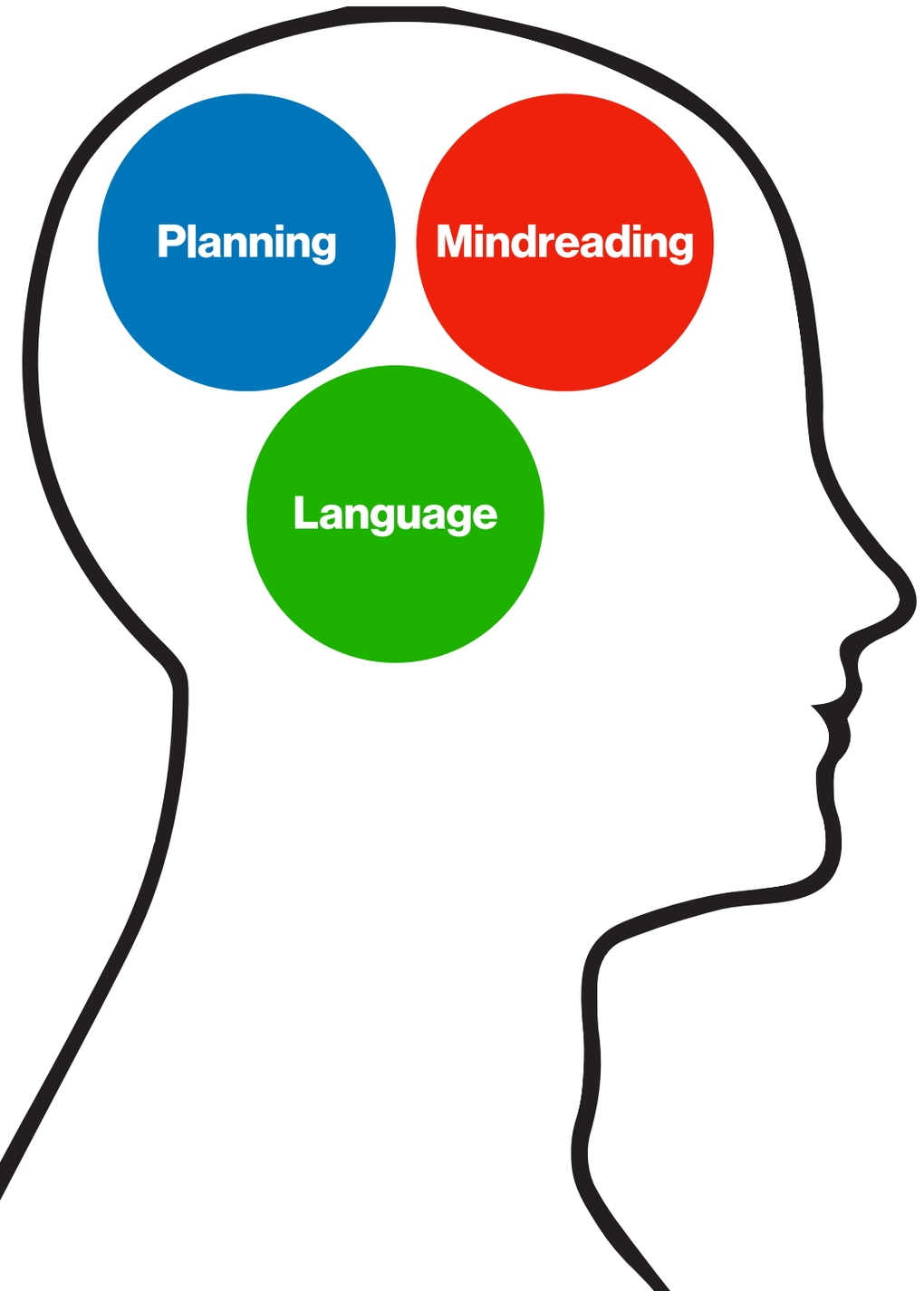
COMMUNICATION & COGNITIVE ARCHITECTURE

Week 2: Intention Recognition and its Psychological Underpinnings

Daniel W. Harris

1. Intention Recognition and its Psychological Underpinnings

(Sept 14)



Our capacity for intention recognition emerges from our capacities for mindreading, planning, and language.

Whereas language is a Fodor-modular system, planning and mindreading are not.

Theo

What are the stakes of the more controversial claims you put forward for the project as a whole? If, for example, it was found that some animal has significantly more planning, mindreading, and complicated communicative systems then has currently been shown, would that radically alter your theory, or merely change some things around the margins? What about if the evidence eventually weighed against the encapsulation of the language system?

Alanna:
Why focus on humans? Why not study cognitive architecture and communication across species? What are the possible benefits when comparing and contrasting across species? What are the limitations of understanding humans in comparison to understanding the limitations of other species?

For example, if we talk about planning it might be useful to look beyond the perspective of humans because we are limited in planning by our relationship to time and space. Temporal qualities shape how far ahead we can foresee, remember, and react. Humans don't seem to be exceptionally gifted at this. Just different from most species. What does it mean to be even gifted at this?...

Alanna:
It seems like we have many advantages compared to other species to communicate with our bodies. Why do we have these advantages? What are the roles of biological evolution? Why does it seem like humans are thriving? Are we?

https://danielwharris.com/book/DanielWHarris-WhatMakesHumanCommunicationSpecial.pdf

Chapter One:

What Makes Human Communication Special?

Daniel W. Harris*

Draft of October 27, 2020

8 Our flexible decisions about when, what, and with whom to communicate

The use of semantically underspecified signals requires flexible sensitivity to background information on the part of receivers. We also display considerable flexibility in the kinds of situations in which we decide to send signals at all, and in the degree to which the communicative functions of our signals may be detached from the situations in which we send them.

For the most part, nonhuman organisms signal in a limited range of situations, and what they communicate is usually closely tied to predictable features of the environment that they are in. Although it is notable that honeybees dance to communicate information about distant resources that their audiences have never experienced, they do this only soon after they have returned from these resources, and only with the function of sending their hive-mates there. Many primates will issue alarm calls only if they take their group members to be in earshot, indicating that they are sensitive to whether they have an audience (Cheney and Seyfarth, 2018; Seyfarth and Cheney, 2018). And some primates continue to issue alarm calls until all of their group members do the same—a mechanism for ensuring that their addressees have understood (Wich and de Vries, 2006). However, primates produce alarm calls only as a direct result of perceiving threats (Cheney and Seyfarth, 1990).

9 Our ability to design signals for our addressees

Humans interpret signals in flexible ways, and also make flexible decisions about when, where, and what to communicate. But we also make highly flexible decisions after we've decided what to communicate, when it comes time to design a signal with which to communicate it to a particular addressee. We customize our signals in ways that no other creatures do.

Suppose that you want to tell me something about a particular person, and you need to choose a way of referring to them in order to do so. You have many referring expressions to choose from, and making a good selection will require accounting for the situation in which we're talking, including your information about the information that is available to me. One possibility is that the person you want to tell me about is me, and you know this, in which case you should utter 'you'. Another possi-

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Sequential Tool Use in Great Apes

Gema Martin-Ordas[1,2]*, **Lena Schumacher**[1], **Josep Call**[1]

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Abstract

Sequential tool use is defined as using a tool to obtain another non-food object which subsequently itself will serve as a tool to act upon a further (sub)goal. Previous studies have shown that birds and great apes succeed in such tasks. However, the inclusion of a training phase for each of the sequential steps and the low cost associated with retrieving the longest tools limits the scope of the conclusions. The goal of the experiments presented here was, first to replicate a previous study on sequential tool use conducted on New Caledonian crows and, second, extend this work by increasing the cost of retrieving a tool in order to test tool selectivity of apes. In Experiment 1, we presented chimpanzees, orangutans and bonobos with an out-of-reach reward, two tools that were available but too short to reach the food and four out-of-reach tools differing in functionality. Similar to crows, apes spontaneously used up to 3 tools in sequence to get the reward and also showed a strong preference for the longest out-of reach tool independently of the distance of the food. In Experiment 2, we increased the cost of reaching for the longest out-of reach tool. Now apes used up to 5 tools in sequence to get the reward and became more selective in their choice of the longest tool as the costs of its retrieval increased. The findings of the studies presented here contribute to the growing body of comparative research on tool use.

