicating with the self through speaking versus typing. Participants in this study shared their freely-flowing thoughts in an SoC format, either speaking, typing, or doing

both simultaneously. We then investigated lexical diversity and richness, as well as sentiment of these SoC reports, and situated these human-generated thoughts in comparison to an exploratory dataset generated by a Large Language Model fed the same base task.

2 - Methods

2.1 - Study design

118 undergraduate students (age: mean = 19.44 years, sd = 2.594 years; gender: men = 21, women = 96, and other = 1) came into the lab and provided consent on a computer screen. Two participants from an original pool of 120 were excluded due to a failure to complete the task as instructed or performing as an extreme outlier. Following consent, they provided two 10-minute long stream-of-consciousness (SoC) reports. Participants were asked to either speak their thoughts aloud (audio recorded), type their thoughts, or simultaneously type while thinking aloud (i.e., speaking). The first of the SoC reports was always either typed or spoken; then, the second SoC was either the modality not first used or the simultaneous version. The possible resulting conditions were: spoken followed by typed SoC, typed followed by spoken SoC, spoken followed by simultaneous SoC, or typed followed by simultaneous SoC. Participants were told to share their thoughts freely in a stream-of-consciousness, not worrying about grammar or correctness, and were not given specific instructions on what topic or content to think about.

After completing the two SoC tasks, participants then completed a series of questions, including demographics, experiences with communication modalities, and individual difference scales. These included a Big 5 personality scale, BECK Anxiety Inventory, and BECK Depression Inventory. At the end of the study, participants were provided an option to specify the

data privacy level they were comfortable with – in cases where participants consented to the most open level, raw texts and spoken transcripts will eventually become publicly available in a dedicated corpus of intrapersonal communication. Participants recruitment continued until 120 runs were completed with a consent level other than deletion.

This research was approved by the UCLA North General Institutional Review Board. The study was built using the JsPsych library (De Leeuw, 2015), and data was stored locally on the testing and researcher computers. Participants were recruited from the UCLA Department of Communication’s study pool, and received course credit for their participation. Spoken SoCs were transcribed using OpenAI’s Whisper medium model. When typed SoCs were in progress, individual keypresses and their timings were logged to enable future investigation into temporal dynamics.

An additional dataset was collected where OpenAI’s gpt-oss-20b model was prompted to generate SoCs. It was fed the same basic prompt, either describing thoughts as if speaking aloud or simply typing. This model generates both the output response text as well as a reasoning text that may reflect a thought-like mechanism – however, due to short and repetitive reasoning texts, these were not analyzed in this study.

2.2 - Analysis setup

Document linguistic features were extracted using Linguistic Inquiry Word Count (LIWC) for all texts and spoken transcripts (Boyd, Ashokkumar, Seraj, & Pennebaker, 2022). The LIWC data was then used to evaluate overall word counts as well as sentiment.

We then evaluated the types (unique words) and tokens (total words) for each modality to evaluate lexical diversity. The relationship between types and tokens is expected to follow a

power-law function, described as Heap’s Law (see Chacoma, 2020). As such, we include analyses where we first log-transform the types and tokens. We computed type-token ratios over time with a sliding window as well, to see whether distinctions in lexical diversity are driven by length rather than comparable language segments. The data from just the first SoC generated will be used for the analyses here to isolate basic modality differences.

3 - Results

3.1 - Language and semantic variation

Spoken SoCs generated more words overall compared to typed ($t(77.349) = 18.881, p < .001$), with the typed mean = 491.848 and spoken mean = 1428.932. The distributions of unique words (types) differed between modalities when compared through a two-sample Kolmogorov-Smirnov test ($D = 0.847, p < .001$).

We modeled the types over tokens for each modality, factoring in the expected non-linear shape of vocabulary growth predicted under Heap’s Law by log-transforming types and tokens (Chacoma & Zanette, 2020). The model is as follows:

$$\log(\text{Types}_i) = \beta_0 + \beta_1 \log(\text{Tokens}_i) + \beta_2 \text{Modality}_i + \beta_3 (\log(\text{Tokens}_i) \times \text{Modality}_i) + \varepsilon_i$$

Increases in tokens significantly predict increases in types, as expected by Heap’s law ($\beta = 0.554, t(114) = 14.439, p < .001$). Modality and the interaction of modality and tokens also were significant ($\beta = -.779, t(114) = -2.237, p = .027$ and $\beta = .137, t(114) = 2.668, p = .009$, respectively). This indicates that while initially typing may begin with less types, the growth in lexical diversity is more rapid. The type-token distribution and quadratic trends for the SoCs are presented in Fig.1a.

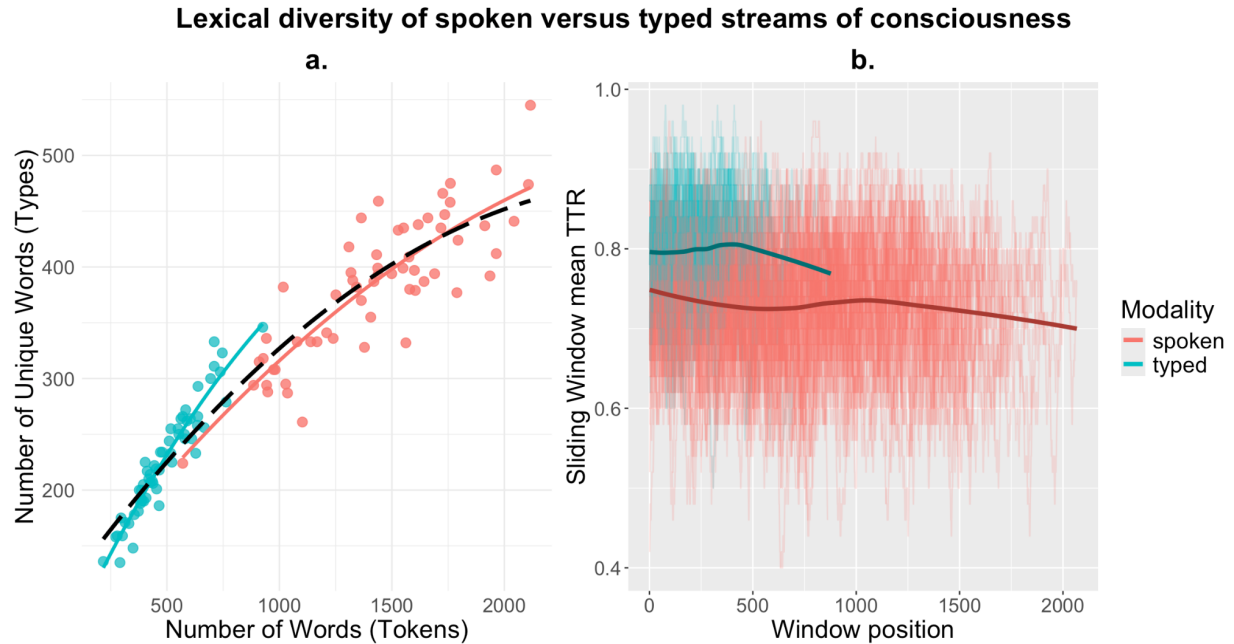


Figure 1: *a. Heap's style plot of spoken versus typed SoCs. Spoken transcripts had significantly higher word counts compared to typed streams-of-consciousness. Colored lines represent the quadratic trend for each modality, and the black dashed curve is the average quadratic trend overall. b. Calculating type-token ratio (TTR) for a sliding window of 50 words over time reveals a general consistent trend with typed SoCs maintaining a higher TTR. Darker lines represent average trajectories, while the thinner lighter lines are individual participants.*

To test if this difference holds regardless of use of filler words and speech nonfluencies, we created a filter using the LIWC dictionaries for each, adding the word "like" which appeared in the top 15 most frequent words for both modalities. With the filter applied, there remains a significant difference in number of tokens ($\beta = 0.575$, $t(114) = 15.055$, $p < .001$) and the interaction of modality and tokens ($\beta = .119$, $t(114) = 2.334$, $p = .021$). When filtered, the modality difference trends towards but no longer reaches significance ($\beta = -.668$, $t(114) = -1.949$, $p = .054$).

To further investigate the type-token patterns for typed versus spoken SoCs, we then analyzed type-token ratios (TTRs). Overall, the average type-token ratios are significantly different ($t(108.46) = -22.235, p < .001$), with an average ratio of .276 for spoken versus .473 for typed SoCs. Next, lexical diversity over time was analyzed using a sliding-window analysis of TTRs (Fig. 1b). The mean TTR was computed for each window of 50 words, sliding the window one word forward at each step. We then fit a linear mixed-effects model predicting the sliding window TTR from modality, window position, and their interaction, including participant ID as a fixed effect. Typed SoCs exhibited higher TTRs across the sliding windows than spoken ones ($\beta = .061, t(120.3) = 11.808, p < .001$), with a significant interaction with window position ($\beta = 2.436^{-5}, t(107,200) = 8.899, p < .001$). Window position decreases TTR over time for the spoken reference group ($\beta = -2.168^{-6}, t(107,500) = -4.179, p < .001$).

Finally, we looked at Hapax richness, which measures the proportion of words occurring only once over total words. Typing exhibited higher Hapax richness ($t(105.67) = -15.439, p < .001$; spoken mean = .42, typed mean = .635).

