**Experimental investigations of discourse connectives:**

**How linguistic expressions with non-truth-conditional meanings**

**can provide perspective on logical connectives**

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1. **Introduction**

Philosophers of language distinguish between linguistic expressions whose meanings are truth conditional and those that are not. To make this distinction clear, compare the connectives in the following two utterances, (1a) and (1b):

1. a. George Clooney is famous and he is nice.

b. George Clooney is famous but he is nice.

In (1a) the connective “and” is considered truth-conditional because it could be determined as true only when the conjuncts, “George Clooney is famous” and “George Clooney is nice,” are both true. In contrast, the connective “but” (in 1b), while logically equivalent to “and” (because the sentence is true as long as the two conjuncts are), comes with an additional proposition, which is that it denotes a contrast to be drawn between George Clooney being nice and his being famous; alternatively, it encodes that the speaker has an expectation about famous people (that they are not nice) that is denied (Lakoff, 1971; Anscombre & Ducrot, 1977). The extra proposition that the word “but” adds does not contribute to the truth-conditions of the utterance of (1b). If the speaker of (1b) does not have in mind a contrast (or an expectation generated by the first conjunct that is then denied), this will not make the utterance false.

*But*, of course, is not the only discourse particle that has a non-truth-conditional meaning. Other well-known examples are *after all*, *so,* and *therefore* as shown in (2a-c):

1. a. Trump could win in 2020; after all, he won in 2016.

b. Mary got her PhD. so she’s applying for jobs.

c. Paul is French therefore he is a good cook.

What follows *after all* in (2a) introduces information that is presumably accessible and not new to the listener (Ariel, 1998). In the case of *so*, the speaker explicitly draws attention to a conclusion that she has drawn while underlining an inference (Blakemore, 1988). The connective *therefore* is synonymous with *so* but is more formal and less flexible. For example, while utterances can begin with *so* in order to remark on something observable in the environment, as in (3), this would not be felicitous with *therefore*.

1. [Upon observing driver] So we don’t need to go over the bridge to arrive.

These discourse connectives are not the only linguistic elements that have been described as non-truth-conditional (for a discussion, see Fraser, 1999) . Other language particles that are relevant to this discussion include pronouns in (4), which cannot yield truth values until the pronouns get assigned, as well as sentence adverbials in (5).

1. He pushed her into him.
2. Consequently, I cannot come to the party.

Scholars also discuss questions (*Are you American?)* and requests (*Coffee please*) as non-truth-conditional elements in discourse.

The work proposed here, under the aegis of the *Chaire d’Excellence*, is to investigate the processing of the first set of linguistic elements I described above, i.e. discourse connectives such as *et* (and), *mais* (but), *alors* (so), *donc* (therefore), *car* (because) and *si* (if). The overall goal is to characterize their processing properties and to determine whether those that are considered truth-conditional, e.g. *and* or *if*, are distinctive in terms of their inferential behavior from those that are considered non-truth-conditional. An investigation of these non-truth-conditional elements can help better determine whether logical connectives are unique or banal. In what follows, I describe the background that motivates this work as well as the proposal’s goals.

I will begin (in Section 2) by describing prior theoretical (mostly armchair) discussions from both philosophers and linguists and show how they have set the stage for investigations of discourse connectives and what made these cases increasingly relevant to the cognitive sciences generally. I will then briefly describe how prior experimental work with logical truth-conditional connectives (e.g. *and, or,* and *if*) motivates this endeavor, not only because it is highly relevant to cognition and philosophy but, because it provides expectations about experimental outcomes. This determination is pertinent to ongoing discussions about rationality (Section 5 will address this issue in slightly greater detail).

In Section 3, I will introduce both the theoretical and experimental approach that drives this proposal. The theoretical impetus will come from Relevance Theory, as outlined by Blakemore (1988), who views connectives as procedures that help a listener discern a speaker’s intended meaning. This approach has not seen experimental evidence in favor or against it. To set out the proposal’s experimental approach, I will point out that most work on discourse connectives relies on the content of the message (e.g. to determine whether a connective, such as *because* or *so*, ought to be articulated as a function of what one knows about the stated relations in the presented text or discourse). This proposal, in contrast, introduces a paradigm that does not rely on participants knowing the particulars of, e.g. real-life causal, relations. The work will rely largely on one’s appreciation of the procedural meanings of the connectives themselves. To my knowledge, there have been no studies with largely contentless materials in which the role of the connective can be isolated for its processing and inferential features, as has been done, in my lab with logical terms (e.g. see Bonnefond et al., [2012] on conditionals and Chevallier et al., [2010], on disjunctions). The paradigm is designed so that it can ultimately engage theoretically with opposing accounts about discourse connectives while providing data to the field generally.

In the following section (Section 4), I will present, in some detail, the proposal’s experiments. Each set of experiments will have its own Work Package number (ranging from 1 to 5). The experiments include behavioral investigations (with children and adults), EEG experiments as well as investigations of those with Autism Spectrum Disorders (ASD).

In the final research-related section (Section 5), I will describe the intellectual and practical benefit of this work and how it fits in with my prior research. As I indicated earlier, this work is designed to determine whether logical terms, which are considered to be universal, are unique or not among discourse connectives. If these terms are shown to be in some way special or fundamental, it would imply that inference-making from logical terms should reveal themselves as having unique properties, e.g. perhaps they generate faster reaction times than the non-truth-conditional ones. If they are not distinctive, it would imply that their pride of place is a cultural endeavor. This section also addresses certain practical aspects of the proposal. For example, it briefly describes how my presence in the IDEX facilitates the proposal.