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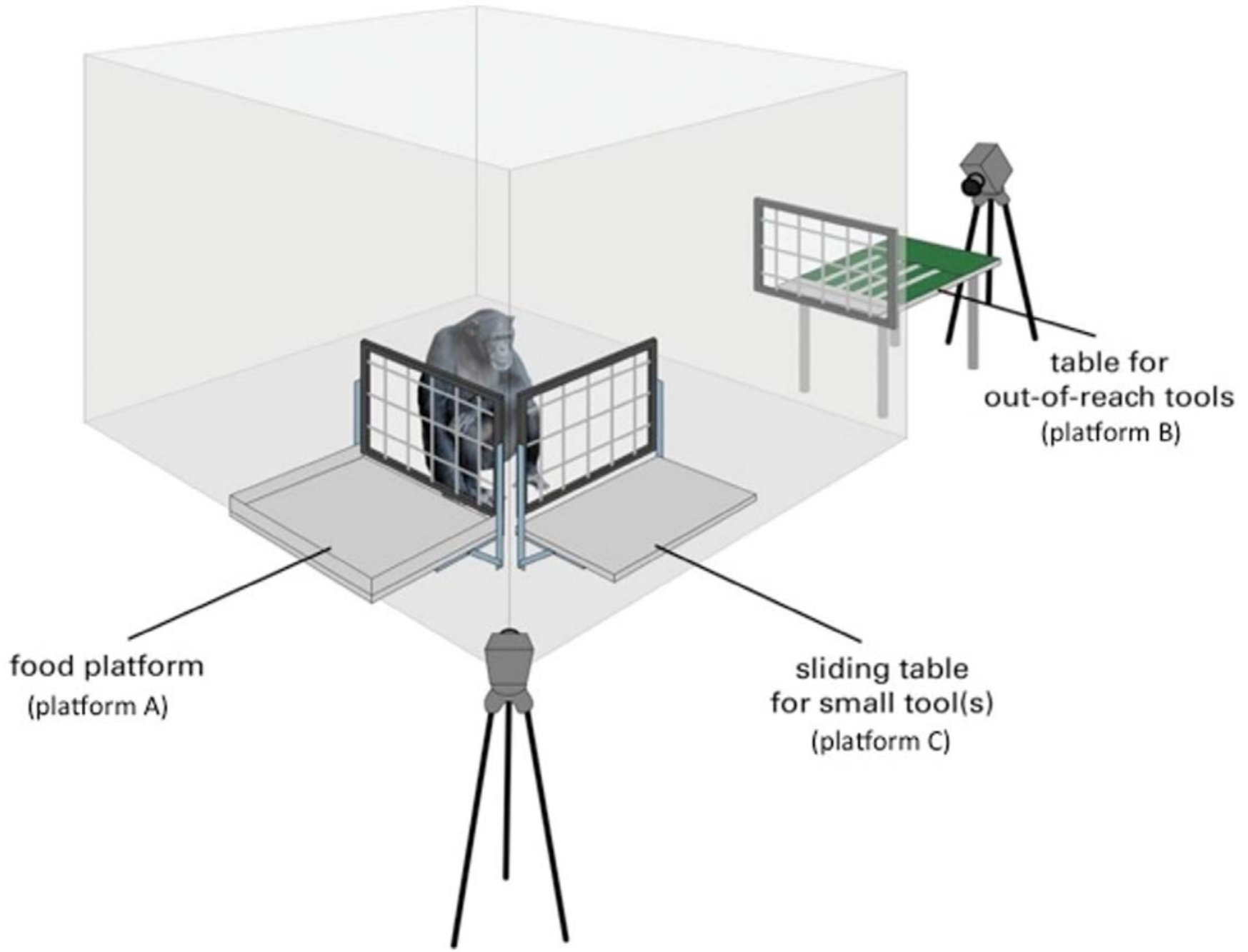

"...the results reported here demonstrate that apes were able to perform multiple steps of a complex behavioral sequence and, consequently, act in a goal-directed manner by using a tool to access as many out-of-reach tools as necessary in order to get a reward."

Eleonora

Which Came First, Linguistic Encoding/Decoding, or Intention Recognition?

I was puzzled by the claim that “the linguistic encoding and decoding involved in human communication always subserves a larger process of intention recognition" (Harris, §7, Ch. 1). In particular, it is not clear to me that the communication + reception of some content is subservient to intention recognition. Rather, it seems to me that the grounding relation should be flipped! This is because I sympathize with the intuition that the most fundamental aspect of communication is to exchange information (which we may loosely identify with semantic content), and that intention recognition is but one way to do so successfully.

Eleonora

In more detail, consider an instance of linguistic communication between a speaker and an addressee. The overarching goal of communication is to convey some content P, and part of what it takes to successfully do so may be for the addressee to recognize the speaker's intention to do so. That is, if S wishes to communicate P, then S should certainly act in ways that will ensure/facilitate that the addressee understands that S means to convey P. However, P may be effectively communicated even without a successful intention recognition. This is because it seems to me that one may successfully communicate some semantic content without a successful intention recognition, but I do not see how there may be successful communication with a successful intention recognition but without some semantic content. In other words, while it is possible for S to communicate P without the intention to do so, S can't have the intention to communicate P without P. In turn, since intention recognition is neither a sufficient nor a necessary condition for successful communication, it is in this sense that I believe that (i) the grounding relation ought to be flipped, as intention recognition subserves the communicative intent of some semantic content, and (ii) P is more fundamental than the intention to communicate P, in the context of human communication.

Elliot, responding to Eleonora (+1 Griffin)

I found this super helpful in thinking through some things related to the overall project. I think its important to distinguish information (or more loosely the stuff communicated) from encoding/decoding. Plausibly all communication involves a speaker getting an addressee to represent some information; so I agree with you that all communication requires some stuff P that is communicated. However, I think the fact that some information is always communicated does not mean this information is always encoded/decoded. In the relevant sense, code is a conventionalized pairing of semantic content to symbols (e.g. SOS pairs to "..._____..." in morse code). But in cases like flushing the goldfish, we don't have any sort of predetermined semantic content paired with the act of flushing. Converesly, in cases where there is encoded semantic content (e.g., "Smith has very good handwriting") the information communicated is subject to considerations of intention recognition (e.g., the sentence appears in a rec letter for smith). I found the first 10-15 pages of 'Relevance' by Sperber and Wilson helpful for understanding what Griceans mean by code.

Eleonora again

Which Came First, *Linguistic Encoding/Decoding, or Intention Recognition?*

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This is because it seems to me that one may successfully communicate some **semantic content** without a successful intention recognition, but I do not see how there may be successful communication with a successful intention recognition but without some **semantic content**.

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Shintaro

Our signals are semantically underspecified, so we use background information to fill the gap. In this process, what ultimately determines the gap to reach full propositions? (For instance, which element is supposed to determine the standard of richness for a particular token of “rich” in this overall picture?)

On the one hand, background information employed by an addressee seems something to play that role. However, on the other hand, the fully specified content is what a speaker intends to convey (if the communication successfully proceeds). In that case, the speaker’s intention seems to ultimately determine the unspecified parts of the signal. Rather, we might think that these elements together play that role in each conversational context. (Or, is the whole picture proposed in section 2 neutral with this issue?)

Neale, This, That, and the Other, p.78:

...it would be perverse to insist upon a distinction between what A meant and what A intended to mean (and for good reason if Grice is right), a distinction between what A said and what A intended to say is not one obviously lacking a point. So, in the first instance, we should separate (i) what A intended to say by uttering X on a given occasion, and (ii) what a rational, reasonably well-informed interpreter in B's shoes would think A intended to say by uttering X on that occasion (which is not to say there are not problems with the idea of a rational, reasonably well- informed interpreter in B's shoes). In cases where (i) = (ii), we can talk freely about what the speaker said. (In cases where (i) ≠ (ii), certainly we could argue about which of (i) or (ii) or some third thing has the 'right' to be called what is said, but what would be the point? First, what third thing distinct from (i) and (ii) could be of any significance to a theory of interpretation? There is simply no rôle for a transcendent notion of what is said upon which (i) and (ii) converge when all goes well. Second, why is a choice between (i) and (ii) even needed in cases where (i) ≠ (ii)?

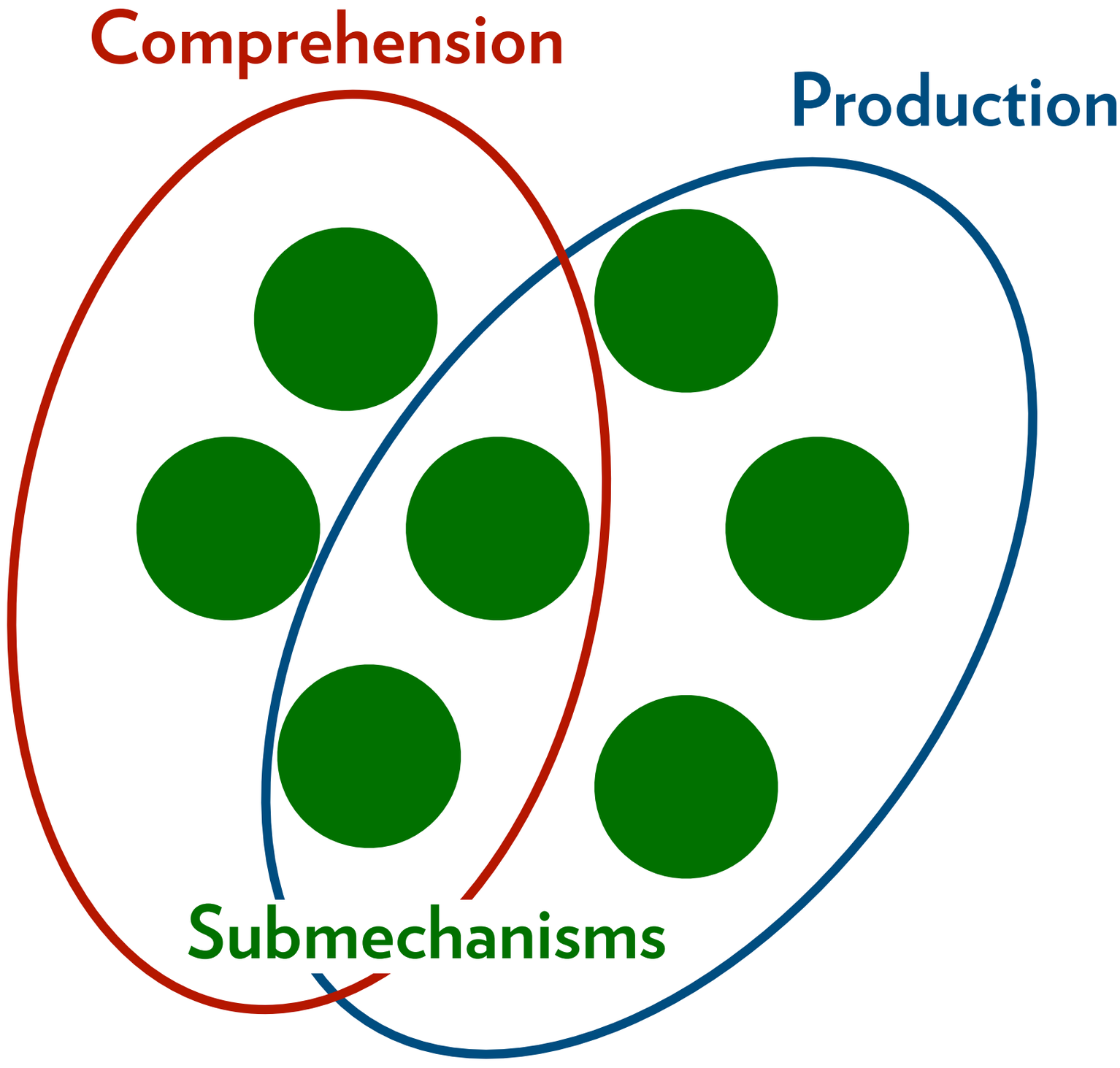
Griffin

My question is whether the encoding (production) and decoding (processing) aspects of language are computed by a single system, or distinct systems? There are considerations that pull in each direction. In favor of a multiple-module view, one of Fodor's criteria for being a module was that the system has a specific domain of inputs. And it seems that production and parsing have different inputs: language production takes motor commands as inputs, whereas language processing takes some sort of mental representation caused by sensory stimuli.