3.2 - Sentiment across modalities

To evaluate sentiment across modalities, we compared LIWC positive and negative tone and emotion scores, which are based on percentages of overall text that fit those categories. Here, emotion represents words explicitly linked to such affect (e.g., happy, sad), while tone includes words associated with affect indirectly as well, such as birthday or kill (for more information, see Boyd et. al., 2022). Under the LIWC dictionaries, emotion words are also categorized under tone, so we analyzed each category separately.

In individual linear models predicting each sentiment measure from modality, three categories differed significantly and one trended towards difference, each higher for typed text: Positive tone ($\beta = .73$, $t(116) = 3.93$, Bonferroni-adjusted $p < 0.001$), negative tone ($\beta = .359$, $t(116) = 2.363$, Bonferroni-adjusted $p = .079$), positive emotion ($\beta = .434$, $t(116) = 3.502$, Bonferroni-adjusted $p = .003$), and negative emotion ($\beta = .279$, $t(116) = 2.622$, Bonferroni-adjusted $p = .04$).

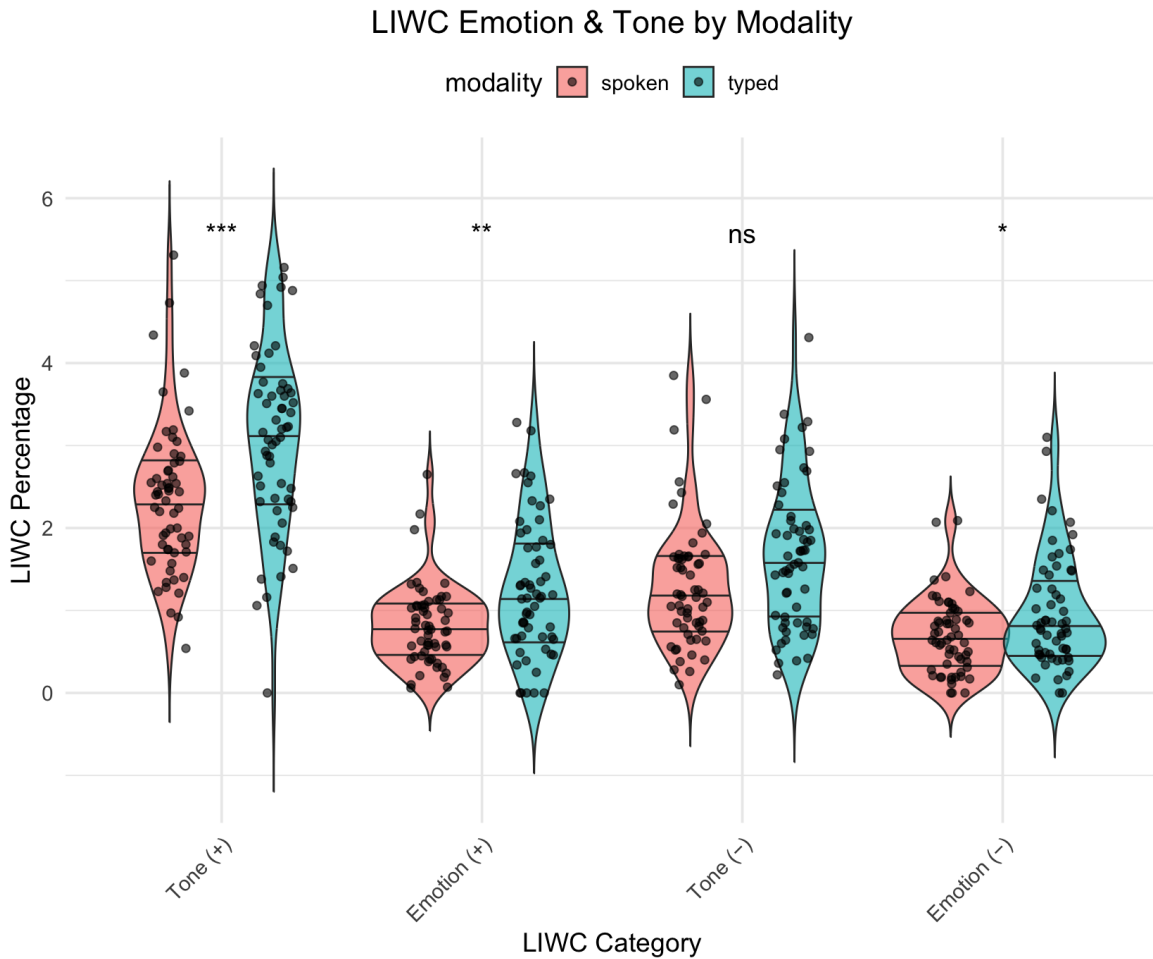


Figure 2: Typed texts included significantly higher percentages of positive (+) and negative (-) tone and emotion compared to spoken transcripts. Horizontal bars represent 25%, 50%, and 75% quantiles per

category. Stars indicate significance; ns indicates it did not reach significance after Bonferroni-correction.

3.3 - Comparison with Large Language Model texts

Chat GPT was asked to generate texts under the same prompts, either as if speaking its thoughts aloud or typing ($n = 250$ texts per modality). A two-sample Kolmogorov-Smirnov test indicates these samples were significantly different, suggesting the LLM indeed intuited distinctions between typed versus spoken thoughts ($D = 0.144$, $p = .011$). The TTRs by modality for the LLMs were similar to each other ($t(492.32) = -1.01$, $p = .313$; spoken mean = .431, typed mean = .436) and Hapax richness was not significantly different ($t(484.58) = -1.144$, $p = .253$; “spoken” mean = .614, “typed” mean = .626).

We then ran the same Heaps’ style model, with log-transformed types and tokens, now including both LLM and human data as an additional predictor “source,” including all interactions. Notably, the three-way interaction of log(tokens), modality, and source was significant ($\beta = -.159$, $t(610) = -2.922$, $p = .004$). The full results of the model are in the Supplemental Materials in Table 2. A Heap’s style plot with the raw types over tokens, with both human and LLM data, is depicted in Figure 3.

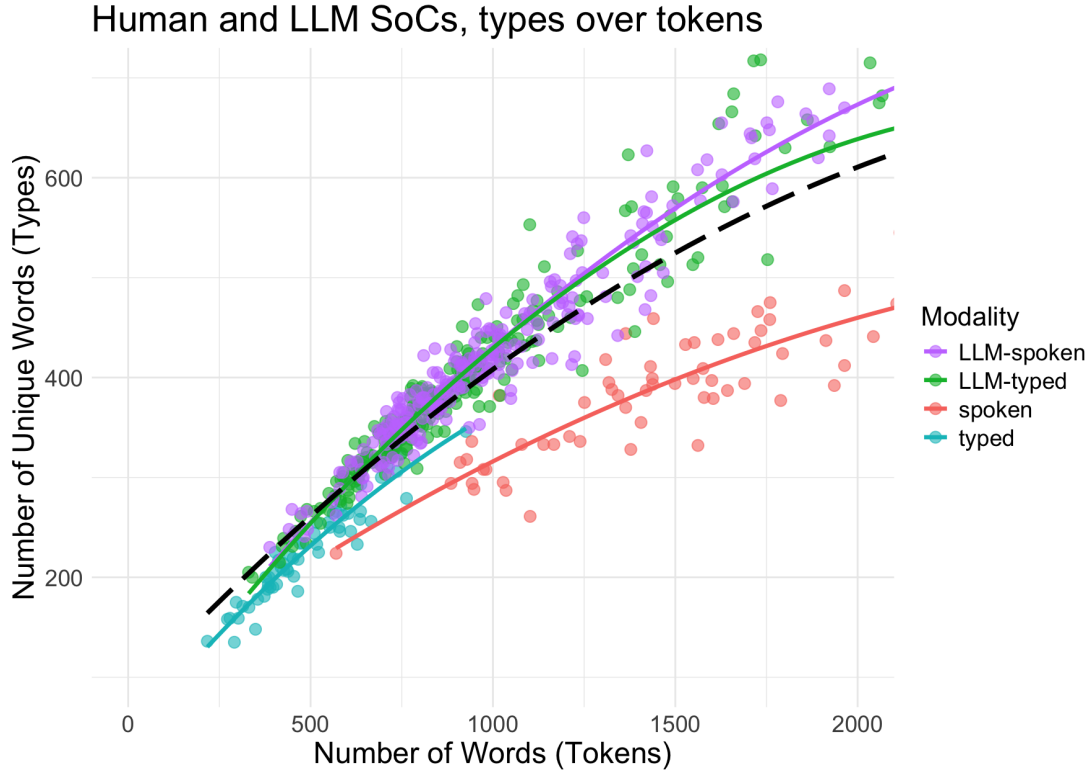


Figure 3: Human and LLM generated "spoken" and typed SoC texts compared for types over tokens. Lines are Quadratic trends. Only the typed and spoken human SoCs had significantly different slopes.

For sentiment, averaging across modalities, the human SoCs use more emotion and tone language, both positive and negative, compared to the LLMs (Positive tone: $t(132.94) = 4.779$, Bonferroni-adjusted $p < .001$, positive emotion: $t(124.45) = 8.818$, Bonferroni-adjusted $p < .001$, negative tone: $t(126.97) = 9.04$, Bonferroni-adjusted $p < .001$, and negative emotion: $t(122.82) = 10.757$, Bonferroni-adjusted $p < .001$). Violin plots depicting the source comparisons for each sentiment category, collapsing modality, are in Figure 4. Violin plots for each source, modality, and sentiment category are depicted in Supplemental Figure 2.