1. **Theoretical background and state of the art**

Here, I briefly consider how work from three disciplines – philosophy, linguistics, and psychology -- have helped set the stage for investigating discourse connectives and have, ultimately, motivated the experimental studies in the current proposal. While the theoretical considerations from each of the three overlap, they have different concerns. That said, these efforts -- viewed collectively – lead to a better understanding about the way listeners process meaning generally and about what connectives, viewed as a group, can reveal about truth-conditional connectives specifically.

* 1. ***Philosophical considerations***

Philosophers hold two opposing positions about *sentence* meaning and its relation to *speaker* meaning, i.e. about the difference between what a speaker says and what she means. These positions can be described as the Ideal Language and the Ordinary Language schools (see Noveck, 2018). According to the Ideal Language school (whose early proponents were Gottloeb Frege and Bertrand Russell), a sentence is the transfer of linguistically encoded information from the speaker that is then unpacked compositionally by the listener. This approach is chiefly concerned with transforming a sentence into a logical form so that it can then be determined to be true or false. This school of thought recognized from the start, however, that the transformation from linguistic code to truth-propositional formula is not always obvious. As Hussein (2010) wrote, “[Frege] maintains that there are elements in linguistic meaning which cannot be analyzed in truth-conditional terms.” So, while members of the Ideal Language school assume that encoded sentences are largely sufficient for giving the hearer access to the speaker’s meaning, they leave an opening for linguistic expressions that are not determinative of truth-functions. In contrast, members of the Ordinary Language school (populated by philosophers such as Paul Grice, J.L. Austin and John Searle) assume that sentences *generally* do not provide enough explicit information for a listener to fully gather all the communicated information. For philosophers in this school, meaning is concerned with what the speaker means when she utters a sentence, i.e. to understand the speaker's intention. According to this tradition, gaps between what is said and what is meant always remain and these need to be filled, not by idealizing away components of the sentence that are problematic but, through some form of reasoning. So both schools recognize that non-truth-conditional discourse connectives are not easily pegged, since they do not readily contribute to logical meaning.

* 1. ***Considerations from Linguistics and Discourse***

Linguists have progressively clarified the category in which non truth-conditional discourse connectives are a part. The revelation of this class comes from the work from two opposing linguistic approaches. One proposes that *discourse markers* (generally) are elements that make a discourse (a series of linguistic units) intrinsically *cohesive* (or, for some others, *coherent*). The other approach, driven by Relevance Theory, proposes that an addressee processes information so that a speaker’s utterances have cognitive effects as he aims to gather the speaker’s intended meaning. For the latter, non-truth-conditional discourse connectives are a category of words that provide procedures that constrain the inferential aspect of comprehension and thus facilitate capturing the speaker’s intended meaning. Let us look at each of these approaches in turn.

* + 1. *Cohesion and Coherence approaches*

In work designed to understand what makes a text (or units of discourse) cohesive above and beyond grammatical structure, Halliday and Hasan (1976:5) argued that cohesion can be achieved through a set of devices – reference, repetition, substitution, ellipsis, and conjunction – so that speakers can create textual contiguity.[[1]](#footnote-1) Conjunction, for example, is comprised of linkers which connect sentences to each other (Martin, 2001) and they come in a variety of forms. That is, conjunctions can be introduced via addition, comparison, temporality, and causality. For example, in (6 b-d), which is borrowed with slight modification from Hussein (2009), cohesion is carried out through linking linguistic expressions such as *and, yet,* and *now*; these provide further information that is characterized as *additive, adversative* and *temporal*.

1. a. John got a very good grade on his math test.

b. And he has been the first in his class for the last two years (additive).

c. Yet he failed his syntax test this term (adversative).

d. Now, he feels very frustrated and is thinking of leaving school (temporal).

To complete this example with the fourth type of conjunction, *causal*, I add the following:

e. Because he studied very hard (causal).

Many adhere to this general view -- that discourse markers are critical for understanding text (understood as a kind of linguistic unit) because they maintain cohesion (Schiffrin, 1987; Fraser, 1990; Zwicky, 1985) -- while disagreeing about the structure or the source of these expressions. Below, I present two other influential accounts from this approach to give a flavor of their lines of accord and discord.

In her seminal book, Discourse Markers (1987), the late Deborah Schiffrin argued that discourse terms are classifiable into word classes that operate across five conversational levels (“planes”). In summarizing her own work, she writes (2001):

I proposed that discourse markers could be considered as a set of linguistic expressions comprised of members of word classes as varied as conjunctions (e.g*. and, but, or*), interjections (*oh*), adverbs (*now, then*), and lexicalized phrases (*y’know, I mean*). Also proposed was a discourse model with different planes: a *participation framework, information state, ideational structure, action structure, exchange structure*. My specific analyses showed that markers could work at different levels of discourse to connect utterances on either a single plane or across different planes.

For example, the connectives *and, but, or, so* and *because* operate on the “ideational structure” in that they organize ideas in discourse while expressions such as *well* and *y’know* operate as part of the “participation framework.”