However, pulling towards the view that there's a single module, we seem to produce and process language using the same Chomskyian grammar. There needs to be some connection here, at least in one direction: the language a person processes must make a difference in language production; we learn linguistic rules by perceiving them. But if language processing and production are informationally encapsulated, and both language production and processing draw on the same base of information, then they are necessarily the same module.

Griffin

Perhaps this is a sort of edge case in which we should add some nuance to informational encapsulation? One idea would be to hold that there are two systems – language processing and production, and each is domain specific, but they are not informationally encapsulated from one another – even if they are informationally encapsulated from the central system(s)


Comprehension
Production
Submechanisms

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An integrated theory of language production and comprehension

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Abstract: Currently, production and comprehension are regarded as quite distinct in accounts of language processing. In rejecting this dichotomy, we instead assert that producing and understanding are interwoven, and that this interweaving is what enables people to predict themselves and each other. We start by noting that production and comprehension are forms of action and action perception. We then consider the evidence for interweaving in action, action perception, and joint action, and explain such evidence in terms of prediction. Specifically, we assume that actors construct forward models of their actions before they execute those actions, and that perceivers of others' actions covertly imitate those actions, then construct forward models of those actions. We use these accounts of action, action perception, and joint action to develop accounts of production, comprehension, and interactive language. Importantly, they incorporate well-defined levels of linguistic representation (such as semantics, syntax, and phonology). We show (a) how speakers and comprehenders use covert imitation and forward modeling to make predictions at these levels of representation, (b) how they interweave production and comprehension processes, and (c) how they use these predictions to monitor the upcoming utterances. We show how these accounts explain a range of behavioral and neuroscientific data on language processing and discuss some of the implications of our proposal.

Keywords: comprehension; covert imitation; dialogue; forward model; language; prediction; production

Steve

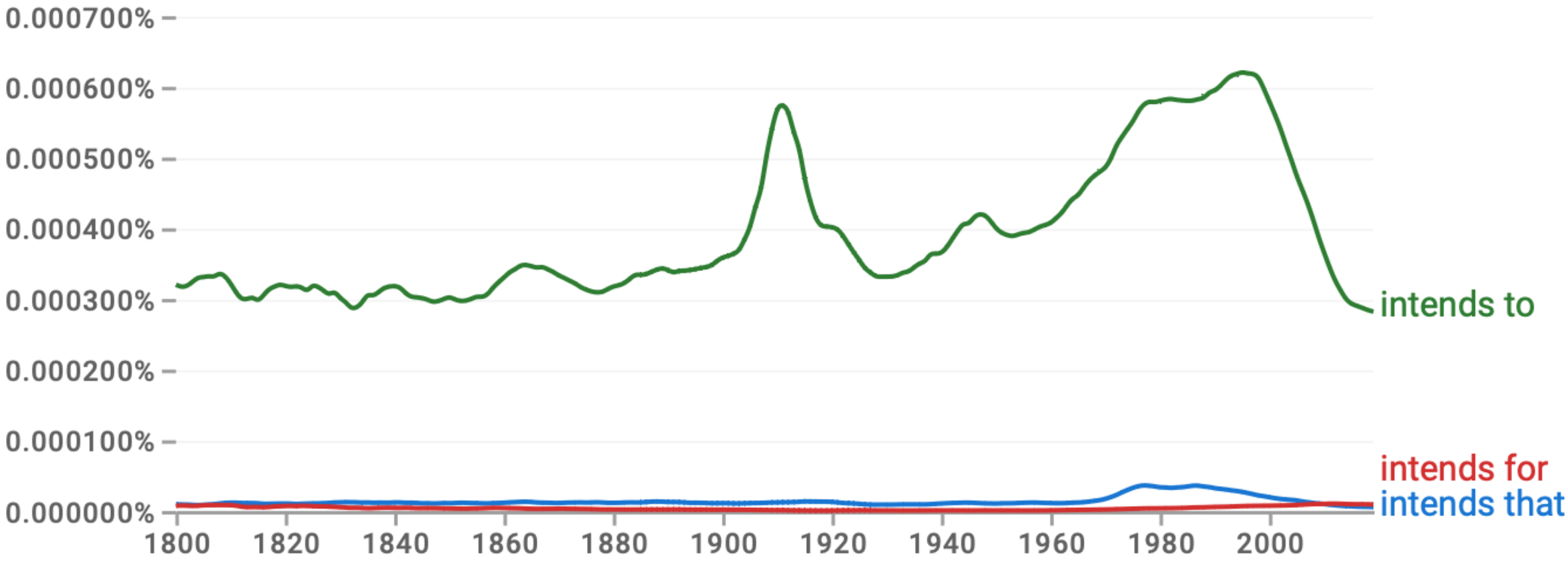
What does it mean for me to intend for you to phi? Surely I can't intend anyone's actions but my own. And if an intention-based theory of communication is trying to provide some psychological explanation for our linguistic actions, then it must be rooted in an individual's mental state, and not some amorphous shared intention/action (which I have a hard time making any sense of).

Another gloss might be: "I intend for you to phi" means "I intend to perform an action that results in you phi-ing." That seems to solve the issue. Not sure if this is a quibble or a deeper issue!

Google Books Ngram Viewer

intends that,intends for,intends to

1800 - 2019 | English (2019) | Case-Insensitive | Smoothing



Steve

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Let's see if Chapter 3 changes your mind!

Steven

I liked the idea of semantic underspecification in §2. It's noted that this feature expands our expressive capacity and improves processing efficiency. It also strikes me as a way to hedge against offensive communications or slights (intended or otherwise). Collectively, these features seem to serve a greater (and perhaps understated) function of communicating complex internal states that may be the sum of many independent intentions - arguably one intention, I suppose, but decomposable nonetheless. We've discussed chains of intentions (X utters Y to produce an action in Y that induces an event Z), but it strikes me that most utterances aim to accomplish many things at once. If I offer an apple to a professor, I may be simultaneously: attempting to curry favor; reinforcing their image of me as a good person; or trying to rid myself of this rotten, bruised apple. It's reasonable that all these may accomplished by the same non-verbal utterance.

Utterer's Occasion Meaning

(Grice 1969)

"U meant something by uttering x" is true iff, for some audience A, U uttered x intending

(i) A to produce a particular response r;

(ii) A to think (recognize) that U intends (i);

(iii) A to fulfill (i) on the basis of fulfilling (ii).

2

Insinuation, Common Ground, and the Conversational Record

Elisabeth Camp

2.1 Cooperation and Conflict

Most theorizing about linguistic communication assumes that conversation is a cooperative enterprise—specifically, one in which parties contribute information to a joint project of figuring out how the world is.[1,2] There are many reasons to adopt an assumption of cooperativity. First, simply as an empirical generalization, many conversations are cooperative; and it's methodologically wise to start with common, simple cases. Second, the fundamental nature of language as a conventional representational system requires a significant degree of cooperation for linguistic communication to occur at all. As Locke says, because the association between linguistic sign and signified is voluntary and arbitrary, each person has an "inviolable liberty to make words stand for what ideas he pleases"; it is only a desire to be understood that produces a "tacit consent" to go along with "common use" (1689, III.2). These features, of voluntariness and arbitrariness, render it very natural to model linguistic meaning as a set of conventions for solving a coordination problem, which builds in cooperativity (Lewis 1969, Skyrms 2010). Third, the fundamental

Kristin:
I'd like to check-in first and make sure I have a somewhat accurate understanding of aspects from pages 9-10:
Because of intention recognition, we can communicate with a novel signal under episodes of non-conventional communication by attributing what state of mind best explains a person's behavior and inferring intention. Employing context as a fallback perhaps, we can then use that inference to pair the signal-type with meaning. With this in place, we don't have to rely on pre-established regularities or convention to explain the person's behavior. And whatever signals that do look to pre-established regularities, conform with convention or acquire stable conventionalized meanings become stored in our repertoire but are nonetheless "subservient" to the powers of intention recognition. They work to offer "partial and defeasible evidence of our intentions" (Harris 10).

Kristin:
What I'm interested in, is David Lewis' "path to convention acquisition" that's mentioned within this explanation, which admits of certain non-conventional communication (9). The section cited is about novel coordination or, since coordination is a "conspicuous common character" within the "class of situations" that language use is a part of (Lewis, Convention, 5), maybe its also about novel communication and/or novel signaling. However I can mush these things together. I was wondering are you (Prof. Harris) citing Lewis because he admits of this non-convention OR because you also see certain elements of Lewis' theory (in the cited section) that are compatible with intention recognition? Or anyone else does. For instance, I could see how 'expectations' would be kind of seamless with intention recognition but there's also this super curious use of 'analogy' in these sections which I'm particularly interested in. Especially because I've found that Lewis believed analog systems and analogy might have shared commonalities. If these assumptions/facts check out, I can elaborate on all this.