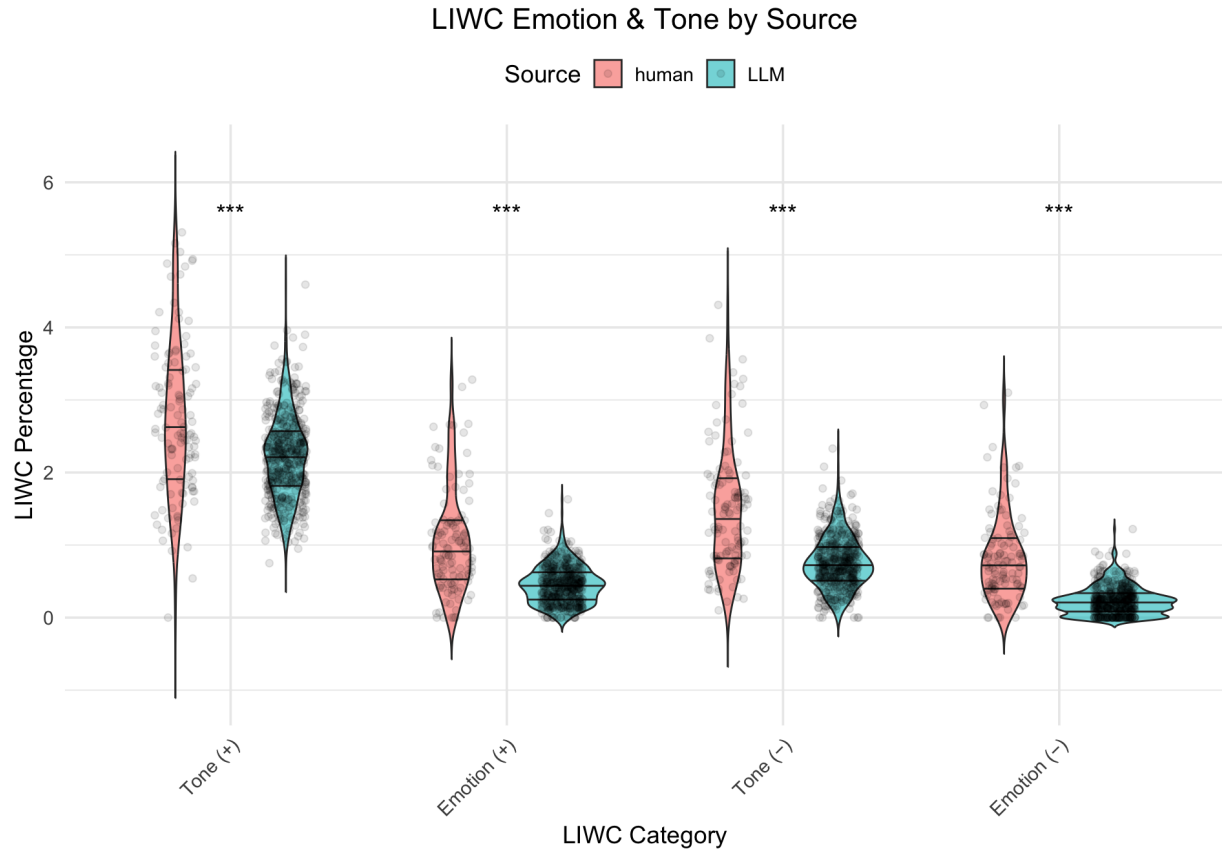


Figure 4: Sentiment for human and LLM generated "spoken" and typed SoC texts. 25%, 50%, and 75% quantiles are represented with horizontal bars.

4 - Conclusion and Discussion

In comparing typed versus spoken streams-of-consciousness, we found speech generates significantly more words, yet typing generates higher lexical diversity. The reduced plannability and greater fragmentation of speech (Redeker, 1984) may suggest we would expect greater types for speech from less constrained exploration, but this was not the case here. Considering this, further investigation should parse out how disjointedness inherent in speech differs in technicalities of production versus conceptually. For example, it is unclear if speaking impacts information retrieval, or simply expends more words to describe thoughts. A task where the

information requested is limited but time is unlimited (for example, completing an essay question for an exam) could uncover whether comparable information is covered but more concisely when typed. While filler words and speech nonfluencies may partially be responsible for reduced lexical diversity in speech, other aspects of spoken language appear to play a role as well, which could be investigated through varying tasks.

Greater positive and negative valence language was found in typed texts. Future work may investigate how vocal prosody and facial expressions may match, or perhaps compensate for, the affect present in the words themselves. Though the sentiment reported here works on proportions of overall text, the verbosity of speech may oversaturate the texts in a way that reduces the ratio of negative or positive tone or emotion terms, without necessarily meaning less emotional disclosure overall. The LLM generated texts had less sentiment usage, and did not distinguish modalities through lexical diversity or richness. Although comparisons were not directly tested across sentiment and lexical diversity, the higher sentiment and TTR of typed thoughts versus the lower sentiment yet similarly high TTR of LLMs may hint at a more complex relationship worth testing. With a larger sample size, more detailed comparisons of topical space could explore whether topic distinguishes humans and LLMs (e.g., brainstorming plans for the day versus processing interpersonal conflict), or sentiment emphasis regardless of topic. Additionally, a larger-scale investigation using multiple models with varied training datasets may better represent how artificial agents could (or could not) mirror human reports of qualitative thoughts.

While the dataset provides an exploratory comparison into modality effects on reported streams-of-consciousness, there are a few limitations. First, participant demographics are not able to represent the general population, especially beyond WEIRD (western, educated,

industrialized, rich, democratic) culture. Norms about what can be talked about or how morality is construed likely shape what we decide we are allowed to think about and what thoughts are considered “intrusive.” It is also possible individuals within the study may have differed in their interpretations of the task itself, or what spontaneous thoughts should look like. The sample is also by nature educated – however, different vocabulary sizes and comfort with typing in general could impact how each modality unfolds for individuals. While the goal was to elicit genuine spontaneous thoughts, participant consideration of the way data would be handled may skew reports towards greater social favorability. Towards reducing this, prior to participation participants were informed they would later have the option to request their data be deleted, though this might not fully eliminate such possible effects. Future work should consider measurements of self-censorship, including how willing an individual may be to explore specific topics privately with themselves. It may also be the case that using a preferred modality of communication matters: for example, a dispreferred modality may hint at unexplored intrapersonal communication that would benefit the individual if encouraged, or may be dispreferred *because* it is not beneficial.

The LLM data provides an initial exploratory comparison into how models might interpret human thought-sharing tasks. The distinctions between being told to generate spoken-like texts, versus using a model that is specifically trained to generate actual audio may yield differing results. A richer comparison of many models across such domains could provide value when considering how an LLM may be used in similar studies, either as a comparison baseline to human behavior, or to test consciousness-like behavior in artificial agents. While the model used here provides reasoning in addition to the output response, in this sample the vast majority of these reasoning texts were limited, such as merely stating “Need stream of

consciousness free flow.” Other models which provide reasoning may generate more tokens, allowing for research comparing reasoning and the resulting output.

Here, participants were given total freedom over what they discussed in their stream-of-consciousness reports, with no guidance on the topic. However, future work should explore how different topic spaces may shift what is shared under each modality. This should also extend to specific outcomes to understand how modalities can be harnessed for benefits in the real world. For example, when planning for logistical aspects of life versus processing emotions, there may be differing benefits to speaking versus typing thoughts out. Other modalities also provide a more complicated self-communicative landscape. Handwriting, for example, may reduce word counts further. There may also be effects of switching from one modality to the next: in this study, participants also completed a second stream-of-consciousness – either performing the modality not done initially, or engaging in both speaking and typing simultaneously – to allow future analysis of how one modality’s effects may bleed into another. Preliminary investigation suggests when engaging in both, typing may constrain the lexical space of speech (see Supplemental Figure 1 in the Supplemental Materials section).

This task focused on externalization of thoughts through language – however, variability exists in internalized streams-of-consciousness. First, not everyone reports experiencing an inner voice, which may impact whether an individual is comfortable expressing spontaneous thoughts in this format at all (Nedergaard & Lupyan, 2024). Even with experience of inner language, how vocal-like this appears in the mind might vary, and some may perceive language in their mind as written or otherwise symbolically represented in a non-auditory way. Other expressive modalities such as music, art, and movement should be explored in direct comparison to language-based strategies.

Overall, this research strives to clarify how speaking versus typing one's thoughts may shift how the thoughts unfold. Considering greater proportion of sentiment language and higher lexical diversity when typing, strategies of intrapersonal communication could be selected from for different purposes. This work may thus build towards applications in mental health, logic and decision making, education, and other domains in the future to understand the utility of intrapersonal communication in day-to-day life.

Chapter 4 - In darkness and mirrors: Exploration of environmental effects on streams-of-consciousness

1 - Introduction

While the previous study explores the influence of modality on streams-of-consciousness through lexical diversity and sentiment, the environment could impose an additional influence on thoughts. For example, deprivation of senses can impact one's self-environment boundaries, which can lead to changes in interoceptive awareness and imagination (Noel et al., 2018). In this study, participants were placed under both visual and auditory deprivation and were tested on their interoceptive accuracy and peripersonal space, and noted shifts in hallucinatory-like perception during a survey. While this degree of sensory deprivation requires a controlled laboratory environment, humans throughout time have engaged in ritual and spiritual practice in spaces such as dark caves, which can facilitate imagination and supernatural thought (Moyes et al., 2021).

