



The Role of Alternatives in Language

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In this review we provide a discussion of the concept of alternatives and its role in linguistic and psycholinguistic theorizing in the context of the contributions that have appeared in the Frontiers Research Topic *The Role of Alternatives in Language*. We are discussing the linguistic phenomena for which alternatives have been argued to play a paramount role: negation, counterfactual sentences, scalar implicatures and exhaustivity, focus, contrastive topics, and sentences with bare plurals and with definite plurals. We review in how far alternatives are relevant for these phenomena and how this relevance has been captured by theoretical linguistic accounts. Regarding processing, we discuss the mental activation of alternatives: its mandatory vs. optional nature, its time course. We also address the methodological issue of how experimental studies operationalize alternatives. Finally, we explore the phenomenon of individual variation, which increasingly attracts attention in linguistics. In sum, this review gives an inclusive and broad discussion of alternatives by bringing together different research strands whose findings and theoretical proposals can advance our knowledge of alternatives in inspiring cross-fertilization.

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INTRODUCTION

Many linguistic utterances convey meaning that must be interpreted against an alternative meaning in order to be fully informative, or even interpretable. For instance, when I say *If I were rich I would travel the world in 80 days*, I am talking about worlds where the proposition *I am rich* is true: I am (usually) saying that these worlds are non-factual worlds and that in the actual world the proposition *I am rich* is false. Thus, I am juxtaposing different (sets of) worlds. Another example is negation. When I say *Chris doesn't eat rhubarb* I am making an assertion about the actual world: in the actual world, the proposition *Chris doesn't eat rhubarb* is true. Usually, though, when I use negation, I am also considering (an) alternative (set of) world(s). In the present case these worlds would be worlds where the proposition *Chris eats rhubarb* is true. Again, we juxtapose alternative worlds.

Since propositions denote sets of worlds, another way of describing the above phenomena is to say that alternative propositions are involved in the interpretation of these sentences, for instance *{Chris eats rhubarb, Chris doesn't eat rhubarb}*. And since sentences are the linguistic objects that may denote propositions, substituting a linguistic expression in a sentence by a different expression will usually produce an alternative proposition. Consider *Chris ate some of the biscuits*. When we substitute *some* for *all*, the sentence changes its meaning: *Chris ate all of the biscuits* is true in different worlds. So the two sentences denote alternative propositions. The two expressions *some* and *all* also are alternatives—on the level of expressions, and on the level of the semantic objects that are denoted by these expressions, here quantificational determiners. Importantly, the presence of an expression like *some* typically in itself evokes alternatives: The sentence *Chris ate some of the biscuits* has the pragmatic meaning *Chris ate some but not all of the biscuits*, even though the denotation of *some*

essentially is *some and possibly all* (i.e. *at least some*). This is a well-known scalar implicature: The use of an expression which has scalar alternatives—*some* and *all* are elements on a scale like *{none, some, many, most, all}* —, is interpreted as expressing the exclusion of the alternatives that lead to a stronger meaning¹ of the sentence, that is *{many, most, all}*. The alternative *none* is not directly relevant here because it is incompatible with the truth-conditional meaning of *some*. Thus, the sentence *Chris ate some of the biscuits* can only be interpreted in the intended way if the scalar alternatives of *some* are considered.

Alternatives also play a role in the information structuring of a clause, most notably for focus and for contrastive topics. Since Rooth (1985), Rooth (1992), and Krifka (2008) the alternative semantics view of focus has been very successful in the explanation of linguistic phenomena as well as in the description of language processing. According to this view, focus indicates the presence of alternatives that are relevant for the interpretation of linguistic expressions (Krifka, 2008: 247). Focus interpretation is anaphoric in that the linguistic context must provide alternatives, or they must be easy to accommodate from the situational context. Consider the sentence *CHRIS ate the biscuits*, where the small capitals indicate prosodic prominence of the word *Chris*, i.e. the presence of a prominent pitch accent. Since one way of indicating focus in English is placing prosodic prominence on a syllable within the focus expression, $[[\text{Chris}]]$ is the focus in this sentence. As a consequence, our sentence presupposes that $[[\text{Chris}]]$ is an element in a non-singleton set of alternatives, where at least one other alternative is provided by the context, for instance *{Chris, Sam}*. Usually, our sentence will be taken to mean that substituting the focus by an alternative results in a false proposition: It is not true that Sam ate the biscuits. Thus, similarly to the case of the scalar implicature, the alternatives which are not the focus themselves are excluded. There are other instances of focus, where there is no exclusion of alternatives, e.g. when focus appears in the scope of additive focus-sensitive particles like *also* as in *Chris also ate CAKE_{focus}*.

It is a natural question to ask at this stage if and how scalar alternatives and focus alternatives ‘interact’, and what the consequences are for the resulting meaning. How is focus on a scalar expression interpreted? Consider (1). In (1a), the accent takes the default position for sentences with wide focus on the whole sentence. In (1b), the accent indicates focus on the scalar expression *some* in the subject of the clause. So there are two sources for the relevance of alternatives in the interpretation: the lexical semantics of *some*, and the focus.

- (1) a. Some of the kids ate CAKE.
 b. $[\text{SOME}]_{\text{focus}}$ of the kids ate cake.

The alternatives that are triggered by these sources arguably are the same, namely a set of expressions and their denoted meanings, e.g. *{none, some, many, most, all}*. Indeed, Fox and Katzir (2011) argue that focus alternatives and scalar alternatives

are the same. As we discussed above, (1a) means *Some but not all of the kids ate cake* because the stronger alternatives are excluded. We also saw that without an additive focus-sensitive operator, focus is interpreted as signaling the exclusion of alternatives. What then is the meaning contribution of focus in (1b)?

To answer this question, it is important to remember that scalar implicatures do not arise obligatorily. In some contexts, scalar items receive the semantic *at least* reading. However, it has been found that placing an accent on a scalar item, i.e. focusing it, interacts with the computation of the implicature (e.g. Fretheim, 1992; Chevallier et al., 2008; Schwarz et al., 2008; Franke et al., 2017). Experimental results indicate that focus leads to a higher rate of implicature readings. These findings can be explained on the alternative semantics view that focus presupposes the existence of alternatives in the context. For (1b) this means that at least one of the alternatives of *some*, *{none, some, many, most, all}*, must have been mentioned in the discourse or must be easy to accommodate. Focus then leads to a ‘reliable’ exclusion of the contextual alternative. Note in this connection that scalarity is not restricted to quantificational elements. Many properties can be ordered on a scale, for instance *{cold, cool, warm, hot}*. Effects of prosody and thus focus on implicature computation were also suggested for these elements (e.g. Horn, 2006). Conversely, focus can easily evoke alternative sets involving a scale without an exclusion interpretation: It has long been noted that in sentences like *Chris only won the [BRONZE]_{focus} medal*, the focus-sensitive operator *only* is not used to exclude the alternatives (*silver* and *gold*): one can only win one medal in a competition anyway. Rather, the sentence expresses that *bronze* was less than what had been expected or wished for (Jacobs, 1991).