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Signalling signalhood and the emergence of communication

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ABSTRACT

A unique hallmark of human language is that it uses signals that are both learnt and symbolic. The emergence of such signals was therefore a defining event in human cognitive evolution, yet very little is known about how such a process occurs. Previous work provides some insights on how meaning can become attached to form, but a more foundational issue is presently unaddressed. How does a signal signal its own signalhood? That is, how do humans even know that communicative behaviour is indeed communicative in nature? We introduce an experimental game that has been designed to tackle this problem. We find that it is commonly resolved with a bootstrapping process, and that this process influences the final form of the communication system. Furthermore, sufficient common ground is observed to be integral to the recognition of signalhood, and the emergence of dialogue is observed to be the key step in the development of a system that can be employed to achieve shared goals.

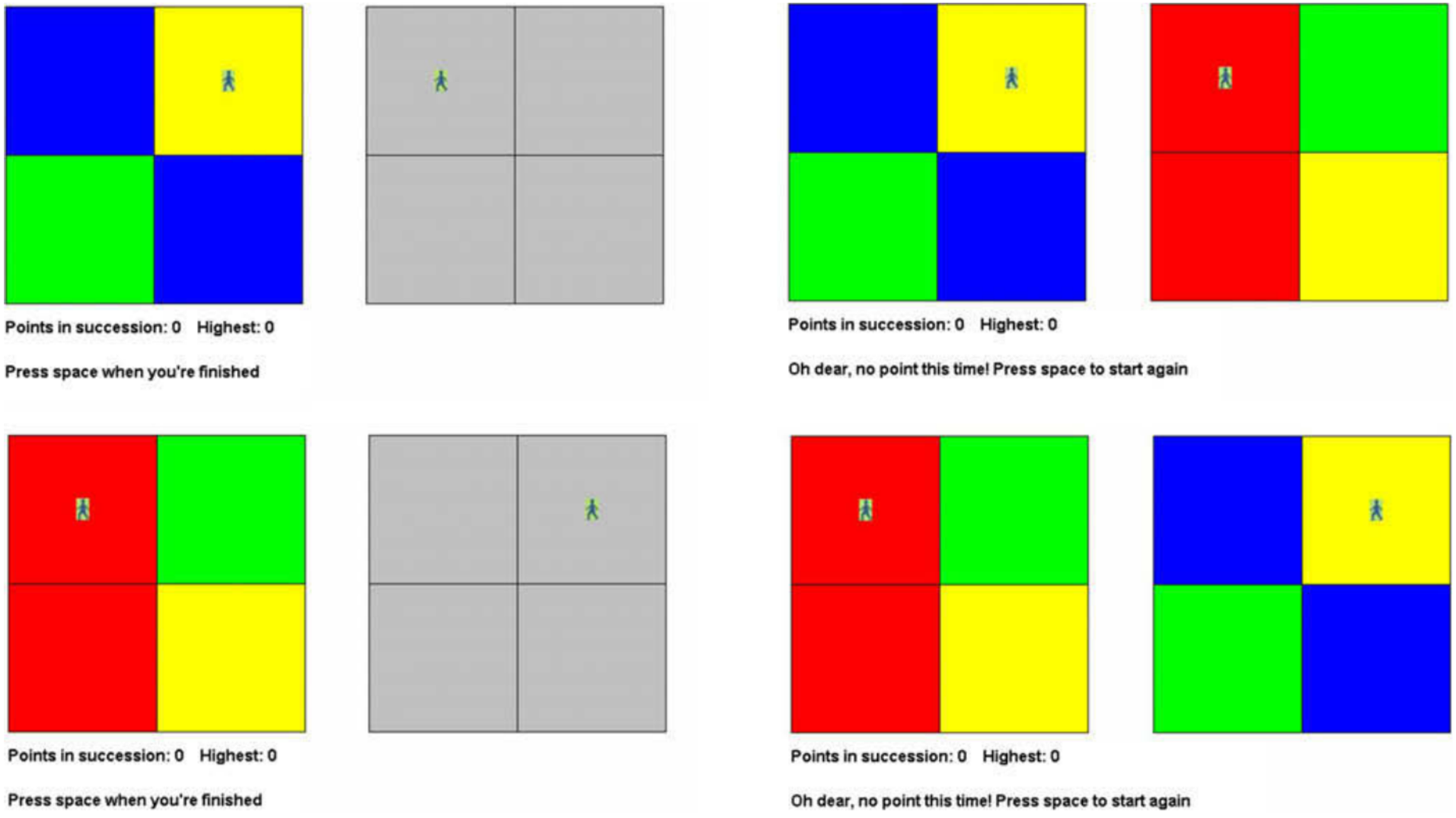

Fig. 1. Screen-shots of the game. Participants play multiple rounds of the game on networked computers. These screen-shots show the view of both players, one on each row, both before (left-hand side) and after (right-hand side) both participants have pressed space to finish their turn. Participants can see their own colours but not the other participants'. Participants move around their boxes at will, and their movements are fully visible to the other participant. At any time the participants may choose to press space to finish their turn, and when they do so all colours are revealed to both participants. Participants score a point if they finish on the same colour. Here, the participants have failed to score a point because they have finished the round on different coloured squares. After each round, the squares are reassigned colours randomly, although there will always be at least one shared colour (in this case, green). Succeeding at the game requires finding some way to communicate the intended destination colour each round. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Sadie

Question: How much might our interpretation of novel signals interact with our understanding of other, non-novel signals, in cases where we have a communicative act that seems to be made up of both kinds of signal? In the goldfish case, it seems like we use our background knowledge of what a particular type of communicative signal (eye contact, which doesn't seem novel, even if still semantically underdetermined in the way described elsewhere in this section) might mean in order to infer intention, as well as working out what the more novel flushing of the goldfish might mean with some other contextual background knowledge. When we interpret this act we use our understanding of how, more generally, looking someone directly in the eye whilst doing some activity acts upon the message conveyed by that action (eg. eye contact often signalling assertiveness whilst avoidance of eye contact might signal shame). The novel signal seems to have a non-novel part that can't be extricated from it.

...a widely adopted marker of ostensive performance in human communication is the presence of eye contact. By intentionally initiating eye contact with an interlocutor either during or shortly before speaking or gesturing for them, speakers can use their eye contact as a mechanism for addressing their words or gestures to the attention of their audience ...

—Richard Moore, "Meaning and ostension in great ape gestural communication"

See also:

Gómez, J. C. (1996). Ostensive behavior in great apes: The role of eye contact. In A. E. Russon, K. A. Bard, & S. T. Parker (Eds.), Reaching into thought: The minds of the great apes (pp. 131–151). Cambridge University Press.

from: Papers and Reports on Child Language Development. Vol . 15
August 1978. pp. 17 - 29

Acquiring a Single New Word

Susan Carey, Massachusetts Institute of Technology
Elsa Bartlett, Rockefeller University

By the time a child has learned a new word, he or she has gained many distinct kinds of information. To take a hypothetical example, consider the word "wolf" being learned by a child who already has a modest animal vocabulary. She must make a new lexical entry: she must note that "wolf" is an English word. She must learn its syntactic subcategorization, namely that it is a common noun. She must relate it to other English words, to its supernyms (such as "animal") and hyponyms (such as "Siberian wolf") and other words in the same lexical domain. She must also learn what "wolf" refers to_ And she must restructure the conceptual domain of animals, at least with respect to how they are named. Suppose, for example, that wolves were previously called "dog." Then learning a new word may be the occasion for learning a new concept, for differentiating dogs from wolves. At the very least, it is the occasion for learning that wolves have a different name from dogs. Clearly, then, learning even a single new word involves learning a great deal of information.

Chapter 3

Word Learning and Theory of Mind

Learning a word is a social act. When children learn that rabbits eat carrots, they are learning something about the external world, but when they learn that *rabbit* refers to rabbits, they are learning an arbitrary convention shared by a community of speakers, an implicitly agreed-upon way of communicating. When children learn the meaning of a word, they are—whether they know it or not—learning something about the thoughts of other people.

What does this tell us about how words are learned? Maybe nothing. Just because the relationship between a word and its meaning is a social fact doesn't entail that one needs social competence or knowledge to learn this fact. After all, when dogs learn to obey the command "Sit!," they are also learning an arbitrary convention, one that exists in the minds of a community of English speakers. But dogs surely don't know this and can learn the command without ruminating about the thoughts of others. All they might do is associate the right behavior

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Could theory of mind be the whole story of word learning? Perhaps learning the meaning of a word just reduces to intentional inference; once we know how children divine the intentions of others, there is nothing left to explain.

But a lot more is needed....

—Bloom, *How Children Learn the Meanings of Words*

LANGUAGE ACQUISITION, *I*(1), 3–55

The Structural Sources of Verb Meanings

Lila Gleitman
University of Pennsylvania

Children's attitude problems: Bootstrapping verb meaning from syntax and pragmatics

Valentine Hacquard | Jeffrey Lidz

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How do children learn the meanings of propositional attitude verbs? We argue that children use information contained in both syntactic distribution and pragmatic function to zero in on the appropriate meanings. Specifically, we identify a potentially universal link between semantic subclasses of attitude verbs, their syntactic distribution and the kinds of indirect speech acts they can be used to perform. As a result, children can use the syntax as evidence about the meaning, which in turn constrains the kinds of pragmatic enrichments they do and do not make in understanding these verbs in conversation.

KEYWORDS

attitude verbs, pragmatics, speech act, syntactic bootstrapping, theory of mind, word learning

Children's attitude problems: Bootstrapping verb meaning from syntax and pragmatics

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KEYWORDS
attitude verbs, pragmatics, speech act, syntactic bootstrapping, theory of mind, word learning

When learning word meanings, children do not have direct access to the semantics: all they ever get exposed to are speaker meanings and syntactic forms. Children somehow have to infer the semantics from both.