In contrast, speaking into a mirror may shift self-awareness in a more grounded manner, with some evidence pointing to possibilities for improved wellbeing. Speaking with self-compassion in front of a mirror, in comparison to speaking aloud without, is associated with increased positive affect and physiological signatures of compassion and emotional regulation (Petrocchi, Ottaviani, & Couyoumdjian, 2016). Additionally, Petrocchi, Ottaviani, & Couyoumdjian found self-criticism to have pronounced effects in the presence of the mirror, with increased negative affect, reduced positive affect, increased heart rate, and decreased heart rate variability (typically associated with less emotional regulation). A more typical association with talking into a mirror is the rehearsal of speaking more generally. English language learners at Timor University showed greater improvements in pronunciation and confidence when

practicing English speaking in front of a mirror, highlighting performance and learning impacts (Pale & Kamlasi, 2021). Together, these findings suggest possible enhancements of the intentions directed towards a mirror, with the potential for both positive and negative outcomes.

Given possible changes in abstraction and imagination, construal-level theory may inform projected outcomes of communicating with the self in these different environments. In a review by Trope & Liberman (2010), perspectives that are considered more distal from the here and now and one's identity lead to more abstract mental construals – so-called construal-level theory. Such distances, referred to as psychological distances, can apply to senses of space, time, and identity, all of which may be shaped by situations such as sensory deprivation. One might predict, for example, that the abstractness of being in darkness may result in greater psychological distance from the self, which could drive levels of abstract thought. Speaking into a mirror may provide a concreteness that reduces psychological distance, although alternatively the presence of another face (despite being your own) could also create distance by separating the self into two.

Different environments could also shape the way we deliver vocalized thoughts acoustically. As such, acoustic information extracted from speech may provide valuable insights into thoughts spoken aloud. Often coded manually, partially internalized private speech is often whispered (Alarcón-Rubio, Sánchez-Medina, & Prieto-García, 2014), with whispers exhibiting both lower intensity and a lack of vocal fold vibration (Jovičić and Šarić, 2008). Some of this vocal information is likely the product of physiological influences that may shape the vocal qualities by way of altering respiration or other vocal apparatus (Scherer, 2003). Higher arousal emotions, such as anger, are likely to increase certain acoustic features, such as intensity and pitch mean, variability, and range. In cases where the content of speech exhibits dissonant

valence to the voice's tone (e.g., positive content with negative tone), the negative valence more strongly influences perception and emotional responses in a study where nurses and nursing school students evaluated mock patient voice recordings (Yogo, Tsutsui, Ando, Hashi, & Yamada, 2000). This suggests that analyses of content alone, such as transcriptions of speech, may not always capture the full emotional experience of spoken self-communicative instances. What specific features are necessary to infer emotion remains somewhat unclear - however, one study found that pitch characteristics alone led to fairly high reliability when evaluating emotive speech samples devoid of emotional semantic content (Fairbanks & Pronovost, 1939). Much of the work on vocal acoustics of emotions make use of actors, which may call into question ecological validity of true emotional expressions.

In this study, participants produced a spoken aloud stream-of-consciousness in either a fully darkened room, in front of a mirror, or without treatment. They then completed a series of questions about themselves and their experiences. Throughout the duration of the study, video and physiological data was collected. We take an exploratory approach, analyzing linguistic and acoustic features as well as heart rate, to explore how each environment may influence our streams-of-consciousness.

2 - Methods

98 (age: *mean* = 19.35 years, *SD* = 2.55 years, gender: men = 18, women = 80, and other = 0) came into the lab and were presented a consent form on a computer screen. They then were equipped with an Empatica EmbracePlus physiological device to capture heart rate. While the device connected, specific details of the study were described by the researchers, including information on the condition the participant was randomly selected into. All participants were

given 15 minutes to speak their thoughts aloud in a stream-of-consciousness (SoC) whilst in isolation in a windowless room. The conditions were: thinking aloud in a fully darkened room, in front of a mirror, or in the control condition with lights on and no mirror visible. In the dark room condition, participants were provided with a tap light they could turn on if they were uncomfortable with remaining in darkness. Participants were video recorded throughout the entire study using a security camera with night vision capability to provide the option to confirm the room conditions, as well as for future analyses.

After the SoC task was completed, the researcher restored the room to a neutral state, closing the mirror away or turning the light back on. The participant was then left alone to complete the questionnaire portion of the study. These questions included a 44-item Big 5 personality scale (John & Srivastava, 1999), the Self-Consciousness Scale (Mittal & Balasubramanian, 2023), and questions about contexts where they believe their minds are most active (such as when trying to go to bed) and experience with relevant activities (such as whether they practice speaking in front of a mirror).

This research was approved by the UCLA North General Institutional Review Board. The study was built using the JsPsych library (De Leeuw, 2015), and data was stored locally on the testing and researchers' computers. Participants were recruited from the UCLA Department of Communication's study pool, and received course credit for their participation. The SoCs were transcribed using OpenAI's Whisper medium model.

3 - Results

3.1 - Language differences

First, we explored possible language differences based on condition. Overall word counts and words-per-sentence were comparable across conditions ($F(2, 95) = 1.38, p = .257$ and $F(2, 95) = 1.16, p = .318$, respectively). Overall, the mean type-token ratios did not significantly differ, although there was a trend towards it being higher for the mirror condition relative to the control ($\beta = .018, t(95) = 1.835, p = .07$). Hapax richness (proportion of words used once over total words) was not significantly different based on condition ($F(2, 95) = .404, p = .669$). Levene's Test was used to compare equality of variances across conditions, and while it does not reach significance there is a slight trend towards difference ($F(2, 95) = 2.514, p = .086$).

We then tested if types over tokens, log-transformed to account for the natural shape expected under Heap's Law (for more information, see Chapter 3 of this dissertation, or Chacoma & Zanette, 2020). As is expected, $\log(\text{types})$ is a significant predictor for $\log(\text{token})$ increases ($\beta = .652, t(92) = 7.045, p < .001$); however, neither condition nor their $\log(\text{tokens})$ interactions were significant. A Heap's style plot and the comparison of overall type-token ratio are depicted in Figure 1.

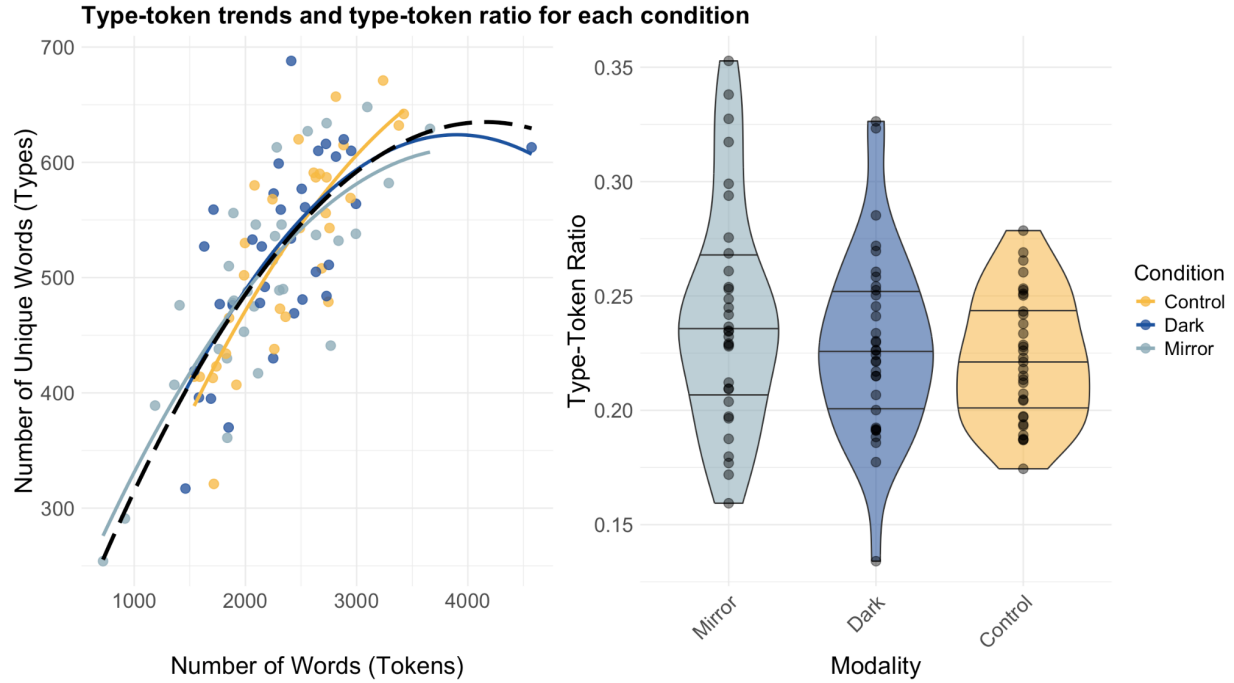


Figure 1: *The relationship between types and tokens is not shaped by condition, though a slight trend favors the mirror condition for a higher type-token ratio. 25%, 50%, and 75% quantiles are indicated in the violin plots with the horizontal bars.*

To further investigate the content of the SoCs, we applied Linguistic Inquiry Word Count (LIWC) (Boyd, Ashokkumar, Seraj, & Pennebaker, 2022), then used Principal Component Analysis (PCA) to reduce down the 117 categories. We retained 26 components based on those needed to reach an 80% cumulative variance threshold. To evaluate which Principal Components (PCs) distinguish each condition from the control, we subsetting the data to target dark-versus-control and mirror-versus-control, then ran generalized linear models for each PC, predicting condition (e.g., dark vs. control) from the loading scores for each LIWC feature within the PC. This preserves the semantic space for the entire dataset, while targeting specifically how these treatments differ from the control condition.