These examples show that alternatives play subtly different roles in different linguistic domains and that different ‘types’ of alternatives may interact. The goal of this review article is to evaluate the concept of *alternatives* in the linguistic domains where alternatives have been suggested to play a fundamental role in the interpretation and structuring of language. These domains have not been pursued completely independently of each other. For instance, counterfactuals, scalar implicatures and also focus often are discussed in relation to negation. However, work that puts negation into the center of its attention, usually asks and answers rather different questions than does work on counterfactuals, implicatures or focus. Our aim is to explore the various ways in which alternatives play a role for the different domains and to identify core characteristics of the notion *alternative* as well as potential differences between the domains. As the research on alternatives is carried out in different areas for each of which there exists a vast research literature, we cannot give a fully exhaustive review. To nevertheless achieve our aim, we are giving a review of a selection of the existing literature which contextualizes the original research contributions in the Research Topic *The Role of Alternatives in Language* (marked with ^{RT} in this paper), and we will refer the reader to more specific reviews on individual topics in the respective sections of this paper. Some linguistic phenomena which might be considered to involve alternatives are beyond the scope of the current

¹See Section *Negation and Counterfactuals* for elaboration on this notion.

review. These include for instance syntactic ambiguity, because we focus on alternatives from a semantic-pragmatic point of view, but also lexical ambiguity, which we do not consider for reasons of space.

We discuss the concept of alternatives both from the perspective of linguistic theory and from the perspective of language processing. Both fields have shown increased interest in alternatives in the last decades but there is not as much interchange as one would wish for. In our view, it is crucial to bring these fields together because the observation that alternatives are relevant or necessary for interpretation begs the question how these alternatives become part of the linguistic representation, which also is a *mental* representation. We may ask how and when alternatives are activated, and for how long they remain available—that is, what the temporal characteristics of alternative activation are, to what extent the exclusion of alternatives is an active mental process, and whether it requires mental resources. Issues like these might be relevant when it comes to grammatical conventionalization or to interpretation preferences, and the answers might be different for different types of alternatives.

The paper is structured as follows. In the section *Alternatives in Different Linguistic Domains* we discuss the linguistic domains where alternatives play a role by summarizing the core questions that have been asked for the respective domain, as well as the answers that have been proposed both on the basis of theoretical reasoning and on the basis of experimental evidence gathered with different methods. The discussion in this section addresses characteristics of the representation of alternatives in these domains both from a linguistic (grammatical) point of view and from a mental model (psychological) point of view. The section *The Activation Process* focuses on the issues of processing listed above, that is on characteristics of the *process* of constructing the representation of alternatives, for instance temporal aspects. In the section *Alternatives in the Lab*, we investigate how alternatives as linguistic objects can be related to possible worlds in experimental settings, that is we discuss the operationalization of alternatives, which is an important issue for the experimental investigation of both the grammar and the processing of phenomena involving alternatives. The section *Alternatives for All? Individual Differences* addresses an issue that has become increasingly relevant in recent years also both in linguistics and in psycho-/neurolinguistics: the extent and evaluation of individual differences. These are pervasive in the realm of alternatives, too, and pose interesting questions for linguistic and psycholinguistic theories. The section *Conclusion* summarizes and concludes.

ALTERNATIVES IN DIFFERENT LINGUISTIC DOMAINS

Negation and Counterfactuals

As mentioned in the *Introduction*, for negation the alternative propositions p and $\neg p$ are relevant: $\neg p$ is what a negative sentence denotes, p is negated. As simple as it sounds, this state of affairs has non-trivial consequences for the factors that influence the

grammar and processing of negation. We will focus on two factors in this section: semantic and world knowledge on the one hand, and discourse context on the other hand.

Semantic and World Knowledge and Negation Alternatives

Negative sentences normally are used to express the falsity of a proposition p whose truth or falsity is at issue. This means that there must be a chance of p actually being true. A sentence like *A robin is not a tree*, although true, is unlikely to be uttered because the negated proposition p (*A robin is a tree*) is unlikely to be true outside very specific contexts. Therefore, sentences negating an unlikely proposition p are usually pragmatically infelicitous and it has been shown that they incur increased processing costs and are harder to recall than pragmatically felicitous negative sentences (e.g., Wason, 1965; Cornish, 1971; Hörmann, 1971; Johnson-Laird and Tridgell, 1972; Wason, 1972; Givon, 1978; Watson, 1979; Arroyo, 1982; Glenberg et al., 1999; Nieuwland and Kuperberg, 2008; Orenes et al., 2016).

The pragmatic (in)felicity of negative sentences is fed by semantic and world knowledge: We know that robins and trees are living organisms in different biological kingdoms—animals and plants—and it is not informative to say that a particular genus of animal is not a clade in the plant kingdom. A true positive proposition like *A robin is a bird*, in contrast, can be considered informative if the addressee does not know what particular animal a robin is. There have been numerous studies investigating the role of pragmatic felicity in relation to semantic and world knowledge, amongst them two studies that have appeared in the Research Topic *The Role of Alternatives in Language* (2019). Haase et al. (2019)^{RT} investigated pragmatic plausibility via the co-hyponym relation such that there is a large semantic feature overlap between alternatives (unlike for birds and trees), and both alternatives in principle would be pragmatically plausible in a sentence such as *George Clooney is (not) an actor/singer*. Haase et al. employed the method of event-related brain potentials, which in earlier research yielded the result that for stimulus sets without pragmatic control the N400 component on the final word is larger for false than for true affirmative sentences, whereas for negative sentences it is the other way round (e.g., Fischler et al., 1983; Kounios and Holcomb, 1992; Lüedtke et al., 2008; Nieuwland and Kuperberg, 2008; Wiswede et al., 2013; Dudschig et al., 2016; for early research using behavioral methods reporting this truth-polarity interaction, see e.g., Wason and Jones, 1963; Gough, 1965; Clark and Chase, 1972; Carpenter and Just, 1975; for a recent review also on findings not showing the interaction, see Kaup and Dudschig, 2020). The truth-polarity interaction has been suggested to result from the semantic subject-predicate mismatch (e.g., *robin—tree*) in the false affirmative and the true negative conditions, and has sparked discussion about a late integration of the meaning of the negative marker, to which we turn in the section *The Activation Process*. As for the role of pragmatic felicity, Haase et al. replicate the above-mentioned ERP-findings for the affirmative sentences but for the negative sentences the (reverse) effect is non-significant. The authors argue that when the correctly negated predicate is a co-

hyponym and thus pragmatically felicitous, anticipation of the negated material is more successful than when there is no co-hyponymy (they do not take a stance as to whether the N400 reflects expectancy, prediction or integration). Their finding supports the relevance of pragmatic felicity for the interpretation of negative sentences, adding to the previous findings on this issue.