Fraser (1999) aimed to unclutter the ideas found in the growing number of papers on discourse markers. In reviewing the literature, he highlighted how Labov and Fanshel (1977) were the first to use the expression “discourse marker” in order to point out how the expression *well* – when it is the first element in a discourse – refers “to an unstated topic of joint concern” and how other prominent linguists, such as Levinson (1983), listed expressions that underline a “relationship between an utterance and the prior discourse.” That list includes all the connectives listed above, from *but* (as presented in 1b) to *after all, so* and *therefore* (as seen in 2a-c) and then some (e.g. *in conclusion, still,* and *actually*). Fraser went on to argue that these linguistic expressions are not a unified class. They have the grammatical status of the main class they belong to. For example, they can be conjunctions (*and* and *but*), adverbs (*anyway* and *however*) and prepositional phrases (*after all* and *in spite of this*). While Schiffrin argued that discourse markers, such as *but*, create coherence locally among adjacent units, Fraser points out that discourse connectives can be global as well. Consider the following exchange in (7), from Fraser (1999, page 938), in which the adversarial *however* does not directly address the idea about “going” but about something larger in the context:

1. A: I don't want to go very much.

B: John said he would be there.

A: However, I do have some sort of obligation to be there.

Fraser also pointed out that, unlike Schiffrin, who viewed connectives as introducing a new segment, connectives could occur anywhere in a sentence (e.g. Fraser presents the sentence *It is freezing outside. I will, in spite of this, not wear a coat*).

The earliest experimental investigations were inspired by a *Coherence* approach. In a seminal paper, Sanders, Spooren and Noordman (1992) identified four features of coherence relations that lead, through various permutations, to a taxonomy of 12 kinds of connectives. The first of the four features is called *basic operations*, which refers to whether relations can be viewed as either additive (conjunctive) or causal. The second is called *source of coherence*, which refers to whether the maintenance of coherence calls on semantic or pragmatic properties. To make this distinction clear compare (8a), where the cause is propositional (and minimizes interpretation for the listener), to (8b), where the cause relies on making an intentional reading with respect to the speaker.

1. a) My cat died because he was ill.

b) John is not coming to school because he just called me.

The third refers to the order in which segments need to be coordinated. *Basic order* refers to cases in which the first segment is the inferential basis for the second, as in *but* in (1b) and *reversed* refers to cases in which the second segment is the anchor for the first segment, as in the *consequence-cause* relation linked by *because* in (8a) above. Finally, their fourth feature concerns *polarity* and considers whether the connective can be deemed positive or negative.

One way Sanders et al. (1992) tested their taxonomy was to present participants with real corpora minus the connective before asking participants to choose a connective to insert (while providing choices). They showed that, while participants might not retrieve the exact connective spoken at consistently high rates, participants did remain in the categories identified above at high rates (e.g., they would respect the sequence’s polarity by appropriately choosing a negative additive, such as *but*, over a positive additive, such as *moreover*). This group (Spooren and Sanders, 2008) also profited from prior findings on the acquisition of discourse connectives (Bloom, 1980) to posit that connectives come with increasing complexity. These authors thus propose that their categories can be viewed (from less to more complex) as: Additive < Temporal < Causal < Adversative (i.e., *and < and then < because < so < but*).

* + 1. *Relevance accounts and the conceptual/procedural distinction*

As indicated above, an opposing approach comes from Relevance Theory (RT), a cognitively oriented account of communication. In this section, this theory is described in greater detail. The proposal then delves into its account of discourse connectives.

Relevance Theory views interlocutors as *information* processors who seek inputs. Input is *relevant* when it combines with a processor's (say, an addressee’s) mental states or background knowledge in order to produce new cognitive effects. The theory describes two features that can capture the relevance of incoming input. One is how much *effort* it takes to process an input and the other is the cognitive *effects* that that input produces (e.g. in terms of new conclusions produced) by the processor. As can be seen, the word *relevance* here is a technical term that describes how processing is determined by the interplay of effort and effects (highly relevant input will be minimally costly while providing maximal cognitive effects). According to Relevance Theory, an ostensively signaled communication (which need not be spoken words) prompts cognitive processing; utterances are by definition signaled communications worth processing. An utterance will help a listener determine the speaker’s intended meaning, but only part of the way. Relevance Theory is designed to explain how a listener arrives at a set of assumptions (or propositions) based on a speaker's utterance. Interpretations from an utterance are made with greater or lesser accuracy or with greater or lesser confidence. Relevance Theory has been prodigious in explaining linguistic-pragmatic effects, including scalar implicature (Noveck & Sperber, 2007), metaphor (Carston, 2010; Rubio-Fernandez, 2011), irony (Jorgensen et al., 1984; Spotorno and Noveck, 2019) and much else.

Turning to discourse connectives, Diane Blakemore, a Relevance Theorist, began by making a distinction between words encoding a concept (conceptual words), such as *boy* and *runs*, and words encoding an instruction regarding how to process a concept (procedural words), for example *because, so* and *but*. While Blakemore (1987) originally considered that procedural words map on to non-truth-conditional meaning of discourse connectives uniquely, Wilson (as recounted much later in a special issue in Lingua, 2016) followed up on Blakemore’s insights to argue that her distinction need not map on to that philosophical distinction. Blakemore (2000) would later concur. The upshot is that RT distinguishes between two types of meaning, conceptual and procedural, each of which could possibly be non-truth-conditional.

According to Blakemore (2000), the procedures linked to the discourse connectives constrain the kind of cognitive effects that the utterance can draw. To make this clear, consider the following two segments in (9):

1. a. John can open Tom’s safe. b. He knows the combination.

How does one interpret this? Without a connective, the segment in (9b) can be viewed as evidence for (9a) or it can be considered a consequence of (9a). Note how the connective *after all* would lean one towards the former reading, i.e. where (9b) is evidence for (9a), and how the connective *so* would lean one towards the latter, i.e. where (9b) is a consequence of (9a). It is in this way that connectives constrain. Their presence eliminates ambiguities by indicating with greater specificity the speaker’s intended meaning. One can see that according to Relevance Theory, discourse connectives, encode procedures that help addressees better capture the speaker’s intended meaning; in technical terms, utterances with (appropriate) discourse connectives are more relevant than the same utterances without them because it makes the utterance more specific (increase in cognitive effects with minimal effort, i.e. the addition of one small word).