Four PCs were of note – for the dark condition, PCs 10 and 25 reached slight significance ($p = .034$ and $p = .05$, respectively), with a slight trend for PC 13 ($p = .055$). For the mirror condition, PCs 18 and 25 reached significance ($p = .041$ and $p = .049$, respectively). The LIWC features with the top 5 positive and negative loading scores are presented in Table 1, where presence of features with positive values contributes to the PC, while negative values indicate absence of this feature contributes. To learn more about what kinds of language are categorized into each LIWC category, refer to Boyd et al. (2022).

Table 1: Top positive and negative LIWC loadings by principal component and condition, with the LIWC feature and its associated loading score. Blue cells indicate top 5 positive loading scores for each PC, while orange cells indicate top 5 negative scores. Stars indicate significance, with PC 13 trending towards significance.

Dark				Both		Mirror	
PC 10 *		PC 13		PC 25 *		PC 18 *	
Determiners	.204	Food	.202	Abverb	.311	Sexual	.206
Auxiliary verb	.193	Religion	.199	Word count	.249	Friend	.202
Impersonal pronouns	.182	Exclam.	.186	Fatigue	.194	Fatigue	.193
Assent	.175	Polite	.183	Q mark	.181	Present	.148
Swear	.166	Ethnicity	.18	Power	.163	Q mark	.137
Ethnicity	-.159	Wellness	-.165	Non fluencies	-.183	Anxious	-.196
Prepositions	-.159	Risk	-.173	Conversation	-.188	Past	-.228
Cause	-.196	Health	-.177	Male	-.201	Wellness	-.278
Physical	-.225	All punc.	-.177	Auditory	-.241	Risk	-.279
Food	-.277	Moral	-.206	Mental	-.328	Fulfill	-.355

While topical interpretation of the meaning of these PCs is subjective in nature, some of the defining LIWC features may hint at meaningful distinctions. For example, in PC 10 the absence of physical language may reflect a reduction of self-environment boundaries. For the mirror condition, present-tense is characteristic of PC 18 along with the absence of past-tense, which may reflect lessened reflection or a closer psychological proximity when faced visually with oneself.

3.2 *Non-linguistic analyses*

First, we explored heart rate, aggregated by minute and normalized across the duration of the physiological data collection period. We compared the mean heart rate for each condition using a one-way ANOVA. Heart rate did not differ across conditions ($F(2, 94) = .131, p = .877$).

Next, to evaluate differences in vocal production acoustically, we computed pitch and intensity values across the full length of the recordings using Praat version 6.4.65 (Boersma et al., 2026). We calculated the mean and standard deviation in hertz using pitch with filtered autocorrelation, as well as the standard deviation in semitones. For women's voices, we set a standard pitch range between 100-500 Hz, and for men's voices 75-300 Hz. Note that for this study, participants reported their gender rather than biological sex to maintain consistency across the dissertation studies.

We ran linear models to evaluate how pitch and intensity might differ based on the condition, controlling for gender. While the mean and standard deviation for pitch did not differ significantly across conditions, the dark condition differed from the control for both mean intensity ($\beta = -1.705, t(94) = -3.188, p = .002$) and intensity standard deviation ($\beta = -1.082,$

$t(94) = -2.437, p = .017$). The acoustic feature comparisons are plotted in Figure 2, with bars representing the sample means and error bars indicating 95% confidence intervals.

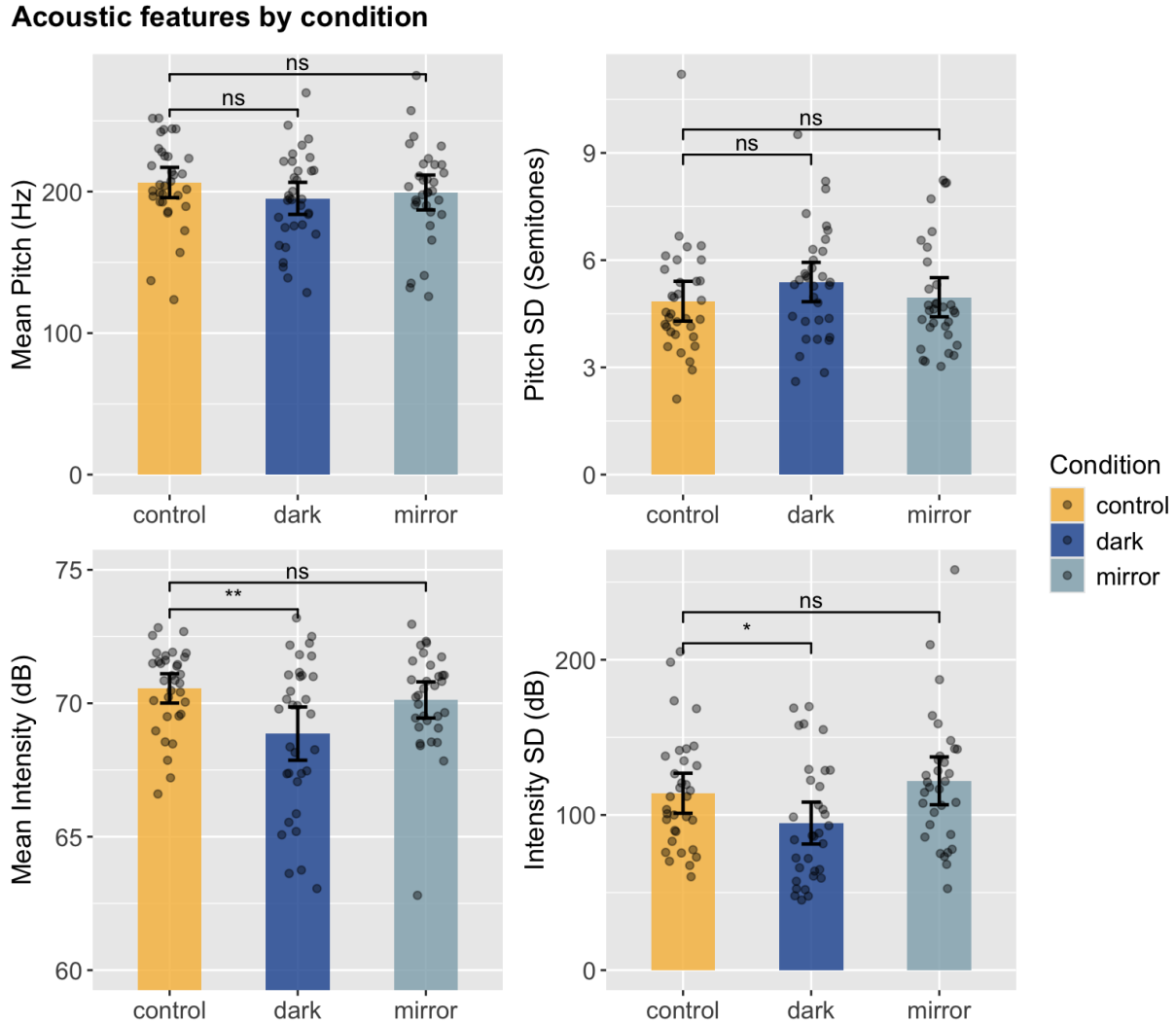


Figure 2: Acoustic feature comparisons across experimental conditions. Bar heights represent the sample means for each feature, and error bars represent 95% confidence intervals. Points represent individual participants. The y-axis for mean intensity is set to a range of 60-75 for legibility.

To follow-up with a multi-dimensional analysis of acoustic features distinguishing the conditions, we then used the `analyze` function from the `soundgen` package in R (Anikin, 2019), minus spectral features and formants and using the final minute of audio from each recording to ensure a manageable yet meaningful quantity of data for processing. By using the final minute, the aim is to capture the features with maximum acclimation to the condition environment and SoC task. The analysis window length was set to 20 ms, with a pitch floor of 50 and ceiling of 700 to capture typical speech while maintaining manageable computational demand. One file was omitted due to failure to extract acoustic features adequately from this final minute.

Next, a PCA was run to cluster the various acoustic features. The first 10 resulting PCs were selected based on reaching an 80% cumulative variance threshold, which were then fed into a multinomial log-linear model. Four components came out as significant or near significant for distinguishing dark and mirror conditions from the comparison group of the control condition: PC1 ($p = .032$), PC2 ($p = .005$) and PC5 ($p = .012$) for dark, and PC10 ($p = .051$) for mirror. The results of the PCA are depicted below in Table 2.

Table 2: Most important PCs distinguishing conditions based on acoustic features extracted from the final minute from each recording. Interpretations factor in the relationship between PC score direction and loading score signs. For the top 5 features, those in bold italics have positive loading scores, while those in regular text are negative. All comparisons situate the control as the comparison group, and interpretations are specific to comparing the treatment (i.e., dark or mirror) to the control.