—Hacquard & Lidz (2018)

Behavioural Processes 86 (2011) 184–195

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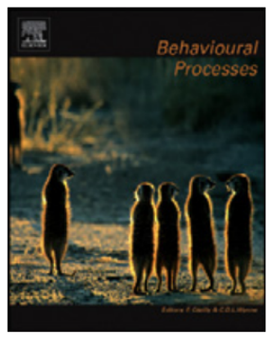

Border collie comprehends object names as verbal referents

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ABSTRACT

Four experiments investigated the ability of a border collie (Chaser) to acquire receptive language skills. Experiment 1 demonstrated that Chaser learned and retained, over a 3-year period of intensive training, the proper-noun names of 1022 objects. Experiment 2 presented random pair-wise combinations of three commands and three names, and demonstrated that she understood the separate meanings of proper-noun names and commands. Chaser understood that names refer to objects, independent of the behavior directed toward those objects. Experiment 3 demonstrated Chaser's ability to learn three common nouns – words that represent categories. Chaser demonstrated one-to-many (common noun) and many-to-one (multiple-name) name–object mappings. Experiment 4 demonstrated Chaser's ability to learn words by inferential reasoning by exclusion – inferring the name of an object based on its novelty among familiar objects that already had names. Together, these studies indicate that Chaser acquired referential understanding of nouns, an ability normally attributed to children, which included: (a) awareness that words may refer to objects, (b) awareness of verbal cues that map words upon the object referent, and (c) awareness that names may refer to unique objects or categories of objects, independent of the behaviors directed toward those objects.

Sadie

Other thing: Thinking about novel signals reminds me of discussions about dance expression and vocabulary – Nelson Goodman talked about dance confronting us with movements which are deliberately 'novel', yet still successfully expressive. Goodman thinks these kinds of movement exemplify rather than denote. Think of Martha Graham's modern dance movements: the 'contraction and release' technique suggesting a 'connection between the attributes of strength and vulnerability' (example stolen from this [https://philpapers.org/rec/HALRLO] interesting paper), without using pre-established communicative conventions. Do we use a similar system to understand them as in the goldfish case?

Kelly

I found section 9 [of "Intention Recognition as the Mechanism of Human Communication"] to be particularly interesting. ...

[I'm wondering] if there are scenarios in which people talk to themselves for functions that are communicative. Is it possible or useful to consider talking to oneself and someone of the communicative functions under the Gricean model, in which person A is both the utterer and the audience. (I'm not sure if this was discussed somewhere in the readings.) The act of talking to yourself as both the utterer and audience forces them to view their lines of reasoning from an external perspective (utterer's pov - audience's pov). I find that this sort of play-acting (pretending to be another person/your audience) very useful (in ways similar to dialectic methods or "bouncing ideas off each other") (and this is also related to the non-communicative functions of verbal practice, honing our thoughts down...). I feel that there is some work done here in self-talk that must be communicative to a certain degree. Of course, I don't think this conflict with any of the presentation explanations for non-communicative functions as well.

Kelly

A scenario of communicative self-talk I thought about is the application of therapeutic methods to manage emotions and calm anxiety where people tell themselves certain affirmations and process those words to calm down. I conceive this as the communication doing most of the comforting work: the perceived gap between the emotional self and the talking self that's doing the comforting allows for the person to calm down.

Cornelia

I'm not sure if I find it plausible that in every case of purported mindreading and practical reasoning, we subconsciously reason in the described (sophisticated) way. That's just because I'm hesitant to subscribe to complex invisible processes in the mind when there may be other simpler explanations. And I feel like there often are: when we have never encountered a certain type of situation before, we may in fact have to figure out what's going on or what to do in the sophisticated way presented here. But often, we are familiar with the sorts of situations that we are in, or we can generalize from a different situation. We may have learned that waving is a good idea of getting someone's attention (if that person can't hear us) when we tried to talk to someone who was wearing headphones. This gives us a guide for the situation in which the car has broken down on the highway. No need to talk about intentions at all, just pure behavioral learning.

Cornelia

How have we learned that's a good way of getting someone's attention? Not necessarily from mindreading! Maybe just from trial and error? Maybe because we've seen other people handle situations successfully this way? In most everyday cases, such an explanation just seems to capture what's going on more plausibly for me. That is not to say we don't engage in mindreading, but is it really that ubiquitous?

Minxin

This passive aspect of mindreading plays a huge role in our social interactions, as demonstrated by the examples in the first section. What I am skeptical about is the role of mindreading in actively influencing what others think through communicative acts.

A distinctive difference between the active and the passive aspects of mindreading is that when influencing others, instead of actually reading another agent's facial expressions, pitches, gestures, or other communicative cues, a mindreading inference is a hypothetical postulate that the interlocutor will convert to the desired state of mind. It cannot be denied that this type of mindreading does take place; in fact, the whole industry of marketing is dedicated to predicting the market response to advertising events to better advertise the product (brand, celebrity, etc.). But the amount of mental labour re,uired seems to prevent it from occurring in most recurring daily communicative scenarios.

Minxin

As the examples of misleading communications indicate, we are all capable of active mindreading that results in postulated inference about how to influence others to a desired response. But in most cases, it seems that conventions and habitual thinkings guide our communicative act. For example, in the job applicant example of section 2, it is plausible that they indeed intend to seem professional when dressing upabout alternative reason for this action might be that they are implying following conventions. They are merely taking what they believe to ,be the conventional action when going to an interview. What I am skeptical here is not if mindreading has a role in active communications, but rather whether all communications involve this populating mindreading inference.

Petru

I had some questions about the mechanisms underlying the recursive function of the planning capacity (by which I just mean its ability to take its own outputs as further inputs), likely beyond the scope of the book itself, but interesting nonetheless (I think).

Petru

Here is one sense in which I might use my planning capacity in suboptimal fashion. I can overthink a plan of action, mulling it over too much, obsessing over its details excessively, breaking it down over and over again into smaller subplans, and thereby possibly impairing my chances of success. Subjecting our planning capacity to excessive runtime demands in this way doesn't seem to be uncommon at all. Situations in which we are highly invested in bringing about certain intended outcomes, communicative or otherwise, could be read as paradigm instances of deliberating about action plans to our own detriment. To guard against this, some (clearly fallible, if the preceding is correct) mechanism must be in place to ensure the optimal function of the planning capacity under "normal conditions." Put otherwise: There seems to be an upper bound to the planning capacity if it is to run optimally and, since we do bring about the outcomes we intend with a reasonable degree of success in most cases, there must be something in place allowing us to ascertain when that upper bound has been reached. Is it a principle of minimal rationality "exert[ing] pressure on our practical reasoning" or is it a further cognitive mechanism of some sort? If it's a mechanism, is it a part of the planning capacity itself, or does it belong to some other central-cognitive capacity? Why does this mechanism fail when it does?

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Target Article

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What is Open Peer Commentary? What follows on these pages is known as a Treatment, in which a significant and controversial Target Article is published along with Commentaries (p. 16) and an Author's Response (p. 43). See bbsonline.org for more information.

Resource-rational analysis: Understanding human cognition as the optimal use of limited computational resources

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Abstract

Modeling human cognition is challenging because there are infinitely many mechanisms that can generate any given observation. Some researchers address this by constraining the hypothesis space through assumptions about what the human mind can and cannot do, while others constrain it through principles of rationality and adaptation. Recent work in economics, psychology, neuroscience, and linguistics has begun to integrate both approaches by augmenting rational models with cognitive constraints, incorporating rational principles into cognitive architectures, and applying optimality principles to understanding neural representations. We identify the rational use of limited resources as a unifying principle underlying these diverse approaches, expressing it in a new cognitive modeling paradigm called *resource-rational analysis*. The integration of rational principles with realistic cognitive constraints makes resource-rational analysis a promising framework for reverse-engineering cognitive mechanisms and representations. It has already shed new light on the debate about human rationality and can be leveraged to revisit classic questions of cognitive psychology within a principled computational framework. We demonstrate that resource-rational models can reconcile the mind's most impressive cognitive skills with people's ostensive irrationality. Resource-rational analysis also provides a new way to connect psychological theory more deeply with artificial intelligence, economics, neuroscience, and linguistics.

ARTICLES
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nature human behaviour

Rational use of cognitive resources in human planning

Frederick Callaway[1]✉, Bas van Opheusden[1], Sayan Gul[2], Priyam Das[3], Paul M. Krueger[1], Thomas L. Griffiths[1,5] and Falk Lieder[4,5]

Making good decisions requires thinking ahead, but the huge number of actions and outcomes one could consider makes exhaustive planning infeasible for computationally constrained agents, such as humans. How people are nevertheless able to solve novel problems when their actions have long-reaching consequences is thus a long-standing question in cognitive science. To address this question, we propose a model of resource-constrained planning that allows us to derive optimal planning strategies. We find that previously proposed heuristics such as best-first search are near optimal under some circumstances but not others. In a mouse-tracking paradigm, we show that people adapt their planning strategies accordingly, planning in a manner that is broadly consistent with the optimal model but not with any single heuristic model. We also find systematic deviations from the optimal model that might result from additional cognitive constraints that are yet to be uncovered.

Elliot:
I think Cornelia's question as to how much communication relies on mindreading is a really important one. Here's a strategy we might use to answer it: consider individuals who have differing mindreading abilities and examine the extent to which they also have differing communicative abilities.

Elliot:

Pursuing this strategy, I've been reading about autism spectrum disorders (ASD). Researchers once thought autism involved widespread deficits in both mindreading (dubbed "mindblindness") and social communication. More recently, Damian Milton has proposed that the problem is actually one of "double empathy"; people with ASD are no worse at mindreading than neurotypical individuals, the two groups are just bad at mutually understanding each other. For example, Sheppard et al. (2015) found that neurotypical people are also ineffective at identifying the mental states of people with ASD. Furthermore, a neuroimaging study by Komeda et al (2015) showed that prompting autistic people with autistic characters, activated brain areas associated with empathy to just as when neurotypical people were prompted with neurotypical characters.