* 1. ***Experimental studies on logical connectives***

A third source of background are psychological studies on truth-conditional connectives. Studies on logical terms have been prominent in the Psychology of Reasoning literature at least since Piaget first investigated the development of logical reasoning. Psychological studies rigorously investigate the way young and adult participants process contiguous statements as a function of the connectives *if, and* and *or*. Unlike in most (though not all) discourse studies, where the discourse connectives are presumably understood, the question behind psychology studies could be viewed as worded as, “are participants (expected to be) competent at carrying out a reasoning task that relies on such-and-such connective”?

What can we learn from these studies? For the sake of brevity, I will concentrate mostly on the way the logical terms *if, and* and *or* interact with pragmatic interpretations (and in the interest of space, I will focus on developmental studies, which usually provide a solid basis for making processing discoveries among adults). Of the three logical connectives, the most fundamental is arguably the conjunction *and*. While *and* simply conjoins two propositions, in practice an utterance with *and* often comes with enrichments through context. To make this clear, consider how *Mary got pregnant and got married* is logically equivalent to *Mary got married and got pregnant*; in conversation, however, the provided order of the two conjuncts can implicitly render *and* to mean *and then* in these cases, providing two very different readings. Noveck and Chevaux (2002; and later Noveck et al., 2009) demonstrated that *and* is more likely to be enriched to mean *and then* with age. To make this clear, consider a brief story that describes a girl, Julie, who had answered a phone call and three sentences later accepts an invitation to a birthday party. Seven-year-old, ten-year-old and adult participants were then required to respond *Yes* or *No* to one of two kinds of follow-up questions:

(10) a. Julie answered the phone and accepted an invitation?

b. Julie accepted an invitation and answered the phone?

Agreeing with (10b) indicates that the participant accepted the minimal meaning of the conjunctive sentence (that the two conjuncts are true). Rejecting it indicates that the sentence’s *and* was enriched (to something like *and then*), making the order of presentation of the two conjuncts relevant. While the sentence in (10a), which presents the two facts in the story’s order, yields near-universal agreement (*Yes*) among participants, the data revealed that 85% of seven-year-olds, 63% of ten-year-olds, and 29% of the adults agreed with (9b). This indicates that enriched readings (from *and* to *and then*) evolve with age and sophistication. This effect has since been replicated (Ariel, personal communication).

Similar developmental semantic-cum-pragmatic interpretation progressions have been reported with disjunctions in classic tasks (Paris, 1973; Sternberg, 1979; Braine & Rumain, 1980), where an inclusive reading (*or and perhaps both*) often suffices for younger children and exclusive (pragmatic) readings (*or but not both*) increase with age. For example, Braine and Rumain (1980) had children and adults evaluate the contents of a box with statements such as, "Either there is a dog or there's a cow in the box" when *both* a dog and a cow are in the box. This led an overwhelming majority of five- to ten-year-olds to respond by saying *Yes*, whereas roughly half of the adults would say *No*. It thus seems, for these two logical connectives, their semantic meanings suffice at younger ages. Processing studies with adults (similarly) show that disjunctive readings appear to be more effort-demanding when they are processed as exclusive (Breheny et al. 2006; Chevallier et al;, 2008). For example, Chevallier et al. (2008) reported that disjunctive statements (in a task that presented, say, *There is an A or B* with respect to the contents of the word "TABLE," which is true with a semantic reading, i.e. *There is an A or B and perhaps both*, and false with a pragmatically narrowed reading, i.e. *There is an A or B but not both*) are more likely to prompt false responses when participants are encouraged to take their time (likewise, participants are more likely to provide true responses when rushed). Thus, pragmatically enriched readings of the disjunction appear to be conjoined with extra processing costs.

While the semantic meaning of *and* and *or* are often good enough (and arguably basic) and pragmatically enrichable (at a cost), the case of conditionals tells a slightly different story. If the progressive understanding of conditionals were that children become more pragmatic with age, one would expect to find logical readings of conditionals among younger participants and increasingly pragmatic readings with age. That is, one would expect to find that Modus Ponens arguments (*If p then q; p//Therefore q*) are readily accepted among younger participants and that, with age, participants are more likely to accept classic pragmatic readings (what Geis and Zwicky [1979] called *invited inferences*), i.e. to accept Affirmation of the Consequent (AC: *If p then q; q//Therefore p*) and Denial of the Antecedent (DA: *If p then q; not-p//Therefore not-q*) arguments, with increasing age. However, data from conditionals clearly show that advancing age is linked to *fewer* *pragmatic* interpretations (Taplin et al, 1974; O'Brien et al., 1989; Barrouillet et al, 2000). These studies reveal that children are more likely to accept AC and DA inferences when they are younger before becoming more circumspect as they grow by being more likely to reject the conclusions that rely on pragmatic inferences. Similarly, adult performance indicates that the rejection of fallacious invited inferences is more time-consuming than acceptance (Bonnefond et al., 2012).

Partly based on these kinds of evidence, Noveck & Spotorno (2013; see also, Noveck, 2018) argued for a distinction between two psychological processes that drive pragmatic processes. One was labelled *voluntary,* which refers to cases in which the linguistically encoded reading can provide an interpretation that is good enough but that can also lead with extra effort to a more informative reading (see *and* and *or* above). The second was called *imposed,* which refers to cases in which a speaker’s expression requires the addressee to enrich an aspect of an utterance in order to provide an approximation of the speaker’s intended meaning. This would account for data on conditionals, which we argued has what is essentially a procedural meaning that tells participants to determine whether the antecedent is in fact true in *if p then q* statements (see Noveck et al., 2011).