Pragmatics as fed by semantic and world knowledge can also play a role via conventionalization (Kronmüller and Barr, 2015; Kronmüller et al., 2017). Kronmüller and Noveck (2019)^{RT} present evidence from a negative reference task where participants picked objects with or without conventional names. A conventional name is for instance *vase* for a vase. An object without a conventional name is for instance an unusually shaped clay form. Participants were instructed not to pick for instance *the sculpture*, where *the sculpture* refers to an unusual object that in the course of the task had been *ad-hoc*-named *the sculpture*. In addition to “the sculpture,” there were two alternative objects. When instructed not to pick “the sculpture,” the choice of object by the participants depended on whether the other objects both were unusual and on whether they had a conventional or *ad-hoc* name (given in the course of the task) or not. The authors show that linguistic conventions (names) and contextual linguistic and visual information influence the inferences listeners make about alternatives when interpreting negative sentences.

The Discourse Context

A proposition $\neg p$ is true in many different (possible) worlds: saying what is not the case is not yet saying what is the case. Therefore, the question arises what representation we form when we hear a negative sentence. From a grammatical point of view, we would say that it is a representation containing a negation operator associated with p , so that two propositions (p and $p'=\neg p$) are elements of the linguistic representation. From a mental model point of view, the representation might also be one of a proposition q , which is true in a subset of the $\neg p$ -worlds but tells us something more about those worlds. For example, when we hear *Chris didn't eat cake*, we might form a mental model corresponding to *Chris ate biscuits*, because we know that biscuits were under consideration in the context (unless we think that Chris didn't eat anything at all). Thus, the discourse context is important for negation because it typically restricts the number and type of relevant alternatives when interpreting a negative sentence. This is true especially for the context preceding the negative sentence, but we will see further below that the context following a negative sentence also is important: it influences the anaphoric uptake of the propositional alternatives p and $p'=\neg p$.

One area where the preceding discourse context has been found to be important is the above-mentioned truth-polarity interaction, which early on has been suggested to result from a two-step construction of the representation of negative sentences (Carpenter and Just, 1975). In recent theorizing, this two-step construction is formulated as two-step simulation of the mental model representing the situation described by the negative sentence (Kaup and Zwaan, 2003; Kaup et al., 2006). The

claim is that first, a situation model is simulated which corresponds to the (false) positive proposition p —the *affirmative* situation—and then a model of the actual, *negative* situation is simulated. Two-step simulation has been shown with different methodologies (e.g., Kaup et al., 2006; Kaup et al., 2007; Dale and Duran, 2011; Autry and Levine, 2012; Orenes et al., 2014; Orenes et al., 2016) but there are also proposals that negation is processed in one step (e.g., Mayo et al., 2004; Anderson et al., 2010; Papeo et al., 2016). For recent reviews on these issues, see Tian and Breheny (2019) and Kaup and Dudschig (2020). Whether or not a simulation happens in two steps depends (inter alia) on the number and kind of alternatives that are available in the discourse. In the following, we will discuss properties of the preceding discourse context that are relevant with respect to this issue. The actual time course of the activation of negation alternatives will be discussed in *The Activation Process*.

Consider the sentence *The window is not open* with the predicate *open*, which has a contradictory antonym: *closed*. It is easy to simulate a situation model of the actual, negative situation because that model must have a closed window in it. So there are two alternatives available that may be simulated in two steps. For predicates with multiple, i.e. contrary antonyms (e.g., *green*), it is unclear what the negative situation looks like because there are many options for the second alternative: blue, red etc. The linguistic or situational context may restrict the number of such alternatives and thus provide ‘more suitable’ content for a simulation of the negative situation, and it has been shown that this has an impact on negation processing (e.g., Wason, 1961; Kroll and Corrigan, 1981, also see Mayo et al., 2004). We are illustrating the relevance of the number of alternatives here with findings from Orenes et al. (2014), who conducted a multi-picture visual-world paradigm with four different colors where a context sentence announced either two alternative colors (e.g., *green, blue*), or more than two alternative colors (e.g., *green, blue, yellow, pink*) to be present in the picture. They found that in the two-alternative context, participants listening to negative sentences like *The figure is not green* briefly looked at the green figure and then focused their attention on the blue figure, i.e. the figure representing the one contextually plausible negative situation. In the multiple-alternative context, participants focused on the green figure only. Thus, when the context restricted the alternatives to two, two alternatives are activated, otherwise this is not the case.

The preceding context may also influence the availability of the affirmative situation by providing several $\neg q$ -alternatives $\{\neg q_1, \neg q_2, \dots\}$. Assume we wish to ask some students for their opinions about a city they have never been to. To establish the set of appropriate addressees, we ask the students: *Who hasn't been to Bielefeld?* This gives us the set of students who have not been to Bielefeld, and by extension a set of alternative negative propositions, e.g., $\{Alex\ hasn't\ been\ to\ Bielefeld, Chris\ hasn't\ been\ to\ Bielefeld, Robin\ hasn't\ been\ to\ Bielefeld\}$. This set does not contain a positive proposition. For negative sentences uttered in the context of such a question, there does not seem to be two-step simulation (Tian et al., 2010; Tian and Breheny, 2016). The context question is the so-called *Question under Discussion* QuD

(Roberts, 1996; cf. von Steutterheim, 1997). It introduces and restricts focus alternatives: The answer to the QuD must contain an alternative that is an element in the focus alternative set introduced by the QuD. Thus, similarly to the interaction of focus alternatives and scalar alternatives (see *Introduction*), we find that the mental representation and linguistic relevance of alternatives from different domains interact. The alternative set relevant for negation is $\{p, \neg p\}$, but with a QuD like the above, the p -alternative is not relevant/salient, whereas the focus alternatives prescribed by the QuD are. The interplay of focus and negation has received considerable interest in the theoretical linguistic literature (e.g., Jackendoff, 1972; Jacobs, 1991; Partee, 1993; Hajičová, 1996; Rooth, 1996; Herburger, 2000; Beaver and Clark, 2008; Büring, 2016b). For a recent review, see Fălăuș (2020).

The relevance of the subsequent discourse for negation alternatives has only recently attracted attention. As already mentioned, in linguistic theorizing it is typically assumed that a negative sentence introduces two propositions that are principally available for anaphoric reference: p and $\neg p$ (e.g., Krifka, 2013; Meijer, 2016; Meijer and Repp, 2018; Claus et al., 2019). Which proposition gets picked up by a propositional anaphor depends on characteristics of the subsequent discourse. Experimental evidence from acceptability judgment studies suggests that propositional anaphors like *that* preferentially are interpreted as taking the negative proposition $\neg p$ as antecedent (Claus et al., 2019). $\neg p$ is of course the proposition that is denoted by the negative sentence (and that is associated with the final situation model). Therefore, a general preference for $\neg p$ might not be surprising. Importantly, certain parameters in the sentence containing the anaphor might change this preference. For instance, modal particles, belief-state verbs vs. reporting verbs, and counterfactual tenses have all been suggested to play a role. Claus et al. (2019) show for German that the presence of the adversative conjunction *but* vs. the focus particle *auch* ('also/too') in a dialogue like the following changes the preference from $\neg p$ to p : A: *Tom didn't steal the bag.* B: *Jenny believes that_{¬p}, too./But Jenny believes that_p.* Meijer and Repp (2018), also investigating German, find a shift to p -interpretations that is triggered by tense and by a modal particle. Illustrating the former, when someone says *Alex wasn't here on Monday*, a response like *That would be weird* typically is interpreted as meaning that Alex's absence would be weird, i.e. *that* refers to $\neg p$. A response like *That would have been weird*, in contrast, is typically interpreted as meaning that Alex's presence would have been weird, i.e. *that* refers to p . The authors argue that the response in these examples is the consequent of a contextual counterfactual and means *It would have been weird if Alex had worked on Monday*. The interpretive difference between the tenses results from the specific way tense is interpreted in the consequent of counterfactuals. The findings from this literature suggest that negative sentences indeed make available a positive proposition that principally is available for anaphoric uptake.

