Evolution and Human Behavior 37 (2016) 423–428

Contents lists available at ScienceDirect

Evolution and Human Behavior

journal homepage: www.ehbonline.org

Original Article

Something to talk about: are conversation sizes constrained by mental modeling abilities?☆

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ARTICLE INFO

Article history:
Initial receipt 7 September 2015
Final revision received 30 May 2016

Keywords:
Communication
Group size
Language
Theory of mind
Mentalizing
Social brain

ABSTRACT

Conversations are ubiquitous and central elements of daily life. Yet a fundamental feature of conversation remains a mystery: It is genuinely difficult to maintain an everyday conversation with more than four speakers. Why? We introduce a "mentalizing explanation" for the conversation size constraint, which suggests that humans have a natural limit on their ability to model the minds of others, and that this limit, in turn, shapes the sizes of everyday conversations. Using established methodologies for investigating conversation size, we pit this mentalizing hypothesis against two competing explanations—that the size of a conversation is limited by a short-term memory capacity (limiting the factual information we process) or by an auditory constraint (speakers need to be able to hear what each other are saying)—in conversations drawn from a real-world college campus and from Shakespearean plays. Our results provide support for the mentalizing hypothesis and also render alternative accounts less plausible.

1. Introduction

> "Each person's life is lived as a series of conversations."
> [- Deborah Tannen (1991, p. 13)]

Conversation wears many hats. Conversation enables strangers to engage in everyday cooperative acts—from business transactions to building social relationships. Conversation is a means by which friends are made and romances kindled (or snuffed out). Yet, as any dinner party host knows, a conversation with more than a handful of speakers is hard to sustain.

Multiple studies affirm this: Everyday conversations, as opposed to lectures or formal discussions, rarely exceed four participants (one speaker and three listeners; Dezecache & Dunbar, 2013; Dunbar, Duncan, & Nettle, 1995; Dunbar, 2009, 2016). With the addition of a fifth participant, or more, one conversation typically fissions into two. Indeed, this real-world effect is so robust that dramatists mirror it in fiction: Across Shakespearean plays, modern "hyperlink" films, and even British soap operas, the average number of speakers per scene does not exceed four (Krems & Dunbar, 2013; Matthews & Barrett, 2005; Stiller, Nettle, & Dunbar, 2005).

If everyday conversations are how we cooperate, connect, and ultimately communicate with one another, then why are we typically limited to conversing with no more than three other people at a time? Two alternative hypotheses have been suggested—that the constraint is set by the number of minds a speaker has to model (the mentalizing hypothesis; Krems & Dunbar, 2013) or by the effect that the physical spacing of speakers has on speech detectability (the speech detectability hypothesis; Cohen, 1971; Dunbar et al., 1995; Sommer, 1971; Webster, 1965). A third possibility, not explored in the literature, is that the size of a conversation is limited by the mind's capacity for information processing (the 'magical number' 4 ± 1; Cowan, 2001).[1]

1.1. Mentalizing constraints

A mentalizing account draws on advances in research on human theory of mind (ToM). ToM refers to the capacity to understand another person's mindstate (i.e., to mentally model another's wants, beliefs, etc.). In the sentence "Bettina understood that Eliott wanted to play tennis," Bettina is modeling Eliott's mind, thereby exhibiting ToM. But ToM is just one 'level' of the larger capacity for mentalizing, which can be understood in terms of levels of intentionality. For example, when Bettina

☆ The data analyzed in this article are freely available here: https://dataverse.harvard.edu/dataverse/conversation_size_constraint.

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[1] Previously, Miller (1956) had suggested that people could remember approximately 7 ± 2 chunks of information in short-term memory. Updating this long-standing and widely-taught limit, Cowan (2001) gathered growing and robust evidence suggesting that people actually possess a lower capacity (of 4 ± 1).

http://dx.doi.org/10.1016/j.evolhumbehav.2016.05.005
1090-5138/

models Eliott's mind, she is mentalizing at second-order intentionality (exhibiting ToM), but when the reader models Bettina's mind, which is, in turn, modeling Eliott's mind, the reader is mentalizing at third-order intentionality, and so on (e.g., You *comprehended* that Bettina *understood* that Eliott *wanted*…; Dennett, 1988; Kinderman, Dunbar, & Bentall, 1998). Intentionality thus forms a naturally-recursive hierarchy of increasingly embedded mindreading. Thus, each additional instance of simultaneous mental modeling adds an additional level of intentionality (e.g., the authors *intended* that the reader *comprehend* that Bettina *knew* that Eliott *wanted*…).[2]

Higher-order intentionality can be cognitively demanding. Almost all human adults can comfortably work at fourth-order intentionality, and many can ably manage fifth-order (Kinderman et al., 1998; Powell, Lewis, Roberts, Garcia-Fiñana, & Dunbar, 2010; Stiller & Dunbar, 2007). But only about 20 percent of people can cope above fifth-order intentionality (Kinderman et al., 1998; Stiller & Dunbar, 2007; Zunshine, 2006). For most, the multiple layers of thoughts, beliefs, and desires simply become too difficult to follow. Similarly, there may be limits on the number of other individual minds that one can model at any one time. For example, Bettina might be able to keep straight what Eliott thinks of her, what a second person thinks of her, and what a third person thinks of her, and so on, but each additional instance of second-order mentalizing might be increasingly difficult to simultaneously manage.