All told, these truth-conditional connectives have yielded clear, replicable effects that call for integration into discussions of non-truth-conditional discourse markers. These cases are models for what can be predicted with respect to the discourse connectives of interest here. One ready prediction is that data from the discourse connective *but* will generate data similar to those reported with other imposed processes, such as *if*. That is, developmentally speaking, I predict that younger children, say three-year-olds, will treat *but* as a conjunction but that data will show that they gain a greater appreciation for its contrastive meaning with age. Moreover, adults will not be able to suspend the contrastive meaning. To say that *there is an A but there is a B* in the word TABLE will be treated as true and with relative ease by a 3-year-old but will be viewed as odd, and as a source of slowdown, by an adult.

1. **The current proposal’s experimental approach**

This proposal’s aim is to determine how the discourse connectives *and, so, but*, *because* and *if* are related to one another by investigating their inferential profiles through adults’ reaction times, EEG, and development. The experiments in the proposal are useful in two ways. One is that the experimental record on discourse connectives is relatively sparse. There are a handful of mostly corpora-based investigations as described earlier along with a handful of experiments that investigate specific connectives (see Zufferey et al., 2015; Kohne & Demberg, 2013 ; Bernard et al. 2012). The other is that most of the existing studies rely on participants detecting an appropriate connective based on the content in the segments presented (e.g. Bernard et al. [2012] investigate whether 3- to 5-year-old children detect that the presence of *because* makes for a stronger argument than a statement without it). What is missing from this important literature are investigations that isolate the meaning of, what can be described as the procedural meaning of, discourse connectives while keeping the material constant and inferential information from the background to a minimum. By investigating discourse connectives with largely contentless materials, this work would fill a major gap.

In order to put a set of connectives on the same playing field, one needs a paradigm in which each connective is in a position to have a felicitous effect. The paradigm proposed here presents a simple memory game about letters of the alphabet that can appear on a hidden blackboard. Imagine being told that “On a hidden blackboard, I have written down three letters in the order that they appear in the alphabet” (e.g. ABC, XYZ etc.). This is going to be repeated, and practiced at first, so that letter-triplets can be readily imagined. For expositional purposes, the proposal will stick with a single example, where L is the first letter. It follows that the three letters for this case are LMN. See Figure 1 below for details.

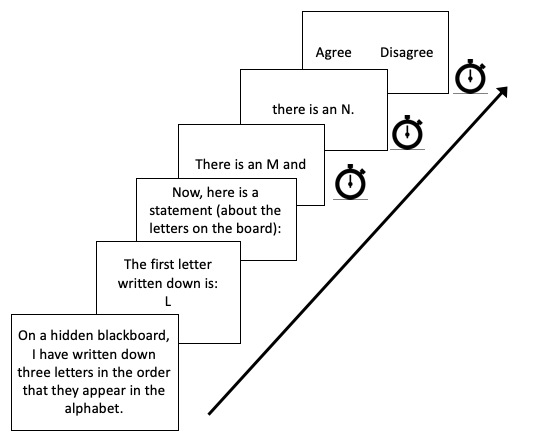


Figure 1: A schematic representation of a single trial from the paradigm. Through the first three screens on a computer an “interlocutor” informs the participant that she has written down three letters (in the order they appear in the alphabet) and that the first of these is the letter L. This implies that the two other letters are M and N. This sets up a test statement regarding two segments (see the 4th and 5th screens). Note how the connective (*and* in the 4th screen) can be replaced (e.g. with *so, but, if,* or even nothing). Reaction-time profiles are anticipated to change as a function of the connective and the letters in the segments. A stopwatch indicates where reaction times are critical for the experiment’s purposes as participants advance in a self-paced manner.

In practice, the paradigm will present a different starting letter each time (and, for the sake of variety, the trial can ask about fewer or more letters). The experiment’s goal is to set up a self-paced study so that participants’ own reactions can reveal how easy or difficult it is to process a sentence as a function of the connective and the letters in the segments.

The paradigm puts one in the position to detect how (or whether) a single word (e.g. *et* versus *mais* versus no connective) can have effects on the uptake of the information in the first segment (e.g. *There is an M and* [underline added for exposition purposes]) as well as downstream when processing the second segment (e.g. *There is an N*). At its most basic level, one can compare multiple experimental statements, which will be described in greater detail in the work packages that follow. While Work Package 1 (WP1) focuses on forward-going connectives (*so, but*), WP2 focuses on reversed-going connectives (*because, if*). Whereas WP3 describes how one can adapt the task for purpose of EEG investigations, WP4 investigates how cognitive effort could affect processing, which is expressed through developmental studies as well as dual-task studies. It is in WP4 that we will consider how participants on the Autism Spectrum perform. WP5 explores how typological and historical linguistics can generate investigations into discourse connectives diachronically and synchronically.

1. **Work Packages**

***4.1*** ***Work Package 1: Using reading times on forward-going connectives***

The first Work Package determines whether the discourse connectives *so* (*alors*) and *but* (*mais*) are both distinctive from *and* (*et*) and from one another. The common thread among the connectives here is that *so* and *but* rely on the first segment to make claims about the second one. As indicated earlier, a speaker’s use of *so* is to explicitly draw attention to a conclusion that she has drawn while underlining an inference; the speaker’s use of *but* is to make a contrast (or to deny an expectation raised in the first conjunct).