Staying briefly with counterfactual sentences, we note that they are generally interesting for negation alternatives because (typically) a positive sentence describes a negative situation—and the factual and a non-factual world are juxtaposed. In indicative conditionals, the alternatives $\{p, \neg p\}$ also are relevant. Indicatives differ from counterfactuals in the tense of antecedent and consequent

(counterfactual—past: *if there had been... there would have been...*; indicative—present: *if there are... there are...*). In an indicative, an antecedent containing the proposition p restricts the truth of the consequent proposition q to p -worlds and excludes $\neg p$ -worlds. In a counterfactual, the alternativeness is intuitively more prominent because the actual world (usually) is assumed to be false and the non-factual worlds are the worlds 'of interest.' In the theoretical literature, it is usually assumed that for a counterfactual to be plausible the factual and the non-factual worlds must be very similar (Goodman, 1955; Stalnaker, 1968; Lewis, 1973). We cannot address this issue here for reasons of space but we would like to point out that the similarity approach has recently been argued to be problematic (Ciardelli et al., 2018). The empirical argument involves *if*-clauses with negation, which seem to be judged differently than would be expected by the similarity approach. However, Schulz (2019) argues that the negation in the *if*-clause introduces alternatives which become relevant for the interpretation, similarly to alternatives that are introduced by a disjunction in the *if*-clause (e.g., Alonso-Ovalle, 2009; Santorio, 2018; Willer, 2018). Thus, we observe that there are intricate interactions between different 'types' of alternatives in the domain of counterfactual conditionals, too. For a recent review on counterfactuals, see Arregui (2020). We return to counterfactual and indicative conditional sentences in the section *The Activation Process*, when we discuss issues of processing.

(Scalar) Implicatures and Exhaustivity

In the *Introduction* we discussed scalar implicatures involving scales for quantificational determiners like *some*, and scales for predicates like *warm*. These scales were scalar in an intuitive sense. A scale like $\{none, some, many, most, all\}$ is a scale of quantities, which is something we can measure in the real world even if the threshold for using a particular element on the scale rather than its neighbor is not clear in every case. Similarly, scales like $\{cold, cool, warm, hot\}$ concern properties in the real world. In this section, we discuss implicatures that might be considered to be less intuitively scalar because the relation of strength, which we appealed to when we talked about the exclusion of scalar alternatives, seems to concern information states or knowledge about the world—or indeed, the common ground \neg , and not objects or properties in the world.

The Gricean and the Grammatical View of Implicatures

Assume a context where two people are under consideration for having been invited: Chris and Alex. A dialogue ensues: A: *Who did Toni invite?* B: *Chris*. B's answer is usually taken to mean that B invited Chris but not Alex. This is a run-of-the-mill Gricean implicature (Grice, 1967), where the meaning of B's answer is a *strengthened meaning*. The traditional, Gricean explanation for why this meaning arises is the following (see e.g., Horn, 1972; Grice, 1975; Gazdar, 1979; Soames, 1982; Levinson, 2000). Assuming that B is cooperative, their answer will be relevant in the context of the question, and it will entail all the information that is compatible with B's knowledge. If B knew that Toni invited Chris and Alex, saying so would have conveyed a stronger meaning: the proposition *Toni invited Chris and Alex* is true in fewer worlds than the proposition *Toni invited Chris* because

the latter is also true in worlds where Toni invited Chris but not Alex. Thus, a stronger meaning is one where we know more about the world we are in. Since B did not choose to express the stronger meaning, B's answer implicates that the stronger meaning is not true—it is excluded—and we arrive at the strengthened meaning *Toni invited Chris but not Alex*.

It has long been noted that the original Gricean view faces problems, which have fueled the development of two different types of theoretical accounts. One of the most-discussed phenomena in this regard are embedded implicatures, which arise in the scope of a higher operator. Returning to our example from the *Introduction*, *Some of the kids ate cake*, recall that the strengthened meaning is *Some but not all of the kids ate cake*. Embedding our example sentence under the verb *know* yields: *Toni knows that some of the kids ate cake*. Intuitively, the sentence means *Toni knows that some of the kids ate cake and Toni knows that not all of the kids ate cake*. It does not mean *Toni knows that some of the kids ate cake and it is not the case that Toni knows that all of the kids ate cake*, which, however, would be expected under a Gricean account. One type of account assumes that implicatures of this sort arise due to a silent exhaustification operator, *EXH* (alternatively O_{alt/O_c}). *EXH* can be introduced locally, but is (also) introduced by default at the top node of every matrix sentence. *EXH* exhausts the alternatives, i.e. it excludes stronger alternatives, so that a strengthened meaning arises. This view, which derives implicatures involving exhaustivity effects compositionally, is the *grammatical* view of implicatures and was first proposed by Chierchia (2004), Chierchia (2006); also see Katzir (2007), Fox and Katzir (2011), Chierchia et al. (2012), Trinh and Haida (2015). The other type of account are the (Neo-)Gricean approaches, including rationalist accounts and relevance-based accounts, which place pragmatic reasoning at the center of the explanatory framework (e.g., Sauerland 2004; Van Rooij and Schulz, 2004; Schulz and Van Rooij, 2006; Benz and Van Rooij, 2007; Geurts, 2009; Geurts, 2010; Franke, 2011; Russell, 2012; Frank and Goodman, 2012; Frank and Goodman, 2014; also see Benz and Stevens, 2018). There are also accounts explicitly combining aspects of both theories (e.g., Potts et al., 2015). For recent reviews on theories of implicatures, see for instance Breheny (2019) or Nicolae and Sauerland (2020).

Characteristics of Scalar Alternatives

There are several contributions in the Research Topic *The Role of Alternatives in Language* that explore specific characteristics of scalar alternatives. Trinh (2019)^{RT} investigates the contextual source of alternatives that are relevant for implicature computation. Tomioka (2021)^{RT} and Singh (2019)^{RT} explore implicatures in different subdomains—disjunction, quantificational determiners, numerals and so-called free-choice implicatures. Feng and Cho (2019)^{RT} consider so-called *indirect implicatures*. In contrast to the *direct implicatures* we have investigated so far, indirect implicatures arise when a scalar term at the *endpoint* of a scale is negated: *Toni did not always go to the beach last week* implicates that it is not the case that Toni never went to the beach last week, that is sometimes, Toni did go to the beach. Both Singh (2019)^{RT} and Feng and Cho (2019)^{RT} investigate the processing cost of these various implicatures. We

will discuss their contributions in the section *The Activation Process*, where we will see that the computation of strengthened meanings can but need not be costly (e.g., Bott and Noveck, 2004; Breheny et al., 2006; Huang and Snedeker, 2009; Marty et al., 2013; Chemla and Bott, 2014; Cremers and Chemla, 2014; Benz and Gotzner, 2020). In this section we concentrate on the role of the context and discourse factors more generally.