Cognition, 21 (1985) 37–46

Does the autistic child have a "theory of mind"?*

SIMON BARON-COHEN
ALAN M. LESLIE
UTA FRITH

MRC Cognitive Development Unit, London

Abstract

We use a new model of metarepresentational development to predict a cognitive deficit which could explain a crucial component of the social impairment in childhood autism. One of the manifestations of a basic metarepresentational capacity is a 'theory of mind'. We have reason to believe that autistic children lack such a 'theory'. If this were so, then they would be unable to impute beliefs to others and to predict their behaviour. This hypothesis was tested using Wimmer and Perner's puppet play paradigm. Normal children and those with Down's syndrome were used as controls for a group of autistic children. Even though the mental age of the autistic children was higher than that of the controls, they alone failed to impute beliefs to others. Thus the dysfunction we have postulated and demonstrated is independent of mental retardation and specific to autism.

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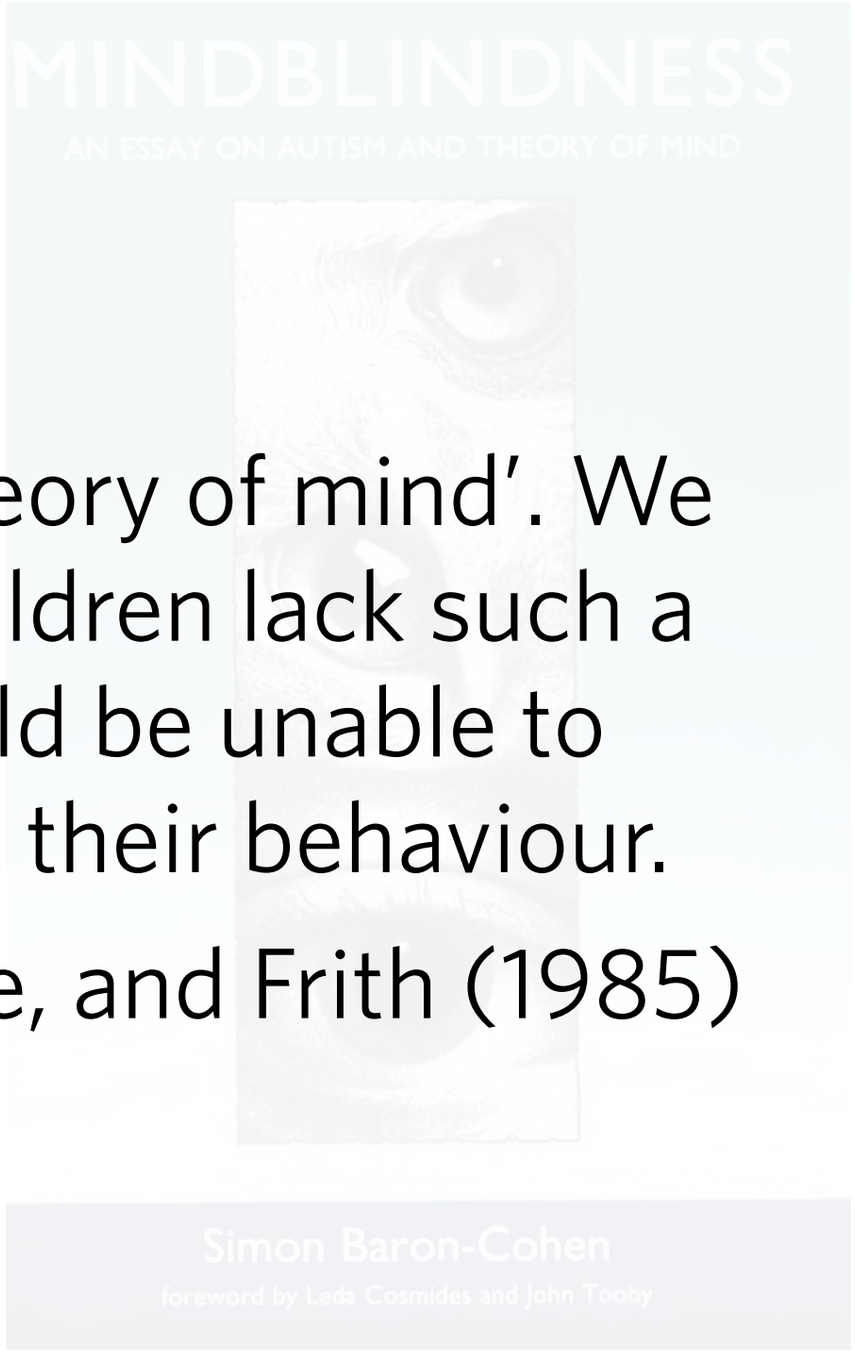

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—Baron-Cohen, Leslie, and Frith (1985)

The diagnostic criteria [for autism] at present are behavioural...and the main symptom, which can be reliably identified, is impairment in verbal and nonverbal communication.

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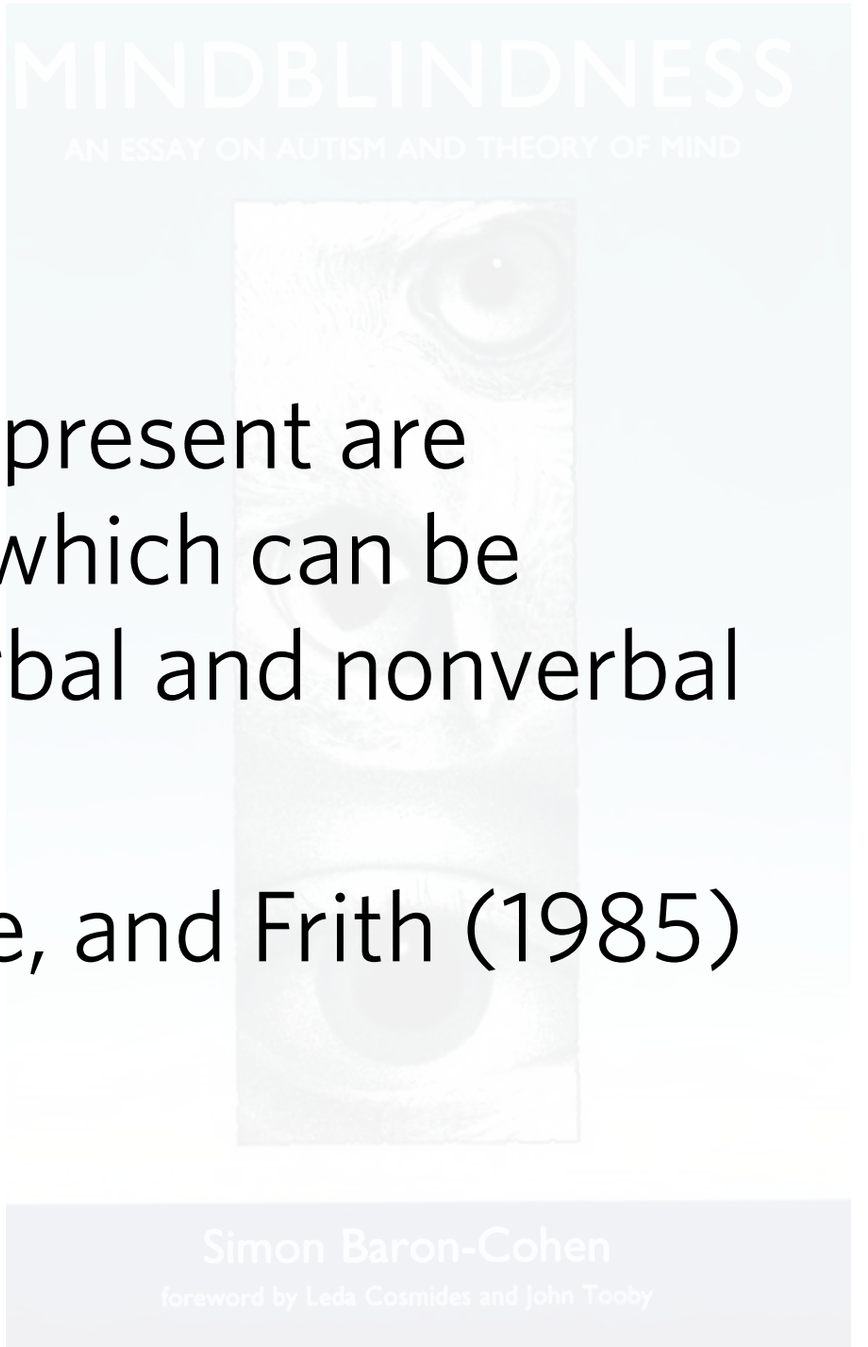

COGNITIVE NEUROPSYCHIATRY, 1996, *1* (1), 55–71

Are Children with Autism Deaf to Gricean Maxims?

Luca Surian

MRC Cognitive Development Unit, University of London, UK and
Universita di Padova, Italy

Simon Baron-Cohen

*Departments of Experimental Psychology and Psychiatry,
University of Cambridge, UK*

Heather Van der Lely

Department of Psychology, Birkbeck College, University of London, UK

High-functioning children with autism show a severe deficit in the development of pragmatics whereas their knowledge of syntax and morphology is relatively intact. In this study we investigated further their selective communication impairment by comparing them with children with specific language impairment (SLI) and normally developing children. We used a pragmatic task that involved the detection of utterances that violate conversational maxims (avoid redundancy, be informative, truthful, relevant, and polite). Most children with autism performed at chance on this task, whereas all children with SLI and all normal controls performed above chance. In addition, the success of children with autism on the pragmatics task was related to their ability to attribute false beliefs. These results are consistent with the idea that communication deficits in autism result from a selective impairment in representing propositional attitudes. Their implications for domain-specific views of cognitive development are discussed.

Journal of Autism and Developmental Disorders, Vol. 24, No. 2, 1994

An Advanced Test of Theory of Mind: Understanding of Story Characters' Thoughts and Feelings by Able Autistic, Mentally Handicapped, and Normal Children and Adults[1]

Francesca G. E. Happé[2]
Medical Research Council Cognitive Development Unit

Research has suggested that the core handicaps of autism result from a specific impairment in theory of mind (ToM). However, this account has been challenged by the finding that a minority of autistic subjects pass 1st- and even 2nd-order ToM tests while remaining socially handicapped. In the present study, able autistic subjects who failed ToM tasks, those who passed 1st-order, and those who passed 2nd-order tasks were tested with a battery of more naturalistic and complex stories. Autistic subjects were impaired at providing context-appropriate mental state explanations for the story characters' nonliteral utterances, compared to normal and mentally handicapped controls. Performance on the stories was closely related to performance on standard ToM tasks, but even those autistic subjects who passed all ToM tests showed impairments on the more naturalistic story materials relative to normal adult controls.