See Table 1’s 18 prototypical example trials (broken down into 6 groups of 3) to appreciate the paradigm’s set up and internal comparisons. Each of the rows reflects the way a unique combination of letters, marked as 1 through 6, is conjoined by a connective (labeled with *and*, *but* and *so*). While the correct answer for any of these follows the truth table for conjunctions (*Agree* when both conjuncts are true), one can see how felicity is affected by the choice of connective. In the last column, correct responses in italics point to potentially infelicitous statements. For example, it can appear infelicitous to conjoin two true propositions with *but* when there is no contrast or an expectation that is denied. These cases can lead to the response “disagree” or slowdowns to “agree.” That is, while *but* in (5.but) appears felicitous because it contrasts a letter excluded from the triplet LMN and another that is included, the cases of (1.but), (2.but) and (3.but) appear infelicitous. Likewise, while *so* appears felicitous for (1.so), since L can be viewed as the direct source of inference with respect to the production of the triplet, M in the first segment (of 2.so), appears slightly infelicitous because it is arguably more a consequence, than an inferential source of, L’s appearance (also see 6.so). A question mark indicates that statements are not readily decipherable, e.g. when the inferential reference of *so* in (5.so) is opaque.

Table 1. A representation of the materials in Work Package 1 through prototypical trials, which investigate forward going connectives (*so, but*) with *and* as a control condition.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Prior Information | Screen 4 | | Screen 5 | Screen 6  (Options) | Technically correct Response |
| Label | Rule | First proposition | with connective | Second proposition |
| 1.and  1.but  1.so | Three letters in a row from alphabet starting with L | There is an L | and (et)  but (mais)  so (alors) | there is an N. | Agree/  Disagree | Agree  *Agree*  Agree |
| 2.and  2.but  2.so | Three letters in a row from alphabet starting with L | There is an M | and (et)  but (mais)  so (alors) | there is an N. | Agree/  Disagree | Agree  *Agree*  *Agree* |
| 3.and  3.but  3.so | Three letters in a row from alphabet starting with L | There is an N | and (et)  but (mais)  so (alors) | there is an L. | Agree/  Disagree | Agree  *Agree*  Agree |
| 4.and  4.but  4.so | Three letters in a row from alphabet starting with L | There is an M | and (et)  but (mais)  so (alors) | there is a K. | Agree/  Disagree | Disagree  Disagree  Disagree |
| 5.and  5.but  5.so | Three letters in a row from alphabet starting with L | There is no Q | and (et)  but (mais)  so (alors) | there is an M. | Agree/  Disagree | Agree  Agree  ? |
| 6.and  6.but  6.so | Three letters in a row from alphabet starting with L | There is an N | and (et)  but (mais)  so (alors) | there is no Q. | Agree/  Disagree | Agree  Agree  *Agree* |

The dependent variables are multiple. Expressions of comprehension will come from rates of Agree/Disagree for each statement in Screen 6 as well as their speed of response. Likewise, the speed with which Screen 4 is processed with its connective is informative (e.g. does *but* slow participants down compared to *and*?) as well as the speed of processing Screen 5 in the wake of Screen 4. For purposes of experimental control, the paradigm will also include cases having no connective, with each row labelled as *nc* (for no connective), leading to two separate sentences (see examples in Table 2).

Table 2. A representation of further control trials having no discourse connectives.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Prior Information | Screen 4 | | Screen 5 | Screen 6  (Options) | Expected Response |
| Label | Rule | First proposition | No connective | Second proposition |
| 1nc. | Three letters in a row …starting with L | There is an L. |  | There is an N. | Agree/  Disagree | Agree |
| 2nc. | Three letters in a row …starting with L | There is an M. |  | There is an N. | Agree/  Disagree | Agree |
| 3nc. | Three letters in a row …starting with L | There is an M. |  | There is a P. | Agree/  Disagree | Disagree |
| 4nc. | Three letters in a row …starting with L | There is an M. |  | There is a K. | Agree/  Disagree | Disagree |
| 5nc. | Three letters in a row …starting with L | There is no Q. |  | There is an M. | Agree/  Disagree | Agree |

Critically, this paradigm is in a position to test prior claims. For example, according Spooren and Sanders (2008), additives (*and*) should be less complex (i.e. prompt faster treatments) than “causals” (*so*) and adversatives (*but*). Arguably, statements linked with *so* should be easier to process than *but*, even though this might be too subtle a difference to capture. It is also possible that the presence of a specific connective will speed up processing downstream. For example, the *but* in (5.but) restricts the world of discourse possibilities with respect to Screen 5 in a way that *and* in (5.and) does not.

One concern of this paradigm is that *alors* has two syllables whereas the other connectives have one, making *alors* a bit longer. This can be dealt with in two ways. One is to measure the reading time of this statement based on the number of syllables (reading time divided by the number of syllables) and the other is to conduct follow-up experiments that replace *alors* with *donc*. The second solution would allow us to determine the extent to which the two causal expressions prompt similar outcomes.

***4.2*** ***Work Package 2: Reversed-going connectives***

As can be seen in Table 3, the same template can be applied to reversed-going connectives, *because* and *if*, while keeping the fundamental *and* in place as a control item. However, note that several rows have been eliminated because they generate infelicitous cases (to appreciate how, go to Table 1, replace *but* and *so* with *because* and *if* in the row labeled 6 and note how its sub-rows produce incongruities). This, in itself, is edifying.