Trinh (2019)^{RT} explores how the set of alternatives that are relevant in the computation of exhaustivity implicatures can be restricted in a way that predicts intuitively correct implicatures in a number of subdomains. For instance, our question-answer discourse above might have given the impression that the question provides the relevant alternative set—as it would do in the case of focus alternatives: *{Toni invited Chris, Toni invited Alex}*. However, recall that it is actually the conjunction of these propositions that is the relevant stronger alternative for the exhaustivity implicature of the response. So the alternative set should be *{Toni asked Chris, Toni asked Alex, Toni asked Chris and Toni asked Alex}*. But then, why should we not also make *Alex did not ask Chris* part of the alternative set? After all, we are interested in who Toni asked—and thus also in whom they did not ask. Trinh discusses issues like these within the grammatical approach of implicatures and explores three notions that may be used to restrict the alternative set: relevance (closure under Boolean operations), utterance (what was explicitly uttered in the linguistic context: “formal alternatives”) and salience (what is contextually salient). Trinh shows that these notions make distinct predictions for the computation of implicatures and argues that salience poses some non-trivial problems.

Tomioka (2021)^{RT} investigates disjunction within the grammatical approach to implicatures. In the exhaustivity literature, disjunction has been argued to display some special characteristics. To illustrate, Hurford's constraint (Hurford, 1974) says that one disjunct must not entail the other: *#Toni traveled to Cologne or to Germany* is infelicitous, because traveling to Cologne entails traveling to Germany. Interestingly, this constraint does not apply to disjunctions of scalar alternatives (Gazdar, 1979): *Toni read some or all of the books*. This observation has been explained in the grammatical approach by assuming that the *EXH* operator applies to the first disjunct before the disjunction is interpreted. *EXH* changes the meaning of the first disjunct and thus removes the entailment relation: *Toni read some but not all of the books, or all of the books*. The order of the disjuncts is relevant here (Singh, 2008): *#Toni read all or some of the books* is infelicitous without a lexical *only* in the second disjunct. This observation is explained as a result of incremental (i.e. left-to-right) computation of the disjuncts, which makes insertion of *EXH* into the second disjunct ineffectual, which is disallowed (Singh, 2008; Fox and Spector, 2018).

Tomioka (2021)^{RT} shows that the empirical observations about disjunctions carry over to coordinations, subordinations and even independent sentences that are separated by a turn-take in conversation. Compare the following contrastive coordinations: *#Toni traveled to Cologne but Alex to Germany*; *Toni read some of the books but Alex read all of them*; *#Toni read all of the books but Alex read (only) some of them*. Tomioka argues that the previous accounts cannot explain these facts

because they rely on disjunction, and proposes that the alternatives that are at issue here, are focus alternatives: *Toni read [some]_{focus} of the books or Toni read [all]_{focus} of the books*. He proposes the *Contrast Antecedent Condition*, which requires that the first of the two sentences provides an antecedent from which a focus alternative set can be generated that fits the focus in the second sentence. Furthermore, the focus alternative set must contain mutually exclusive alternatives comprising the meaning of both sentences. The asymmetry of Hurford's constraint is explained (roughly) as follows: If the meaning of the first sentence can be strengthened (e.g., *some... → some and not all...*) and the meaning of the second sentence (e.g., *all...*) provides a mutually exclusive alternative, the result is felicitous. If the meaning of the first sentence cannot be strengthened (e.g., *all... → /*), the meaning of the second sentence (e.g., *some...*) does not provide the required alternative. By appealing to focus rather than scalar alternatives, Tomioka explains the observed effects in structures beyond disjunctions.

Focus and Contrastive Topics

In the previous sections, we repeatedly encountered focus alternatives. We saw that focus interacts with other types of alternatives (negation, scalars), and that focus alternatives for some phenomena might offer the better explanation than other alternatives (scalars). In this section, we consider research where focus alternatives are the central object of investigation. One strand of this research is concerned with the prosodic marking of focus. For instance, for intonation languages it has been shown that certain accents trigger the activation of alternatives during comprehension. Often, arguably more prominent accents, like English L+H* in contrast to H* lead to a more reliable activation of alternatives (e.g., Dahan et al., 2002; Weber et al., 2006; Ito and Speer, 2008; Watson et al., 2008; Braun and Tagliapietra, 2010; Husband and Ferreira, 2016; Braun et al., 2018). Yan and Calhoun (2019)^{RT} show for a language which marks focus prosodically not through accenting but through pitch range extension—Mandarin—that this kind of prosodic prominence also triggers focus alternatives. Furthermore, the choice of accentuation pattern in intonation languages has been shown to influence memory retrieval (e.g., Fraundorf et al., 2010; Gotzner et al., 2013; Repp and Drenhaus, 2015; Gotzner, 2017; Tjuka et al., 2020). Finally, the presence of elements that require focus for semantic reasons, like the focus particle *only*, influences the processing and memory of accented words and their alternatives (Spalek et al., 2014; Gotzner et al., 2016). See section *The Activation Process* for more details on processing.

Focus alternatives can be triggered by prosodic means without discourse context. Since focus is anaphoric, this begs the question what exactly serves as a suitable focus alternative. Building on some of the studies mentioned above, Braun and Biezma (2019)^{RT}, and Yan and Calhoun (2019)^{RT} compared different types of potential focus alternatives: what they call *contrastive alternatives* (words from the same semantic field as the focused expression, e.g., *swimmer—diver*), and *non-contrastive alternatives* (words which are semantically related via the event, e.g., *swimmer—pool*). Braun and Biezma consider the activation of alternatives by a prenuclear accent that arguably

marks a contrastive topic in German (L*+H). Contrastive topics have received various analyses, all of which involve information-structural alternatives: either 'simple' focus alternatives, or more complex alternatives, which may also reflect a specific QuD-induced discourse (e.g., Büring, 2003; Wagner 2012; Constant, 2014; Büring, 2016a). Braun and Biezma report that prenuclear L*+H activates alternatives quite similarly as a nuclear focus accent does, suggesting that a parsimonious analysis of contrastive topics should assume contrastive topics to be as similar to focus as possible.