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Table IV. Subjects Giving at Least One Incorrect Mental State Justification

	MH controls (n = 13)		Normal children (n = 26)		Able autistic subjects (n = 18)	
Story type	n	%	n	%	n	%
Pretend	1	7.7	2	7.7	8	44.4[a]
Joke	0		3	11.5[b]	5	27.8[a]
Lie	0		0		4	22.2[a]
White lie	0		4	15.4	9	50.0[a]
Figure of speech	1	7.7	8	30.8	5	27.8
Misunderstanding	1	7.7	2	7.7	6	33.3[a]
Double bluff	3	23.1	2	7.7	8	44.4[a]
Sarcasm	2	15.4	10	38.5[b]	10	55.6[a]
Persuasion	0		4	15.4[b]	7	38.9[a]
Contrary emotion	1	7.7	6	23.1[b]	1	5.6
Appearance/reality	0		0		5	27.8[a]
Forget	0		3	11.5[b]	5	27.8[a]

[a]Significantly more autistic subjects than young normal and MH controls make mental state errors, on chi-square test and Page's trend test $p < .05$ or $p < .01$.
[b]Significantly more of the young normals than the MH controls make mental state errors, on chi-square and Page's trend test $p < .05$ or $p < .01$.

J Autism Dev Disord (2010) 40:1104–1117
DOI 10.1007/s10803-010-0960-8

ORIGINAL PAPER

Scalar Inferences in Autism Spectrum Disorders

Coralie Chevallier · Deirdre Wilson · Francesca Happé · Ira Noveck

Published online: 9 February 2010

Abstract On being told "John or Mary will come", one might infer that *not both* of them will come. Yet the semantics of "or" is compatible with a situation where both John and Mary come. Inferences of this type, which enrich the semantics of "or" from an 'inclusive' to an 'exclusive' interpretation, have been extensively studied in linguistic pragmatics. However, the phenomenon has not been much explored in Autism Spectrum Disorders (ASDs), where pragmatic deficits are commonly reported. Here, we present an experiment investigating these inferences. We predicted that, as a result of the reported pragmatic deficits, participants with ASD would produce fewer inferential enrichments of "or" than matched controls. However, contrary to expectations, but in line with recent findings by Pijnacker et al. (Journal of Autism and Developmental Disorders, 39, 607–618, 2009), performances did not differ across groups. This unexpected finding is discussed in light of the literature on pragmatic abilities in autism.

Keywords Autism Spectrum Disorders · Scalar inference · Language · Prosody · Pragmatics

Introduction

One of the challenges linked to everyday utterance interpretation is that there is always more to be understood than what is linguistically encoded (Burton-Roberts 2007; Horn and Ward 2004; Sperber and Wilson 1986/1995). To illustrate, consider the following three utterances (taken

PLOS ONE

RESEARCH ARTICLE

Children with Autism Understand Indirect Speech Acts: Evidence from a Semi-Structured Act-Out Task

Mikhail Kissine[1]*, Julie Cano-Chervel[2], Sophie Carlier[1,2], Philippe De Brabanter[1], Lesley Ducenne[2], Marie-Charlotte Pairon[2], Nicolas Deconinck[1,2], Véronique Delvenne[1,2], Jacqueline Leybaert[1]

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Citation: Kissine M, Cano-Chervel J, Carlier S, De Brabanter P, Ducenne L, Pairon M-C, et al. (2015) Children with Autism Understand Indirect Speech Acts: Evidence from a Semi-Structured Act-Out Task. PLoS ONE 10(11): e0142191. doi:10.1371/journal.pone.0142191

Editor: Emese Nagy, University of Dundee, UNITED KINGDOM

Received: February 26, 2015

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Abstract

Children with Autism Spectrum Disorder are often said to present a global pragmatic impairment. However, there is some observational evidence that context-based comprehension of indirect requests may be preserved in autism. In order to provide experimental confirmation to this hypothesis, indirect speech act comprehension was tested in a group of 15 children with autism between 7 and 12 years and a group of 20 typically developing children between 2:7 and 3:6 years. The aim of the study was to determine whether children with autism can display genuinely contextual understanding of indirect requests. The experiment consisted of a three-pronged semi-structured task involving Mr Potato Head. In the first phase a declarative sentence was uttered by one adult as an instruction to put a garment on a Mr Potato Head toy; in the second the same sentence was uttered as a comment on a picture by another speaker; in the third phase the same sentence was uttered as a comment on a picture by the first speaker. Children with autism complied with the indirect request in the first phase and demonstrated the capacity to inhibit the directive interpretation in phases 2 and 3. TD children had some difficulty in understanding the indirect instruction in phase 1. These results call for a more nuanced view of pragmatic dysfunction in autism.

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Oh! Il n'a pas de lunettes

[= Oh! He has no glasses on!]

Q: Will autistic children interpret this as an indirect request/ suggestion as often as typically developing children?

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A: Yes!

Review Article

Autism & Developmental Language Impairments

Autism & Developmental Language Impairments
Volume 3: 1–24

DOI: 10.1177/2396941518763166
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SAGE

Is verbal reference impaired in autism spectrum disorder? A systematic review

Louise Malkin, Kirsten Abbot-Smith and David Williams
University of Kent, UK

Abstract

Background and aims: Pragmatic language is a key difficulty in autism spectrum disorder. One such pragmatic skill is verbal reference, which allows the current entity of shared interest between speakers to be identified and thus enables fluid conversation. The aim of this review was to determine the extent to which studies have found that verbal reference is impaired in autism spectrum disorder. We organise the review in terms of the methodology used and the modality (production versus comprehension) in which proficiency with verbal reference was assessed. Evidence for the potential cognitive underpinnings of these skills is also reviewed.

Main contribution and methods: To our knowledge, this is the first systematic review of verbal reference in autism spectrum disorder. PsychINFO and Web of Science were systematically screened using the combination of search terms outlined in this paper. Twenty-four studies met our inclusion criteria. Twenty-two of these examined production, whereby the methodology ranged from elicited conversation through to elicited narrative, the 'director' task and other referential communication paradigms. Three studies examined reference interpretation. (One study investigated both production and appropriacy judgement). Four studies examined the relationship between appropriate usage of verbal reference and formal language (lexico-syntactic ability). Two studies investigated whether reference production related to Theory of Mind or Executive Functioning.

Conclusion and implications: Across a range of elicited production tasks, the predominant finding was that children and adults with autism spectrum disorder demonstrate a deficit in the production of appropriate verbal reference in comparison not only to typically developing groups, but also to groups with Developmental Language Disorder or Down syndrome. In contrast, the studies of reference interpretation which compared performance to typical control groups all found no between-group differences in this regard. To understand this cross-modality discrepancy, we need studies with the same sample of individuals, whereby the task requirements for comprehension and production are as closely matched as possible. The field also requires the development of experimental manipulations which allow us to pinpoint precisely if and how each comprehension and/or production task requires mentalising and/or various components of executive functioning. Only through such detailed and controlled experimental work would it be possible to determine the precise location of impairments in verbal reference in autism spectrum disorder. A better understanding of this would contribute to the development of interventions.

Keywords

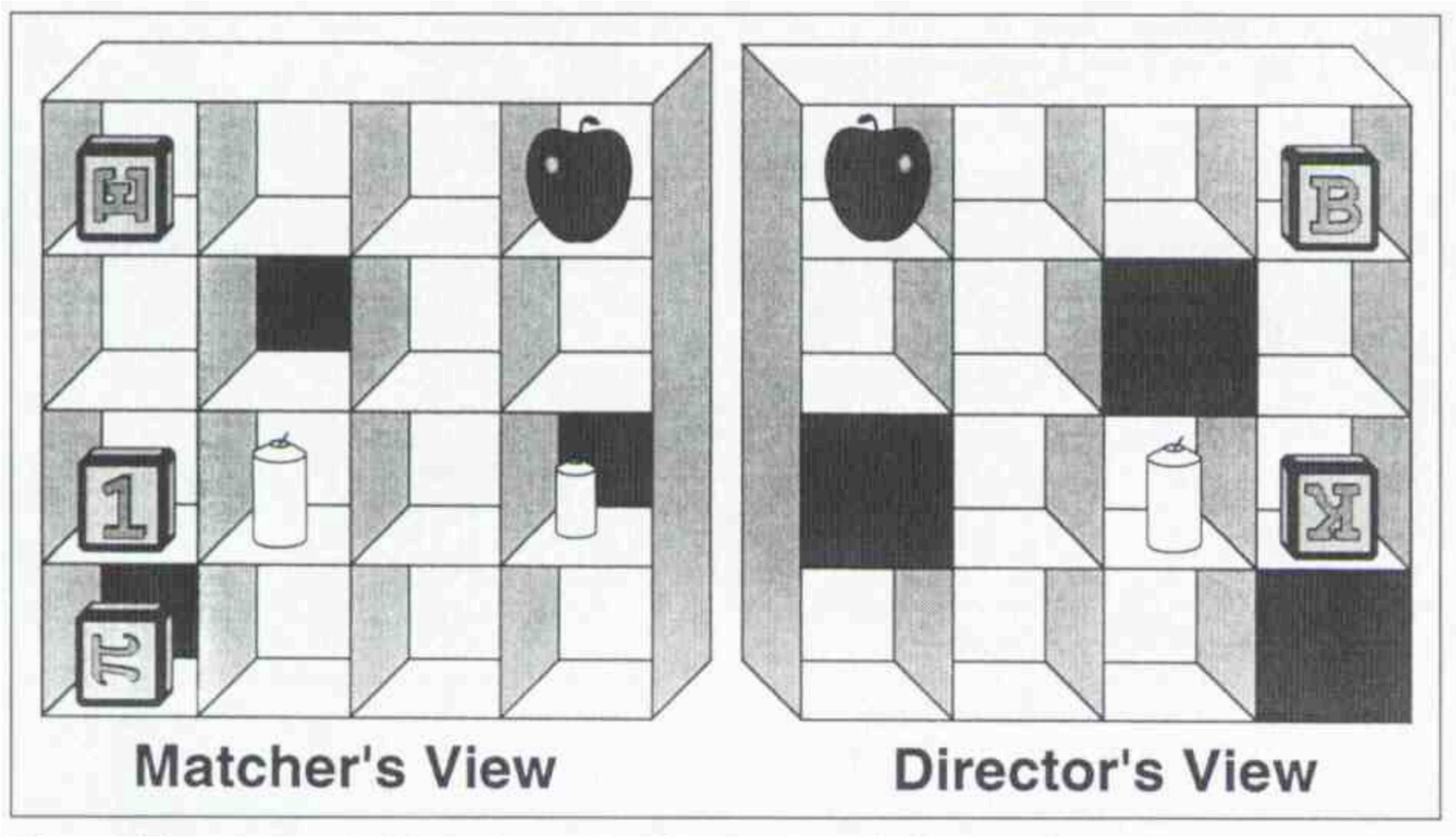
Autism spectrum disorders, pragmatics, referential communication, narrative, audience design