The directionality of *because* and *if* can be appreciated by comparing the examples in rows labelled as (3) versus (1) in Table 3. Whereas the attribution of order from segment 2 (in Screen 5) towards segment 1 (Screen 4) is inferentially justified for the examples in the row labelled (3), since L is arguably a source for producing N, the inverse order expressed through *because* and *if* in the row labelled (1) does not appear felicitous. That is why it is not clear what to expect as responses for the cases of (1.bec) and (1.if), as noted with a question mark in the last column. It is possible that participants accept (1.if) as non-problematic due to an invited inference (or for a lack of inference). Piloting will be critical for the cases exemplified in Table 3 because one does not want to have too many potentially infelicitous sentences in a paradigm. It is possible that we will have to remove even more of these. Regardless, one can determine whether indicators of inference (*so*) are more effort-demanding than the conjunction *and* by comparing the three trials in the row labelled (3). Of course, performance with these connectives can be compared to the data collected in WP1; in fact, one can imagine preparing an experiment that combines all or some of these connectives.

Table 3. A representation of the materials in Work Package 2 through prototypical trials, which investigate reversed-going connectives (*because, if*) with *and* as a control condition.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Prior Information | Screen 4 | | Screen 5 | Screen 6  Options | Technically correct Response |
| Label | Rule | First proposition | with connective | Second proposition |
| 1.and  1.bec  1.if | Three letters in a row from alphabet starting with L | There is an L | and (et)  because (car)  if (si) | there is an N. | Agree/  Disagree | Agree  ?  ? |
| 3.and  3.bec  3.if | Three letters in a row from alphabet starting with L | There is an N | and (et)  because (car)  if (si) | there is an L. | Agree/  Disagree | Agree  Agree  Agree |
| 4.and  4.bec  4.if | Three letters in a row from alphabet starting with L | There is an M | and (et)  because (car)  if (si) | there is a K. | Agree/  Disagree | Disagree  *Disagree*  *Disagree* |
| 5.and  5.bec  5.if | Three letters in a row from alphabet starting with L | There is no Q | and (et)  because (car)  if (si) | there is an M. | Agree/  Disagree | Agree  ?  ? |

***4.3*** ***Work Package 3: Applying EEG***

Based on prior work generated by my lab in Lyon (see Bonnefond et al., 2012; Bonnefond & van der Henst, 2009), one can expect this paradigm to derive electrophysiological reactions as well. Specifically, our prior work with *If* when it was part of a conditional reasoning argument revealed the relevance of two ERP components. One is that P3b’s arise when an expectation is satisfied. That is, the minor premise *P* in [*If P then Q; P//Q*] prompts a P3b when it comes in the context of the conditional’s major premise as opposed to when the premises are reversed as in [*P; If P then Q//Q*]). The other is that an N200 arises when an expectation is *not* satisfied. For example, we showed – surprisingly – that the minor premise of an Affirmation of the Consequent (AC) argument, viz. the *Q* (in the second premise) in *If P then Q; Q*, prompts (both a slowdown in self-paced reaction-time studies and) an N200 among participants universally, when compared to the minor premise of a Modus Ponens argument (*If P then Q; P*) and regardless of their truth-value judgements (participants are typically mixed in responding to AC arguments; true is pragmatically justified and false is logically justified). Based on these findings, we argued that, in the wake of an *If-then* statement, participants are anticipating the conditional’s antecedent. These revealing signatures can be applied to the current paradigm.

Consider how one can use the example in the row labelled (3) from each of the three Tables. The dependent variable would be reactions to the letter in the second segment in Screen 5. In the wake of *and,* the letter L would be uneventful and serves as a solid control. In contrast, one would expect that the presentation of the letter L in the wake of *but* (from [3.but] in Table 1) would prompt an N200 whereas it would likely prompt a P3b in the wake of *if* or *because* (i.e. [3.but] from Table 3). In and of itself, an EEG experiment applied to an array of discourse connectives would be novel for the literature. The same theoretical considerations from earlier still apply; the measures would simply be more refined.

Of course, an EEG experiment calls for adjustments to the paradigm with respect to Figure 1 above. For example, the uptake in EEG experiments calls for immediate reactions and not self-paced ones. Furthermore, it might pay to limit the wordiness of the self-paced task and determine if one can simply present screens showing “L”, “because”, “M.” Prior work conducted in my lab began with full syllogisms such as “If Jean goes to the cinema, then he travels by bicycle” and ended up being presented as “If J then C” (see Bonnefond et al., 2012). This will be determined on site.

***4.4*** ***Work Package 4: Developmental studies and other investigations of cognitive load***

The task in this paradigm is ideal for determining how participants perform when under cognitive load. Cognitive load can be expressed in two ways. One classical way is to track children’s performance as they get older. Given that children become increasingly more efficient as they grow, younger children’s performance often reveals how less mature systems view the meaning of critical words. For example, prior work on scalar implicature (Noveck, 2001) was energized by showing how younger children are more likely to treat *Some* semantically (as *Some and perhaps all*) while adults are more likely to treat it pragmatically (as *Some but not all*). For this proposal, prior developmental work on conditionals (e.g. O’Brien et al., 1989) would be instructive. This work indicates that the conditional is understand as a conjunction among the youngest children, which makes sense if one assumes that the conditional’s specific procedural meaning is acquired with age. The same principles can be extended to the other discourse connectives here.

Another way to separate out the procedural meaning of a discourse connective is to put adult participants under (slight) cognitive strain. To accomplish this, one can ask adult participants to carry out a secondary task, one that prevents them from applying all their cognitive resources to the main task at hand. Similarly to younger children, the scalar literature has shown that adult participants are less likely to generate pragmatic readings when they are simultaneously carrying out a second task (see De Neys and Schaeken, 2007). The same procedure can be used here to determine how adults, when encumbered, interpret the studied discourse connectives. Do they treat the sentence with a more fundamental conjunctive meaning or are they perhaps unperturbed by a secondary task?