The issue of what a suitable focus alternative is does not only arise in the absence of context. For the additive particle *also*, this issue is notorious. It has been observed that for sentences with *also* a relevant alternative must have been uttered in the context or be entailed by it. Accommodation usually fails, different from other focus particles: *Tim is a sugar addict. He even[#] also eats [candied FLIES]_{focus}*. Recall that similarly subtle restrictions on the contextual availability of alternatives have been discussed for scalar alternatives by Trinh (2019)^{RT} (section (*Scalar Implicatures and Exhaustivity*)). The controversy surrounding *also* is whether the context must provide an alternative proposition (e.g., *He eats marshmallows*) or whether an alternative to the focused constituent is sufficient (*marshmallows*) (Corblin, 1991; Heim, 1992; Asher and Lascarides, 1998; Geurts and van der Sandt, 2004; Roberts, 2010; Tonhauser et al., 2013; Ruys, 2015). Grubic and Wierzba (2019)^{RT} discuss this issue for the German particle *auch* 'too.' On the basis of experimental evidence, they argue that positing the presence of a propositional alternative is too strict but a sub-propositional alternative neither is sufficient to make the use of *auch* felicitous. However, it can be sufficient if merely accommodating the propositional alternative makes the discourse more coherent. We will see in the section *The Activation Process* that for scalar alternatives, comparable suggestions have been made (Singh, 2019)^{RT}: Creating coherence or/and answering a QuD more completely are objectives that influence the cost and success of the computation of the meaning of alternatives.

For some phenomena involving focus alternatives, focus itself is not enough to create coherence. Cleft sentences are an example. They are well-known to show exhaustivity effects, for which it is under debate whether they are a presupposition or an implicature (e.g., Halvorsen, 1978; Atlas and Levinson, 1981; Horn, 1981; Percus, 1997; Velleman et al., 2012; Büring and Križ, 2013; De Veugh-Geiss et al., 2018; see e.g., Onea 2019 for a recent review). Furthermore, clefts often are thought to involve contrastive focus, where the notion of contrast is somewhat unspecified (Repp, 2016 for a discussion of *contrast*). Destruel et al. (2019)^{RT} argue for English and French, that the contrast in clefts is a doxastic type of contrast concerning the interlocutors' expectations (*contrariness* in Zimmermann (2008)): A cleft signals a stark contrast between what has been said or insinuated by another person and what the speaker assumes, that is the focus alternatives are restricted by the discourse context and the contrast concerns properties of the discourse.

This, or a similar discourse property of clefts might also be responsible for the observation in Yan and Calhoun (2019)^{RT} that syntactic focus marking in Mandarin through clefting does not activate alternatives (whereas prosodic marking does). The

authors suspect that clefts in Mandarin might require different context conditions from ‘plain’ focus, which in their experiments were not given. They also speculate that prosodic prominence and not focus might trigger alternatives, which would be compatible with Braun and Biezma’s (2019)^{RT} assumption that contrastive topics and focus are similar in terms of alternative activation. However, such a hypothesis leaves open what kind of alternatives the alternatives are from a semantic point of view: they do seem to be restricted to *contrastive* alternatives (*swimmer—diver*). Note, incidentally, that these are co-hyponyms, which are also relevant for negation alternatives (*Negation and Counterfactuals*).

Generics and Plural Definites

The last domain that we will discuss here are particular nominal expressions that occur in the subject position of a sentence: bare plurals as in *Beetles fly*, and definite plurals as in *The beetles are red*. The issue here roughly is to what extent the group of individuals denoted by these expressions must (not) be homogeneous in having the property expressed by the predicate of the sentence. Alternatives come into play in various ways.

The sentence with a bare plural, *Beetles fly*, is a generic sentence: It makes a generalization and is true although not all beetles fly—generalizations allow for exceptions. The term *exception* suggests that the predicate in a generic sentence must apply to the majority of the individuals of interest, contrary to fact: *Birds lay eggs* is felicitous although less than the majority of birds lay eggs—male birds do not. Conversely, there are generic sentences where the predicate does apply to the majority of individuals, and nevertheless they are infelicitous: *Germans are right-handed* (cf. Carlson, 1977). Thus, an approach to generics which relies on statistical information like *a majority of x* and calculates the probability of having a certain property (Cohen, 1999; Cohen, 2004) seems problematic. However, the other prominent approach to generics, which is based on assumptions about *normal* individuals or circumstances (e.g., Asher and Morreau, 1995) quite clearly also faces problems.

In probabilistic approaches, alternatives have been used to keep the intuition about the majority rule: the set of individuals may be restricted by a set of alternatives to the predicate (Cohen, 1999). For instance, for *Birds lay eggs*, the set of birds intersects with a set of predicates which only apply to female animals, e.g., *{lay eggs, give life birth}*. Consequently, the relevant set for the majority rule is female birds. Including predicate alternatives this way yields the so-called *absolute reading* of generics sentences (Cohen, 1999): the sentence asserts something about birds *without* comparing birds to other individuals. Generics may also have a *relative reading*. For instance, *Dutchmen are good sailors* is felicitous because Dutchmen are compared to other nationalities, and not because the absolute majority of Dutchmen (even if restricted by a predicate alternative set) are good sailors. Cohen suggests that on the relative reading, a generic sentence must have an accent on the subject: to indicate the relevant focus alternatives. In the absolute reading, the predicate is in focus.

Kochari et al. (2020)^{RT} explore subject and predicate alternatives and the associated readings in detail for English and propose that the relative reading is the basic meaning (cp.

Tessler and Goodman, 2019): On the one hand, the relative reading reduces to the absolute reading if no alternatives for the subject are available. On the other hand, the relative reading finds grounding in learning mechanisms, which is critical for generics because making generalizations requires learning about the world. Kochari et al. also argue for a third type of alternative: causal background factors. These factors are additional properties that are causally relevant for the individuals having the property at issue in the generic sentence.

For sentences with plural definites, homogeneity becomes relevant as follows. *The beetles are red* seems to be truth-conditionally equivalent to *All the beetles are red* and express universal quantification. However, in a situation where some beetles are red and others are blue—i.e. a “non-homogeneous” situation –, the sentence with the definite is judged to be neither true nor false whereas the sentence with the universal quantifier is simply false. For the negated versions of the two sentences, there is the same discrepancy. This characteristic of plural definites—to be neither true nor false if the group of individuals is non-homogeneous in the property of interest—is known as *homogeneity* or *gappiness* effect, because there seems to be a truth value gap (Fodor, 1970; Löbner, 1987; Schwarzschild, 1994; Löbner, 2000; Magri, 2014; Križ, 2015). One explanation for the effect is that plural definites come with a maximality presupposition (e.g., Schwarzschild, 1994; Löbner, 2000). However, this clashes with the observation that in certain contexts, non-maximal readings are available. For instance, after a party a sentence like *The guests were happy* can be true even if not every single one of the guests was happy (Dowty, 1987; Malamud, 2012). Another explanation is that plural definites are semantically underdetermined, and may receive an existential or a universal reading, depending on the context (downward-entailing/upward-entailing, Krifka, 1996; /non-monotonic, Malamud, 2012). The existential and the universal reading are scalar alternatives, which can be the basis for scalar strengthening (Krifka, 1996; Magri, 2014; Križ 2015; Bar-Lev, 2018; Križ and Spector, 2020). In the sections *Alternatives in the Lab* and *Alternatives for All? Individual Differences* we come back to homogeneity effects of plural definites when we discuss the contribution by Tieu et al. (2019)^{RT} in relation to the experimental operationalization of alternatives and individual variation.