PC	% Variance explained	Significant condition	Direction of effect (based on PC score)	Top 5 associated acoustic features	Interpretation of top features cluster
PC1 ($p =$	28.95%	Dark vs. control	Dark higher in PC	amMsFreqVoiced_mean, <i>amMsPurityVoiced_mean</i>	Dark led to greater purity

.032)				, amMsFreq_mean, <i>amMsPurity_mean</i> , quartile50Voiced_mean	of amplitude modulation and peaks in amplitude occur less
PC2 (<i>p</i> = .005)	12.96%	Dark vs. control	Dark higher in PC	<i>Roughness_mean</i> , <i>roughness_median</i> , <i>roughnessVoiced_median</i> , <i>roughnessVoiced_mean</i> , <i>quartile75_mean</i>	There is greater roughness in voice in the dark
PC5 (<i>p</i> = .012)	5.53%	Dark vs. control	Dark lower in PC	<i>loudnessVoiced_mean</i> , <i>loudnessVoiced_sd</i> , <i>loudnessVoiced_median</i> , <i>amplVoiced_sd</i> , quartile50_sd	Dark shows attenuated loudness of voice, with more variability in spectral median
PC10 (<i>p</i> = .051)	1.99%	Mirror vs. control	Mirror lower in PC	Flux_sd , flux_mean , amEnvDep_median, amEnvDep_mean, entropy_sd	Mirror led to less fluctuation in features and more shift away from tonality

PC1 suggests the dark condition led to less frequent, more regular amplitude peaks relative to the control. PC2 suggests greater vocal roughness in the dark condition. PC5 reiterates the results from the Praat analysis on the full audio, with attenuated vocal intensity distinguishing the dark room condition from the control, even isolating the final minute. PC10 suggests the mirror reduces general fluctuations in features, although tonality may be reduced relative to control.

4 - Conclusion and Discussion

When sharing thoughts aloud without specific boundaries or prompts on what to think of, individuals may explore ideas differently when in a fully darkened room or in front of a mirror. Here, we found lexical diversity trended higher when in front of a mirror, which may indicate more deliberate language similar to the effect of typing over speaking reported in Chapter 3 of this dissertation. There was also a potential trend towards differences in type-token variance across conditions. Additionally, content-based differences measured using LIWC distinguished the dark or mirror conditions from the control, suggesting our environments may shape the ideas we explore when thinking out loud. One possible interpretation suggests psychological distance may have been shaped by the presence of a mirror, with increased present-tense focus and reduced past-tense language.

We also found lower vocal intensity and intensity variability when speaking aloud in a dark room, as well as increased roughness, which may impact detectability. Darkness may discourage loud broadcast signals due to the vulnerability to danger the dark naturally brings, even if the participants may not have consciously held this concern. Alternatively, it could be the case that darkness reduces a sense of an interlocutor to be communicating towards – if communication was directed to the self, then a reduced sense of self could shift vocal features away from aiming for detectability. More direct investigation into self-awareness as a mediator or moderator could clarify how our self-models play a role in our self-communicative experience. We included a few questions relating to this: who they felt they may be communicating to, whether they believed they were overheard, and how much knowing a researcher may hear the recording impacted their experience. Participants were mixed: 42/98 stated they felt they were speaking to the researchers (though some also simultaneously selected “self,” “imaginary audience,” “imaginary specific individual,” or “no one”); 39/98 felt they may

have been overheard; while 16 felt not impacted and 40 only a little impacted by later listening from researchers, 33 selected somewhat and 9 very impacted. Future work could explore targeted tasks that encourage specific versions of the self or manipulate conceptions of a possible receiver. Religious perspective may also matter, with 4/98 participants selecting “A higher power” as who they may have spoken to. In some cases, individuals may not believe fully private intrapersonal communication is possible, and this could have impacts on what or how they think. Given ties between dark spaces and spiritual or supernatural thought, future work may specifically target the relationship between these on intrapersonal communication practices and content.

When analyzing the final minute of the recordings in a multidimensional analysis of acoustic features, roughness was increased in the dark condition, alongside reduced intensity/loudness. Some work maps non-linear phenomena like roughness to intensity of emotion, and when context is ambiguous to negative affect (Anikin et al., 2020). Although loudness alone may not be enough to indicate specific emotion, it can contribute to assuming higher activation states (Yanushevskaya et al., 2013). However, some work suggests heightened cardiovascular activity during anger may be specific to the outward expression of it through anger-typical vocal patterns, and this activity can be removed when using anger-incongruent vocal patterns (Siegman & Snow, 1997). While mapping emotion onto specific acoustic features can be challenging and the linguistic analyses here did not suggest anger or other specific emotions stood out between conditions, future work could explore these richer clusterings alongside manual coding, ideally including feedback from the vocalizers themselves. Alternatively, if emotional influence was not the cause of these feature shifts, the roughness with reduced intensity may suggest the voice included whisper-like qualities.

It is worth noting that additional environmental factors could have shaped the content for this particular study. The sample consisted entirely of undergraduate students participating in a lab space on campus, and language specific to their educational lives was common, suggesting this could have mattered as much or even more than being in a dark room or in front of a mirror. For all three conditions, words such as class, study, and school appear in the top 20 most frequent words (see Supplemental Figure 3 in the Supplemental Materials section). Mere participation in an experimental study may also matter, as this very context differs from spontaneous thoughts that may occur for specifically ritualistic contexts, or other comparable scenarios such as at night when preparing to fall asleep. Further investigation of the effects of the environment on the contents of our thoughts should consider not only the immediate space, but broader context such as being in a public space versus in the privacy of one's own home.

The lack of specific task or topical prompt may also matter – for example, if being in darkness can facilitate imagination as suggested by Moyes et al., (2021), a task eliciting and quantifying imagination may be necessary to uncover this benefit. The goal here was to permit unconstrained exploration of thoughts, but targeting possible functions of generating streams-of-consciousness is a necessary next step. While the study included a preliminary exploration into the physiological effects of these environmental contexts, a richer study specific to various aspects of physiological response and affect should also be conducted. Combined with self-reported measures, the ways such environments may benefit emotional regulation or processing could be uncovered. Self-talk can afford a range of functions, such as emotional regulation, task performance or logical reasoning, and brainstorming ideas, and recognizing optimal environments for each can benefit future treatments for education, mental health, or productivity gains.

Chapter 5 - Concluding remarks and future directions

Ultimately, intrapersonal communication is what narrates our life stories, plays memories and future possibilities like movie snippets, and helps us process information from the outside world. Through the technology of language, we can take thoughts, regardless of how verbal in origin, and make them tangible. By characterizing some of the ways these thoughts may transform through language, we can then consider approaches to intrapersonal communication that extend beyond language. Some of the difficulties a discipline of intrapersonal communication has faced relate to the challenges in studying non-linguistic forms. However, without first clarifying differences in linguistic modes, such as by comparing the different dimensions explored in this dissertation, these challenges would inevitably persist. These studies thus aim to generate momentum towards reinvigorating the discipline of intrapersonal communication.

To do this, we have explored verbal intrapersonal communication along a few dimensions: how thoughts are shaped by those preceding, how speaking versus typing may matter, and what influence the environment may have on thinking aloud. The first chapter argues in favor of returning academic attention to intrapersonal communication. Chapters 2-4 then build out an example research series drawing from methodological approaches reviewed in Chapter 1. By exploring the ways psychological momentum, modality, and environmental context may shape linguistic thoughts, we can consider how a variety of communicative behaviors may influence the self. At least in the case of a global event such as COVID-19, orienting thoughts before versus during the event shaped how college students thought about the future. When typing thoughts versus speaking, lexical diversity and sentiment language was greater. Sitting in darkness may attenuate intensity and enhance roughness in our voices, and different topical spaces may arise based on whether you are in the dark or face-to-face with yourself in the mirror.

Each of these studies demonstrated a difference that could be conceptually reapplied to non-linguistic self-directed communication. To illustrate this, let's take an example of a task where participants can manipulate the motion, texture, and sound of a computer-generated blob to represent their emotional state to themselves (see Sievers et al., 2012). One could test how the representative features of an emotive state from timepoint t may result in similar representations at $t+1$, such as by presenting an initial blob already equipped with specific features. We could then compare how the visual versus auditory features in isolation may shift the representations relative to some additional measure, such as self-reported emotion or physiological shifts. Finally, we could explore impacts of the environment when using such a visual-auditory expressive task. While this particular example may not permit sensory deprivation, the presence of a mirror could be studied, or other manipulations to the environment or self-experience. Ultimately, the studies in this dissertation demonstrate taking one self-communicative paradigm and exploring different approaches or influential factors to show that influence on the self can become shifted. Through applying multiple methodologies to various behaviors connected to intrapersonal communication, this area of research can better establish rigorous empirical grounds resistant to future dismissal. As a result, important discussion can be encouraged across disciplines to better understand the role the self plays in shaping our lived experiences.

Another goal of these projects was to begin building a corpus of SoCs. As such, the studies in Chapters 3 and 4 included consent levels for data access, so only those comfortable sharing their streams-of-consciousness contribute to the corpus. For the modality dataset, 28/118 agreed to include their data in the public corpus, while 47 agreed to allow outside researchers to request access (the remaining 43 only permitting the researchers on the project itself access). When asked about overall comfort expressing their thoughts in the study, those who elected to be

in this corpus ranged from “somewhat uncomfortable” to “very comfortable” – however, future work should investigate what individual differences or kinds of thought disclosure may drive this willingness. For the dark room versus mirror think-aloud study, 16/98 consented to inclusion in the public corpus and 39 agreed for outside research access upon request. While the corpus may be skewed based on willingness to be included, this kickstarts what is intended to become a larger database to explore how individuals vary both within and between themselves in their intrapersonal communication.