Different conversations require different management capabilities (i.e., different amounts of mentalizing resources). For instance, a parent lecturing a teenager poses low demands: the parent has to model only the teenager's mind (second-order intentionality), and the teenager has to model only the parent's mind (also second-order intentionality). By contrast, larger conversations may require one to model the minds of more speakers, thus requiring higher levels of competency for successful communication (e.g., Dunbar, 2009; Zunshine, 2006). At the famed Camp David political summit in 2000, for instance, it may have served U.S. President Bill Clinton to know both what Israeli Prime Minister Ehud Barak and what Palestinian Authority Chairman Yasser Arafat thought about him, and it was perhaps even more useful for Clinton to know what Barak thought that Arafat wanted. In this three-person conversation, then, Middle Eastern peace negotiations required at least third-order intentionality.

1.1.1. A mentalizing explanation

As mentalizing competency is limited in most adults, the mentalizing hypothesis predicts that most conversations will be respectful of this limit. Concretely, as it becomes difficult to follow a conversation above fourth-order intentionality (one speaker modeling three other minds), most conversations are not likely to exceed a four-person limit.[3] And the addition of a fifth person may put pressure on the growing conversation to fragment into smaller, mentally-manageable conversations.

This specific prediction accords with the previous literature: everyday conversations do seem to have a four-person limit (Dezecache & Dunbar, 2013; Dunbar et al., 1995; Krems & Dunbar, 2013; Matthews & Barrett, 2005; Stiller et al., 2005). Moreover, a link between mentalizing capacity and conversation size is further bolstered by evidence demonstrating that an individual adult's mentalizing capacity correlates with the size of their core friendship group (Stiller & Dunbar, 2007).

1.2. Alternative hypotheses

Although there is some circumstantial evidence to support the suggestion that mentalizing limits conversation group size, there are at least two alternative explanations that may also account for this four-person limit. According to the speech detectability hypothesis, as the physical size of the conversation circle increases, it gets more difficult for those involved in the conversation to hear one another (Cohen, 1971; Sommer, 1971; Webster, 1965). Previous work in this vein has suggested that auditory constraints can cause an approximately four-person limit on conversation size (Dunbar et al., 1995). And, although not posited in the literature, a factual working memory account might also explain this limit on conversation size. On this view, factual working memory is limited in the number of chunks of information (e.g., numbers) that a person can manage at any one time (4 ± 1; Cowan, 2001). Whereas it may be stretching the context somewhat, applying this limit to conversations might also suggest that conversation sizes would not typically exceed four speakers.

1.3. The present work

A mentalizing explanation, and also each of these two alternative explanations, can all conceivably account for the robust limit on conversation size. However, we can test between the hypotheses by considering the implications of conversation topic. According to the mentalizing hypothesis, everyday conversations might require a speaker to model the minds of fellow conversationalists (e.g., what they think, what they believe others think), but some conversations might further ask a speaker to model the mind of someone named in—but, importantly, not physically present in—the conversation. For example, Bill Clinton could know that he had a tough negotiation on his hands; a person tasked with inferring this is then modeling Clinton's mindstate. If the mentalizing hypothesis is correct in proposing that mentalizing competency constrains conversation size, then talking about an absent party (in this case, Clinton) in a way that requires mentalizing will further restrict conversation size. That is, modeling the mind of a person not physically present in the conversation will eat up "a unit" of mentalizing that can no longer be spent on another fellow speaker. Thus, when speakers are discussing the thoughts, beliefs, or desires of an absent party, the conversation size should drop from its conventional average maximum of *four* to *three*.

In contrast, the speech detectability hypothesis would not expect an influence of conversational content on conversation size. Moreover, a factual working memory account might predict a decrease in conversation size because the absent party's mind is another chunk of information to manage, but this account would also predict a decrease in conversation size when any type information about an absent party is discussed. Thus, we can easily distinguish between the social (i.e., mentalizing) and factual capacity accounts: according to a mentalizing account, speakers' mentalizing resources are only expended when modeling the mind of an absent party, but not when discussing an absent party in such a way that does not call on mentalizing abilities (e.g., "Clinton *intends* to negotiate" versus "Clinton looks older" or "Clinton has arrived"). A working memory account would not make a distinction as to how speakers discuss an absent party.

We test between these three hypotheses by determining whether or not conversation size is affected by topic in two disparate samples, beginning with naturally-forming conversations. As it seems that the rules of everyday social interaction and their psychological underpinnings are also used to design conversations in scripted plays, we also

[2] There may exist different ways to "count" levels of intentionality. Here, we follow an established convention of discussing and calculating levels of intentionality (e.g., Dennett, 1988; Kinderman et al., 1998; Powell et al., 2010), which holds that a level of intentionality is "used" whenever one models the mind of another person and regardless of how one comes to know that mindstate (e.g., whether Bettina inferred Eliott's want to play tennis, comprehended Eliott's want to play tennis, or was told by Eliott that he wanted to play tennis).

[3] This is not to say that all conversations *require* recursive mind-reading; that is, whereas, for example, fourth-order intentionality is inherently recursive, four-person conversations need not be (even as such conversations may still require a speaker to model multiple individuals' minds simultaneously). However, there is some suggestion that engaging in such recursive mind-reading may be helpful for ensuring accurate, clear communication (the speaker knows that the listener comprehends what the speaker intends to convey; e.g., Dunbar, Launay, & Curry, 2015; Sperber & Wilson, 1995).