This concludes our review of linguistic domains that have been discussed in relation to alternatives. We see that often it is not clear yet what kind of alternatives should be assumed to explain a certain meaning aspect, but also that it is highly plausible that there are different types of alternatives because they can be ‘combined’—as is the case for focus and scalar alternatives. We also see that the range of factors determining the selection of (relevant) alternatives are manifold. Overall, some alternatives are more context-dependent than others but context and discourse coherence—maybe unsurprisingly—always play a role.

THE ACTIVATION PROCESS

This section is concerned with the *process* of activating alternatives. It addresses two questions: 1) whether the activation of alternatives

is mandatory for the language processing of the phenomena discussed above or whether alternatives are activated strategically by the language users, and 2) what the time course of this activation process is.

The Nature of the Activation Process (Mandatory or Strategic)

The question whether the activation of alternatives is mandatory (automatic) or whether it underlies the strategic control of language users, has been explored for all the domains where alternatives are relevant that we discussed in the section *Alternatives in Different Linguistic Domains*. Starting with negation, we already mentioned that two-step theories posit the mandatory activation/simulation of the affirmative alternative before the negative alternative. In one-step theories, in contrast, the negative situation is available immediately. However, since most one-step theories assume inhibition of the affirmative situation, both alternatives are activated simultaneously and hence, again, activation is assumed to be mandatory. In the Research Topic *The Role of Alternatives in Language*, the contribution by Beltrán et al. (2019)^{RT} provides evidence for the inhibition and thus mandatory activation of the affirmative alternative. The authors combined the comprehension of positive or negative action or non-action sentences with a go/no-go paradigm while measuring event-related potentials. They observed evidence for inhibition-related effects for negative sentences. Importantly, these effects were independent of the action/non-action sentence type, suggesting that negation triggers inhibition, which indicates mandatory activation of the positive alternative. However, evidence has been accumulating that the negative alternative can be accessed directly and without inhibitory effects if it is the most plausible one in the context (e.g., Nieuwland and Kuperberg, 2008; Dale and Duran, 2011; Autry and Levine, 2012). Hence, it has become a fruitful research endeavor to learn more about the circumstances under which both alternatives are activated. We discussed some of these circumstances in the section *Negation and Counterfactuals*.

Evidence from individual variation (see section *Alternatives for All? Individual Differences*) is also informative about the mandatory vs. strategic nature of the activation process for negation alternatives: In an eyetracking study on counterfactuals using pictorial displays reported in Orenes et al. (2019)^{RT}, participants listened to sentences like *If there had been oranges, there would have been pears*, having to infer that, in fact, there are no oranges and no pears. Initially, that is within about half a second, a significant group of participants increased their looks to both the real-world alternative and to the counterfactual alternative, suggesting parallel activation. Another group looked only at the real-world alternative. This finding may be taken to suggest that the activation of the alternative is not mandatory for the negation alternatives in counterfactuals. Kulakova and Nieuwland (2016a) review the literature on the processing of counterfactuals and conclude that while a dual linguistic representation of both $p \ \& \ q$ and $\neg p \ \& \ \neg q$ seems to be almost part of the definition of counterfactuals, convincing

evidence for the synchronous availability of both representations is hard to come by. This conclusion indirectly supports our assumption that the findings by Orenes et al. (2019)^{RT} speak against a mandatory process. However, as we will see in the section *Alternatives for All? Individual Differences*, there is another explanation available for these observations. Furthermore, other studies, for example a priming study by Santamaria et al. (2005), do support the assumption that both representations (i.e., $p \ \& \ q$ and $\neg p \ \& \ \neg q$) are (generally) available simultaneously (also see Thompson and Byrne, 2002; Byrne, 2005 for discussion).

Turning to scalar implicatures, recall from the *Introduction* that implicatures are not an obligatory part of the ‘final’ meaning of a sentence. Furthermore, we briefly mentioned in the section *(Scalar) Implicatures and Exhaustivity* that different types of scalar implicatures seem to come with different processing costs. Singh (2019)^{RT} observes that for scales of quantificational determiners and of logical operators, the strengthened meaning seems to incur higher processing costs than the non-strengthened meaning; for scales of numerals and so-called free-choice implicatures, it is the other way round (e.g., Noveck and Posada, 2003; Bott and Noveck, 2004; Breheny et al., 2006; Chemla, 2009; Huang and Snedeker, 2009; Marty et al., 2013; Chemla and Bott, 2014; cp. Chemla and Singh, 2014; Crnić et al., 2015; Chemla et al., 2016; van Tiel and Schaecken, 2017; for discussion). These observations might be taken to suggest that for some implicatures the computation of the strengthened meaning of a sentence is an additional, non-mandatory process, but for other implicatures it is not. Singh (2019)^{RT} suggests that rather than explaining the difference on the basis of the particular implicature computation, the two resulting meanings should be compared: 1) in relation to their semantic complexity (\sim presence of EXH), and 2) their usefulness in resolving uncertainties in a discourse (\sim to what extent they answer the QuD; formulated in terms of *entropy*; Shannon, 1948; van Rooij, 2004). Singh suggests that semantic complexity may increase cost for a meaning but if a more complex meaning helps reducing uncertainty about what the truth is better than a potentially less complex meaning does, it eventually is less costly. If we thus assume that alternative scalar meanings are weighed up against each other, the implicature must be computed in any case, that is mandatorily. Note by the way that removing uncertainty may be seen as a discourse factor: answering a question more fully makes for a successful discourse. Thus, Singh’s proposal supports our earlier observations about the paramount role of the discourse in the realm of alternatives.

Apart from discourse, there are several other factors that might play a role for the (non-)automatic computation of scalar implicatures, amongst them factors pertaining to the mental or memory capacities of the language users. For example, De Neys and Schaecken (2007) show that participants compute fewer scalar implicatures when they are under a higher processing load (e.g., Bott and Noveck, 2004; Marty et al., 2013), which might be a result of the strengthened meaning not actually being activated. Feng and Cho (2019)^{RT} demonstrate that non-native speakers in contrast to native speakers do not compute indirect scalar implicatures (e.g., *not always* \rightarrow *sometimes*), which

might be due to working memory limitations or insufficient linguistic competence in L2. An explanation in terms of linguistic competence would be compatible with findings for children, for whom it has been shown that they do not compute implicatures if they do not know the linguistic expressions denoting the relevant alternatives, which is often the case for quantifiers (e.g., Barner et al., 2011; Horowitz et al., 2018), or if they do not perceive an alternative as relevant (Skordos and Papafragou, 2016). However, Tieu et al. (2019)^{RT} observed that neither all children nor all adults compute direct scalar implicatures, so the competence explanation might not be sufficient.

Rees and Bott (2018) show that more implicatures are computed if the alternatives are primed. This is compatible with the assumption that scalar alternatives are not activated obligatorily, but if they are activated—i.e. made salient—the probability of computing an implicature increases. Another way to increase the salience of alternatives is to use prosodic prominence. As mentioned in the *Introduction*, Franke et al. (2017) and other work show that the rate of scalar implicatures increases if the scalar term is prominent. Relatedly, Gotzner (2019) shows that the rate of inference computations (exhaustivity implicatures and additive presuppositions) increases in the presence of a contrastive focus accent. She argues that the accent increases the salience of alternatives and therefore the likelihood of an inference being derived.