There are several limitations to consider, such as in the sample itself. For all three studies, undergraduate students participating for research credit were recruited, limiting generalizability and likely shaping the topical space explored across the board. The vast majority of participants are native English speakers aged 18-22, and all were required to report their thoughts in English. Beyond possible impacts of a language on how ideas are connected and explored, cultural and religious norms surrounding thinking and censorship likely matter. For example, speaking thoughts aloud versus typing them could produce different outcomes if viewed differently on riskiness or associated guilt. Each study also elicited thoughts – whether these externalized forms accurately reflect what would have been communicated to the self internally cannot be determined, particularly with the experimental format of these studies. It is also not known whether participants would engage in these forms of thinking spontaneously, making it unclear whether these results are specific to performing streams-of-consciousness as a deliberate task.

Some of these limitations provide opportunities to further explore what impacts intrapersonal communication, even with these data. For example, keypresses and their timings were tracked in the typing tasks (Chapters 2 and 3), permitting comparison to the temporal dynamics in speech. Exploring when pauses may occur, and whether these reflect elements in the

language used, could hint at self-censoring or uncertainty about disclosing openly. In study 2 (Chapter 3), preferences for communicating over spoken versus typed modalities interpersonally were collected, as well as questions about comfort in expressing themselves in each modality during the study. Questions about journaling usage, mindfulness practice, or other day-to-day experiences were also included, as well as a multitude of individual difference measures for personality and wellbeing, many of which provide an immediate next step following this dissertation. The studies reported here demonstrate mechanics differences that occurred, however outcomes including mental health impacts may rely on an interaction between these mechanics and the specific profile of the individual. This could additionally include the role of reappraisal – while streams-of-consciousness undeniably engage an active sender role (see Chapter 1, Table 2), the receiver role – interpreting of one’s own thoughts – may have been limited or varied based on features such as typing versus speaking.

Future work on intrapersonal communication should also consider individual differences specific to how our intrapersonal communication plays out, such as anendophasia (a lack of inner voice – see Nedergaard & Lupyan, 2024) or aphantasia (a lack of visual imagery). For example, whether those who experience little to no inner voice benefit especially, minimally, or not at all from overt linguistic self-talk is unknown. Although some express skepticism over the validity of these generally self-reported differences (for example, see Lind, 2025), that individuals qualitatively experience their minds in these different ways strongly supports establishing a study of intrapersonal communication, which contributes beyond just studying self-talk or overt private speech. Future directions must venture beyond language-specific communication into gesturing, facial expressions, sensory imagery, and beyond.

Gesturing is available earlier in life than speech due to the fine motor control necessary to articular vocalized language, and differences between vocal-like inner speech versus signed language equivalents should be explored (Gregory, 2026). In the study for Chapter 4, video data was also collected for future possible analysis. Just as Cunningham (1992) criticized, intrapersonal communication often relies heavily on linguistic self-reports. Other modes of communication, such as gestures and facial expressions, may provide additional insights into the way thoughts unfold or guide the self. Facial expressions may serve as nonverbal interjections in face-to-face conversation (Motley, 1993) – but what about face-to-face with the self, via a mirror? More gestures are used when describing a picture when told someone would see a video recording of them (i.e., not live face-to-face communication), and gestures are more frequent when available vocabulary to describe a picture is limited (Bavelas et al., 2002). Interestingly, even congenitally blind individuals gesture, even when speaking to other blind individuals (Iverson & Goldin-Meadow, 2001), which may suggest the proprioceptive feedback may serve self-communicative functions. The growing practice of mindfulness presents yet another interesting example of self-communicative intervention that does not necessitate language, and indeed often recommends liberation from verbal mind-wandering (Creswell, 2017).

The stream-of-consciousness paradigm used throughout these studies also represents only one format through which linguistic thought can be outputted. Dialogical versus monological thinking may serve different functions, with imagined interactions modeling *interpersonal* communication. Indeed, direct comparisons between intrapersonal and interpersonal communication could shed light on how or why we come to communicate with ourselves in the first place. The stream-of-consciousness used here was meant to capture a dynamic and spontaneous flow of thoughts, but the thought-listing paradigm, where a list is generated after a

period of silently thinking to the self, allows for a non-linear traversal of thoughts. The stream-of-consciousness may impose more path dependence, while thought-listing could capture cases of disjointedness or potentially competing thought trajectories. Mental foraging tasks (see Chapter 1) can be used to further look into dynamics of thoughts, and could be combined with this stream-of-consciousness task to see not only explore versus exploit patterns surrounding words, but how we might communicate with ourselves about exploration and exploitation of conceptual spaces. How linguistic thought unfolds spontaneously may also differ across individuals – for example, in one case in Chapter 3, a participant’s interpretation of the stream-of-consciousness task more closely resembled word association or mental foraging, listing words seemingly absent of any grammatical structure.

This dissertation aims to pave the way towards a richer study of intrapersonal communication as a whole by first testing important influential factors on the dynamics and content of our expressive thoughts. These studies use journaling-style and think-aloud paradigms that apply general and dynamic linguistic analysis, acoustics, and physiology, as well as measurements to later explore individual differences, demonstrating a multifaceted approach to intrapersonal communication as described in Chapter 1, Figure 1. Aside from contributing to our understanding of self-communicative dynamics, this work may inform mental health or educational interventions, with a focus on increasingly understanding the role of individual differences and specific needs down the road. Intrapersonal communication may also inform how we theorize about consciousness or existential questions relating to how we process awareness of our own consciousness.

Supplemental figures and tables

Chapter 2

Supplemental Table 1 - Loading scores for the top ten most influential LIWC features for each selected component.

The table below features the seven selected components, the ten most influential LIWC features (ordered from most to least influential, based on their absolute values), and their raw loading scores. Positive loading scores best characterize the during-pandemic condition, while negative loading scores best characterize the pre-pandemic condition.

PC1 (*)		PC4 (*)	
LIWC category	Loading score	LIWC category	Loading score
Health	0.241	Fulfill	-0.231
Illness	0.234	Prosocial	-0.204
Analytic	0.223	Exclamation	-0.202
Pronoun	-0.212	I	-0.183
Neg. tone	0.204	Insight	-0.18
Article	0.204	Space	0.172
Social refs	-0.186	Aux. verb	0.171
Social	-0.182	Social behavior	-0.17
Personal Pronoun	-0.177	Perception	0.166
Physical	0.171	Allure	0.162
PC5 (**)		PC10 (*)	
LIWC category	Loading score	LIWC category	Loading score

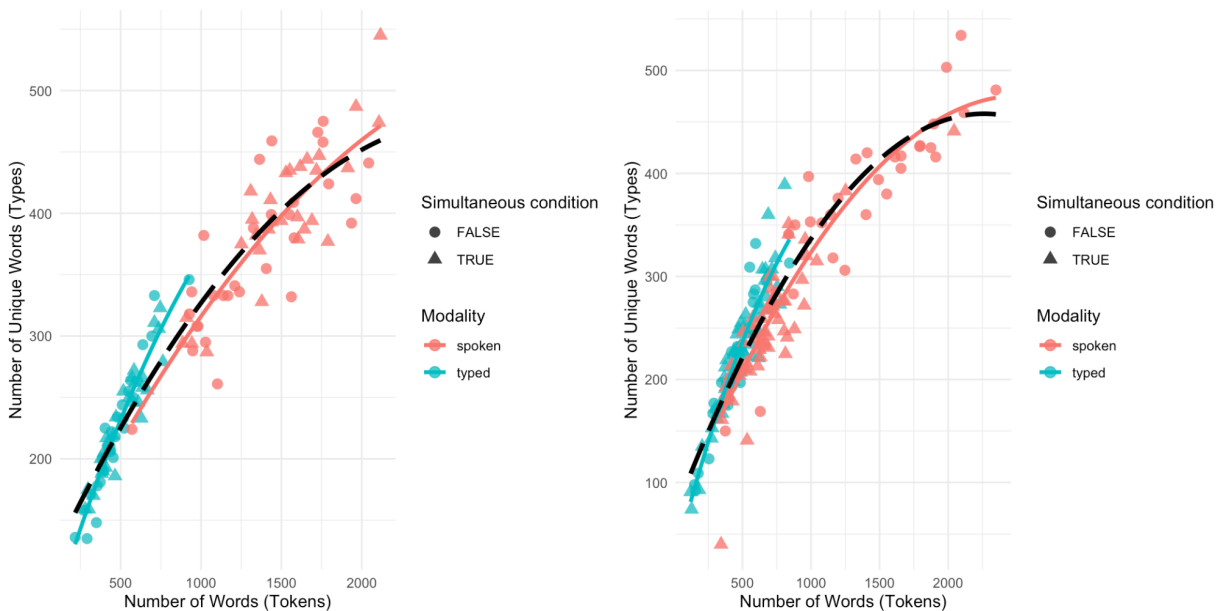
Pos. tone	0.267	Comm	-0.244
Want	0.254	Impers. pronoun	-0.2215
Tone	0.25	Memory	-0.21
Discrepancy	0.244	Conjunctions	0.203
Pos. emotion	0.236	Acquire	0.197
Emotion	0.192	Swear	0.158
Past focus	-0.184	Risk	0.154
Authentic	-0.181	Sad emotion	-0.154
Lack	0.179	Leisure	-0.153
Personal pronoun	-0.173	Lifestyle	-0.15
PC11 (*)		PC13 (*)	
LIWC category	Loading score	LIWC category	Loading score
You	0.243	Cause	0.235
Achieve	-0.229	Mental	-0.228
Death	-0.206	Visual	-0.197
Work	-0.191	Time	0.196
Male	0.177	Perception	-0.19
Cognition	-0.174	Past focus	-0.18
Lifestyle	-0.17	Future focus	0.171
Q mark	-0.166	Conjunctions	0.165
Space	0.162	She/he	0.16
Certitude	-0.161	Need	0.158
PC18			
LIWC category	Loading score		
Moral	0.318		
Impers. Pronoun	0.295		

Need	-0.265
You	-0.208
Personal pronoun	-0.185
Certitude	0.169
Motion	0.169
Words per sentence	0.167
Apostrophes	-0.159
Affect	0.159

Chapter 3 Supplemental Materials

Supplemental Figure 1 - On the left, the first SoC produced; on the right, the second. The first was always either spoken or typed, while the second was either the alternate modality (e.g., if first they spoke, they then typed) or simultaneously engaging in both speaking and typing.