Across a range of elicited production tasks, the predominant finding was that children and adults with autism spectrum disorder demonstrate a deficit in the production of appropriate verbal reference in comparison not only to typically developing groups, but also to groups with Developmental Language Disorder or Down syndrome. In contrast, the studies of reference interpretation which compared performance to typical control groups all found no between-group differences in this regard.

—Malkin, Abbot-Smith, and Williams (2018)

THE DIRECTOR TASK

Keysar, Barr, and Horton (1998): "The Egocentric Basis of Language Use: Insights From a Processing Approach,"



Director's instructions to Matcher:
"Put **the bottom block** below the apple."

If the Matcher moves the block marked ⊏, then they have reasoned "egocentrically"—i.e., failed to account for the Director's perspective.

In the privileged condition, participants with ASD tended towards over-informativity, inappropriately using a specific referring term (e.g. 'big cup' when there was only one cup available from the listener's visual perspective) significantly more frequently than the TD group (p5.01). In the shared condition, the ASD group more frequently failed to use a complex referring term when two competing referents were visible, though this group difference was only of marginal significance (p 1/4 .08, effect size r 1/4 0.24). These findings reflect the simultaneous over and under-informativity in reference use by individuals with ASD which was also the general finding from narrative and conversational studies.

—Malkin, Abbot-Smith, and Williams (2018)

Elliot:

Pursuing this strategy, I've been reading about autism spectrum disorders (ASD). Researchers once thought autism involved widespread deficits in both mindreading (dubbed "mindblindness") and social communication. More recently, Damian Milton has proposed that the problem is actually one of "double empathy"; people with ASD are no worse at mindreading than neurotypical individuals, the two groups are just bad at mutually understanding each other. For example, Sheppard et al. (2015) found that neurotypical people are also ineffective at identifying the mental states of people with ASD. Furthermore, a neuroimaging study by Komeda et al (2015) showed that prompting autistic people with autistic characters, activated brain areas associated with empathy to just as when neurotypical people were prompted with neurotypical characters.

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ORIGINAL PAPER

How Easy is it to Read the Minds of People with Autism Spectrum Disorder?

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Abstract How well can neurotypical adults' interpret mental states in people with ASD? 'Targets' (ASD and neurotypical) reactions to four events were video-recorded then shown to neurotypical participants whose task was to identify which event the target had experienced. In study 1 participants were more successful for neurotypical than ASD targets. In study 2, participants rated ASD targets equally expressive as neurotypical targets for three of the events, while in study 3 participants gave different verbal descriptions of the reactions of ASD and neurotypical targets. It thus seems people with ASD react differently but not less expressively to events. Because neurotypicals are ineffective in interpreting the behaviour of those with ASD, this could contribute to the social difficulties in ASD.

those who have ASD, which could depend on the way that behaviour offers an interpretable signal of those states. This is a potentially important question, because if people have difficulty reading the mental states of those with ASD it could lead to interpersonal misinterpretations that impact negatively on social interaction (Begeer et al. 2008).

Mental states are revealed through various aspects of behaviour, particularly facial expressions (Baron-Cohen et al. 1997). According to DSM-5 (APA 2013), ASD is characterised by a lack of facial expression, though recent studies have yielded somewhat mixed support. For example, Stagg et al. (2014) video recorded children with and without ASD while describing events from their lives, and presented the muted videos to neurotypical adults. The

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Autistic empathy toward autistic others

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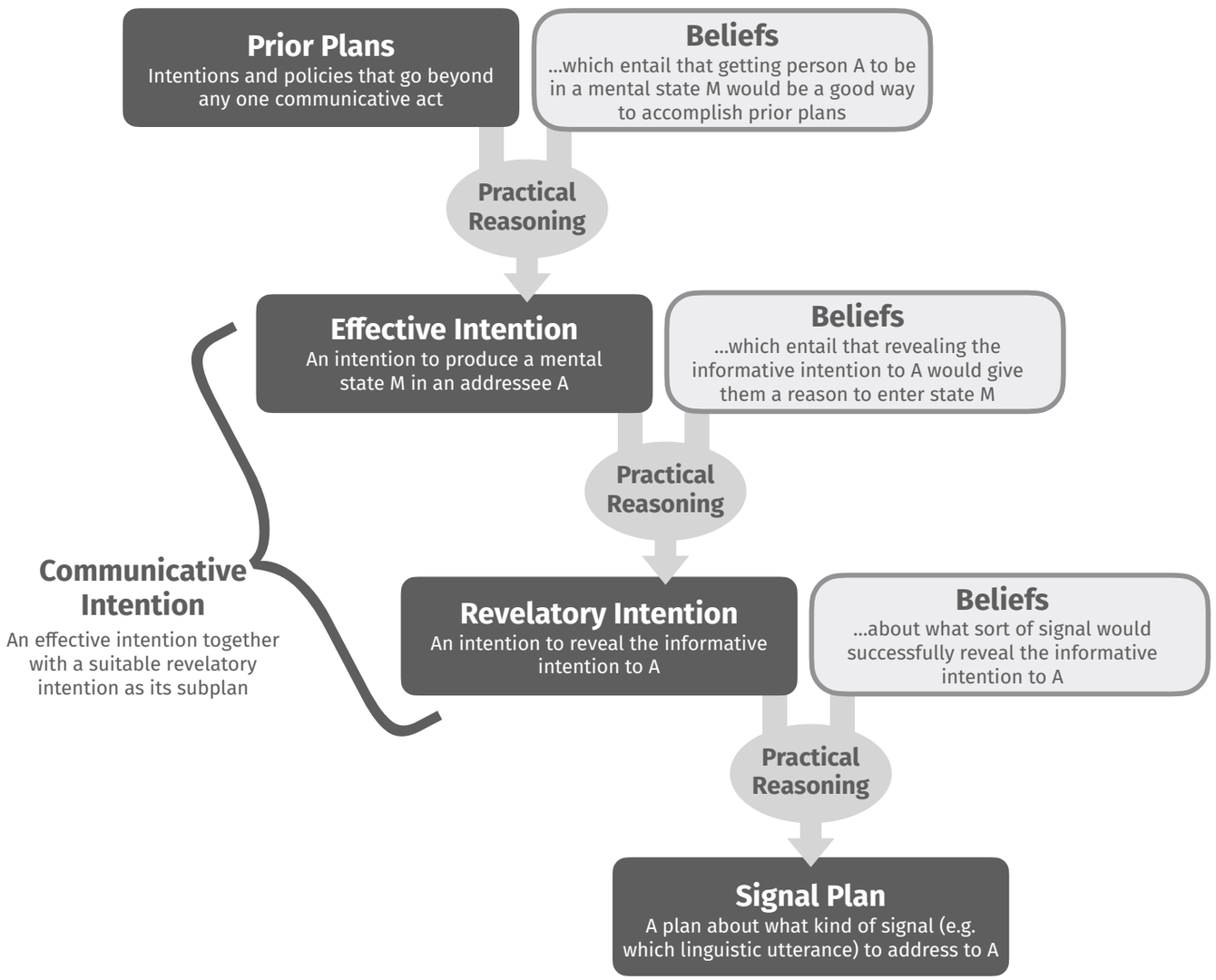
Individuals with autism spectrum disorder (ASD) are thought to lack self-awareness and to experience difficulty empathizing with others. Although these deficits have been demonstrated in previous studies, most of the target stimuli were constructed for typically developing (TD) individuals. We employed judgment tasks capable of indexing self-relevant processing in individuals with and without ASD. Fourteen Japanese men and 1 Japanese women with high-functioning ASD (17–41 years of age) and 13 Japanese men and 2 TD Japanese women (22–40 years of age), all of whom were matched for age and full and verbal intelligence quotient scores with the ASD participants, were enrolled in this study. The results demonstrated that the ventromedial prefrontal cortex was significantly activated in individuals with ASD in response to autistic characters and in TD individuals in response to non-autistic characters. Although the frontal–posterior network between the ventromedial prefrontal cortex and superior temporal gyrus participated in the processing of non-autistic characters in TD individuals, an alternative network was involved when individuals with ASD processed autistic characters. This suggests an atypical form of empathy in individuals with ASD toward others with ASD.

Keywords: autism spectrum disorder; empathy; self; similarity; ventromedial prefrontal cortex

2. Designing Communicative Acts

(Sept 21)



We form communicative intentions as part of the process of designing communicative acts for our addressees.

This design process makes human communication much more powerful and efficient, and this is why we bother with communicative intentions.