Finally, it is in this WP, they we intend to investigate participants with ASD. Participants on the spectrum have long been studied, both because our cognitive investigations can be useful for better understanding (and eventually aiding) them and because this population can help linguists discern how different kinds of cognitive profiles process information. As I highlighted elsewhere (Noveck, 2018), those on the spectrum are less likely to be flexible in their interpretations (e.g. as shown by Pijnacker et al., [2009]) with respect to conditionals. This paradigm requires participants to be flexible, e.g. in providing an Agree/Disagree judgement to potentially infelicitous uses (see [1.but] in Table 1 when there is no real contrast to consider). Would participants on the spectrum be more likely to disagree with an item like Table 1’s (1.but) than typical participants because the procedural meaning of but *requires* a contrast? Or, would they be more likely than a typical participant to accept such a statement because *but* essentially means *and*?

***4.5 Work Package 5: Diachronic accounts of discourse connectives: so, then and but etc.***

In Grossman and Noveck (2015), we wrote:

...both experimental pragmatics and historical linguistics have proposed [how] different types of inferential mechanisms may be involved in understanding utterances. Historical linguistics can bring to the table an enormous body of data, which can be used to formulate testable predictions, and experimental pragmatics can contribute a wide range of research tools to evaluate hypotheses about processing.

Issues of language change can complement the experimental studies here by investigating the language change of the discourse connectives, starting with French. Given that individual discourse connectives appear to incorporate logical features, it would be worthwhile to determine how the connectives under study here made their way into our language. Has there always been a conjunction *and*? Where does it come from? Does *and* predate *but*? A comparative analysis across languages would be of obvious merit too.

The plan is to provide the conventionalization profile of discrete items that are the object of experimental testing – namely, the terms *and, so, but*, *if* and *because.* The profile will be established diachronically, but will not ignore synchronic investigations. This supposes comparability of data across languages. There are some cited claims to be built upon, such as the work from Caterina Mauri and colleagues (e.g. see Mauri & Ramat, 2012), who argue that connectives emerge when ad hoc lists – which implicitly create categories -- get supplemented with particular relations, such as disjunctions and conjunctions.

Frankly, I do not have the competence to carry out these investigations myself, though I do consult with those who do (e.g. Pierre Larrivée, from Caen, and I are currently conducting corpus work on the quantifier *some*). Critically, members of my future lab *le LLF* do pursue this line under the research theme *Variation and Change* (headed by Heather Burnett) and I look forward to working with them.

1. **Benefits, background, feasibility and the Université de Paris IDEX as a setting**

My research career has been driven by theoretical and experimental investigations into reasoning, development, and language. This has allowed me to pursue research that ranges from the cognitive to the neuroscientific and from the linguistic to the theoretical. For most of that time, I have operated under the assumption that we are born with a natural capacity to make logical inference, that this is arguably the source of rational thought and that logical connectives are the expressions *par excellence* to express rational thought. The present work questions that assumption by investigating whether the inference forms that I have investigated throughout my career are merely extensions of discourse that have been adopted to make claims about logical reasoning.

However, it could very well be, as has been argued similarly with respect to number (Chrisomallis, 2010), that logical reasoning emerges from culture due to social pressures. According to Mercier & Sperber (2018), logical connectives do not necessarily hold a special place in our cognitive architecture; rather, they make for more convincing arguments. This is why these authors have a largely deflationary view of logical inference. In contrast, I have provided reasons for assuming that logical connectives do hold a special place in our cognitive architecture (Noveck, 2019), with some evidence coming from neuroimagery studies. As can be seen, the role of logical connectives in our cognitive architecture remains a focus of discussion. These are new questions that apply to a long-running debate about rationality in general (also see Chater et al., 2018).

My arrival at the Université de Paris is opportune. The IDEX brings together researchers from complementary areas in the Sciences and the Social Sciences and my work fits into both. My future lab, *Laboratoire de Linguistique Formelle* (*LLF*), is an ideal setting for pursuing this research. It includes a range of language scholars (including experimentalists, like myself, to semanticists to pragmatists to historical linguists) with whom I can routinely collaborate. This is what is most attractive about my arrival there. The lab also has the equipment (e.g. EEG) and support staff, i.e. everything I would currently need to carry out the proposal.

That said, the *Chaire d’Excellence* would also provide me with a period of acclimatization that would allow me to meet with other relevant partners at the University, such as the language group headed by Thierry Nazzi within the Integrative Neuroscience and Cognition Centre (formerly, the U. Paris Descartes) or with potential colleagues at the Medical School. These encounters would clarify how my research fits in at the University thematically and with respect to equipment and techniques. For example, I look forward to meeting and consulting with specialists of Autism Spectrum Disorders. Similarly, it would be ideal to know about the accessing of an fMRI facility on campus so that I could further pursue the questions raised in this proposal.

The *Chaire d’Excellence* would be an ideal way to facilitate my entry to the *Université de Paris*, which I very much look forward to. Let me add that I appreciate having the opportunity to present myself to this committee. I am anxious to start working with my labmates at *le LLF* and to make a contribution to the academic community in Paris.

1. **References**

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1. The authors describe forms other than discourse connectives that maintain contiguity, such as the use of pronouns, that I will not discuss here. This discussion will be geared towards discourse connectives. [↑](#footnote-ref-1)