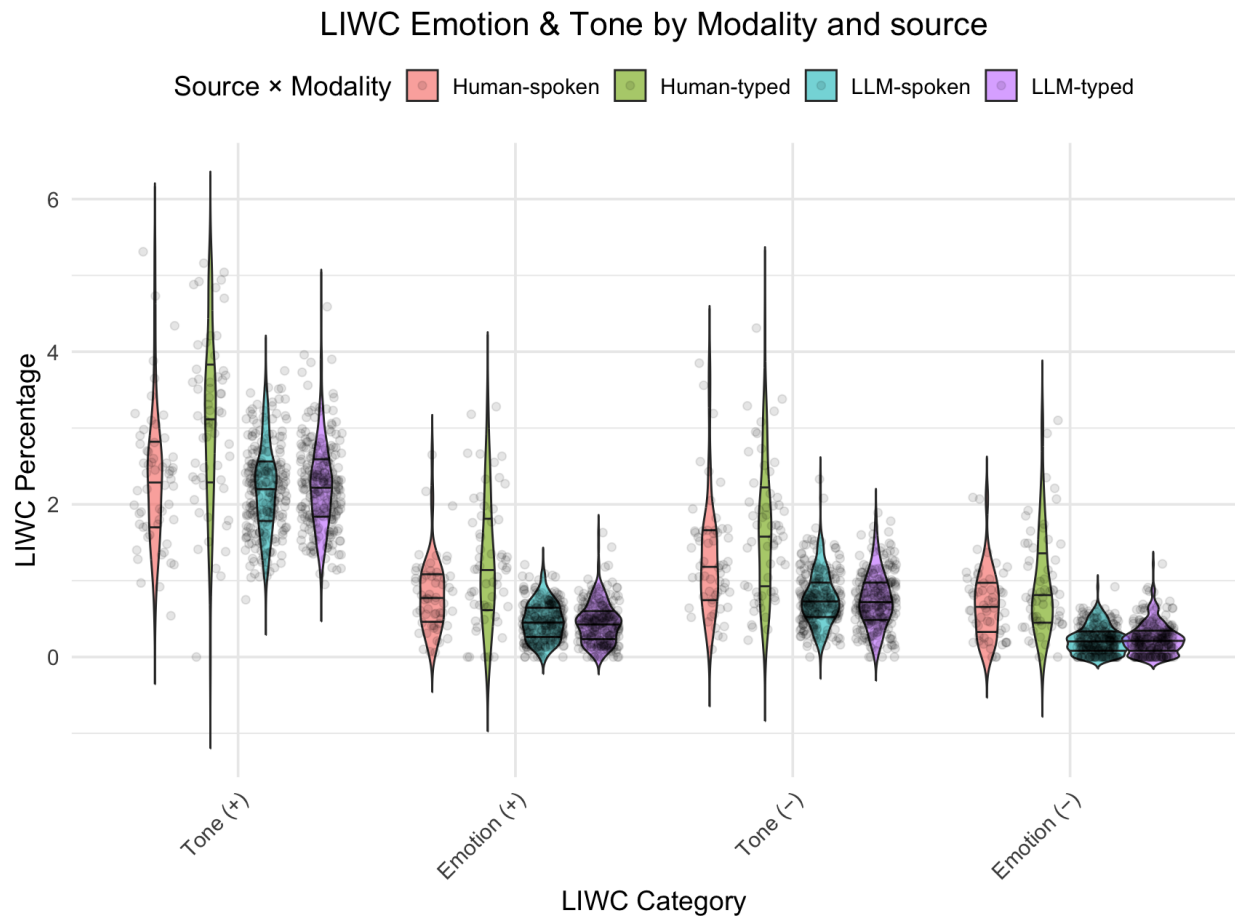
Type-Token Distributions for first (left) and second (right) SoCs



Supplemental Table 2 - The results of a model including the log-transformed types predicted by log-transformed tokens, modality (spoken versus typed), source (human versus LLM), and their two- and three-way interactions.

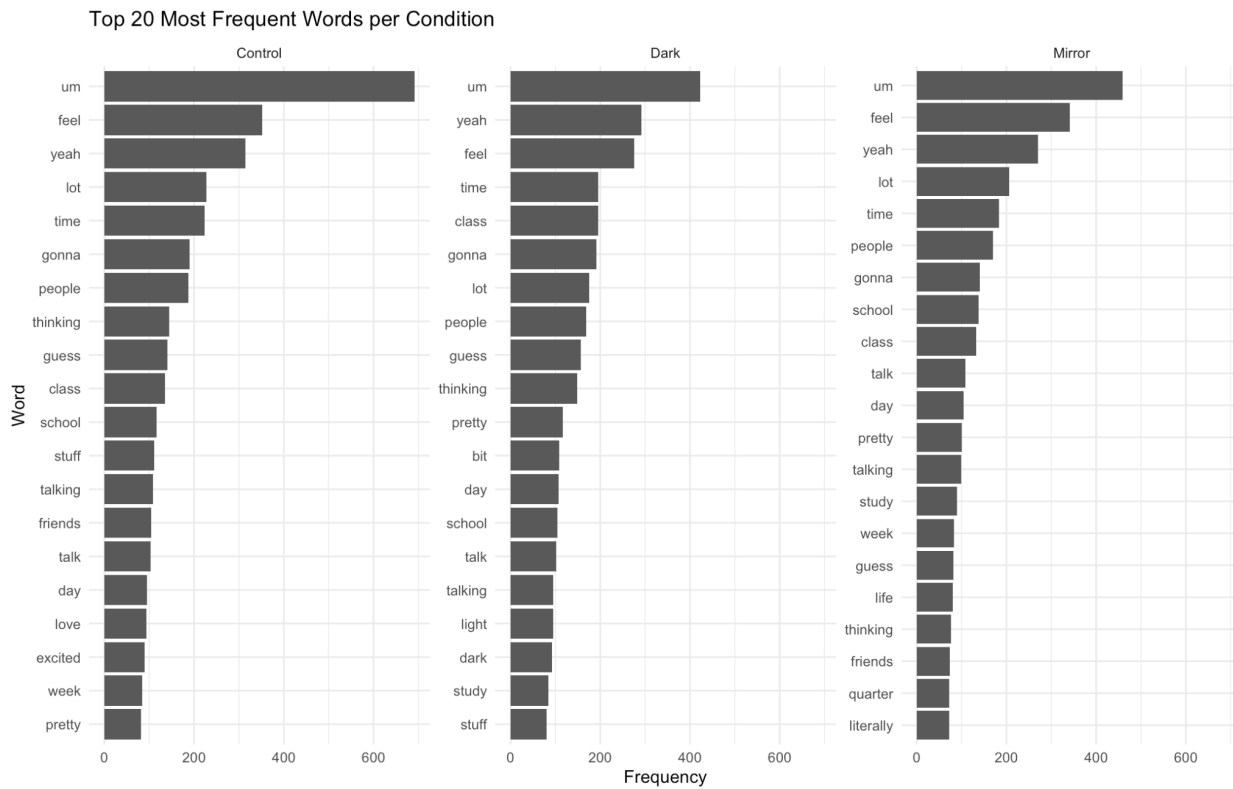
	Estimate (β)	Standard error	t-value	p-value
Intercept	1.92358	0.27805	6.918	< .001
log(tokens)	0.55446	0.03842	14.430	< .001
Modality_{typed}	-0.77924	0.34851	-2.236	0.026
Source_{LLM}	-0.27128	0.29327	-0.925	0.355
log(tokens) * modality_{typed}	0.13698	0.05137	2.666	0.008
log(tokens) * Source_{LLM}	0.08177	0.04073	2.007	0.045
Modality_{typed} * Source_{LLM}	0.91612	0.37076	2.471	0.014
log(tokens) * Modality_{typed} * Source_{LLM}	-0.15948	0.05458	-2.922	0.004

Supplemental Figure 2 - Violin plots showing LIWC sentiment for spoken versus typed, and human versus LLM SoCs.



Chapter 4 Supplemental Materials

Supplemental Figure 3 - Top 20 most frequently used words for each condition.



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