Overall, the evidence suggests that alternative activation might not be mandatory although the final answer to this question might depend on the particular type of alternative, i.e. the linguistic domain or subdomain. Overall, factors like prosodic prominence indicating focus/salience, or priming, which also is associated with salience, seem to increase the likelihood that alternatives are activated. Finally, the cost of alternative activation is strongly influenced by contextual factors. In the next subsection, we will focus on those cases where alternatives are activated and look more closely at the time course of this activation.

The Time Course of the Activation of Alternatives During Processing

Assuming that alternatives are activated as part of the language comprehension process, two main questions arise: When do these alternatives become activated and when do they start to influence the unfolding representation of the utterance? Theories addressing these questions give rather different answers depending on the linguistic (sub)domain. For negation and counterfactuals, some accounts assume that the alternative reading may be activated (simulated) before the reading corresponding to the facts. For focus, it is assumed that a focused expression—which itself becomes part of the discourse representation immediately—triggers the activation of, and/or the search for alternatives in the context. Still, findings on the time course are often contradictory, as we will see below.

Regarding negation alternatives, the time course is a matter relevant to two-step models. Kaup and Zwaan (2003) and Kaup et al. (2006), who argued for two-step simulation of the respective

situations, such that the simulation of the affirmative situation (p) precedes the simulation of the negative situation ($\neg p$), argue on the basis of their experimental evidence that the tipping point from representing p to representing $\neg p$ must occur about 750 ms after having heard or read a negated statement. Hasson and Glucksberg (2006), who investigated the potential of negated metaphors to prime a word related to the p vs. $\neg p$, put the tipping point at a time between 500 and 1,000 ms, thus supporting Kaup et al.'s assumptions. Hasson and Glucksberg observed that initially, recognition of words related to p is facilitated, and starting from 500 to 1,000 ms, recognition of words related to $\neg p$ is facilitated. Tian et al. (2016), who—recall from the section *Alternatives in Different Linguistic Domains*—present data showing that given an appropriate QuD both representations are activated in parallel, find that the positive situation is available for about 900 ms, in accordance with the time estimates given by Kaup et al. or Hasson and Glucksberg.

The time course of the activation of negation alternatives in counterfactuals was investigated inter alia by Ferguson et al. (2008). They presented participants with the negative antecedent of a counterfactual such as *If cats were not carnivores*, followed by a consequent clause consistent with either the real-world or the counterfactual reality, for instance *families could feed their cat a bowl of carrots . . . Carrots* is the critical word which is consistent with the counterfactual reality (cats are not carnivores). Evidence from eye movements and event-related brain potentials, which were recorded while participants were reading the consequent clause, suggests that the real-world representation was active at the critical word and up to two words further downstream the sentence. Only then did the representation shift. Thus, the counterfactual alternative only becomes available after the real-world alternative has been rejected. Similar findings are reported by de Vega and Urrutia (2012) in a study using event-related brain potentials. These authors claim that the real-world representation is available for about 500 ms, but has faded away after 1,500 ms. See Byrne (2016), Kulakova and Nieuwland (2016a) and Ferguson (2019) for recent reviews of processing aspects of counterfactuals.

Regarding the activation of scalar alternatives, an important insight comes from a trio of studies by different authors, but building on one another: Huang and Snedeker (2009), see also Huang and Snedeker (2011), carried out an eye-tracking study in which participants heard sentences like *Click on the girl who has some of the [ITEMS]* while looking at a visual world display. In the display, there were a girl with some but not all items from the depicted totality next to her, a boy who had the rest of these items, and a girl who had the totality of a set of different items next to her. The critical items next to the girls had an overlapping phonological onset. Thus, eye movements up to and during the first syllable were informative about whether participants entertained the strengthened meaning *some-but-not-all* or the literal meaning *some-and-possibly-all*. The results suggest that the strengthened meaning was available about 800–1,000 ms later than the literal interpretation. In a similar study, Grodner et al. (2010) provided more supporting context for the strengthened meaning, which was then available immediately. Degen and Tanenhaus (2016) carried out two studies using pictures of a

gum ball machine (with targets like *You have some of the orange gum balls*). In one of their experiments, they followed the conditions set by Huang and Snedeker (2009) and in the other, those set by Grodner et al. (2010). They replicated both patterns but argue that the sum of the evidence supports immediate availability of the scalar implicature and hence, the co-activation of both alternatives.

Turning to focus, Gotzner and Spalek (2019) in a recent review compare the time course of processing for utterances with a prosodically marked focus vs. utterances where in addition a focus particle associates with the focus. The authors report findings supporting the assumption that mere prosodic focus marking causes an immediate activation of all sorts of related concepts, not just focus alternatives (*contrastive* alternatives in the section *Focus and Contrastive Topics*). However, there also is evidence suggesting immediate activation of focus alternatives only (Braun and Tagliapietra, 2010; Braun and Biezma, 2019^{RT}; Yan and Calhoun, 2019^{RT}). As time passes, only focus alternatives remain activated. Evidence comes inter alia from Husband and Ferreira (2016), who find delays of 750 ms between the presentation of a constituent prosodically marked for focus and a potential alternative, and from Gotzner et al. (2013), who report a similar effect after a delay of 2,000 ms, but only if the delay has been filled with linguistic material, that is a sentence continuing the narrative, not for silent delays. After a matter of minutes and lasting at least up to a day, alternatives of a prosodically marked focus are recalled better from memory than alternatives which were not prosodically marked (Fraundorf et al., 2010; Fraundorf et al., 2013; Tjuka et al., 2020; Koch and Spalek, 2021).

Utterances containing focus particles do not show early effects, but the particles counteract the online effects observed for focus marked by prosody only, like the facilitated visual recognition of words denoting these alternatives. Gotzner et al. (2016) presented words denoting an alternative about 2 s after a focused element and participants had to decide whether this word had occurred in the sentence (the correct answer was *no*). This decision was made more slowly in sentences with a focus particle than in sentences without a particle. Gotzner and Spalek (2019) assume that the presence of a focus particle triggers an active search for relevant alternatives and that this search causes activated elements to compete, which leads to interference during processing. Eventually though, as in the case for prosodic prominence, focus particles improve memory for alternatives (Spalek et al., 2014).

Summarizing the discussion in the section *The Activation Process*, we found that for some phenomena involving alternatives, the alternatives seem to be available very early, even immediately, whereas for other phenomena, the activation of alternatives is delayed, and there are even findings (for negation and counterfactuals) suggesting that the expressed meaning is available later than the alternative, which needs to be suppressed in processing. Our short review has shown that there is no clear divide by linguistic domain (negation, scalars, focus, etc.). The most striking observation is that for all investigated phenomena, there is at least one study suggesting the immediate availability of an alternative or, in the case of

negation and counterfactuals, the immediate availability of the negative situation/the counterfactual world. As Degen and Tanenhaus (2016) demonstrate, the exact experimental details play an important role. Even more important seems to be the role of context. In psycholinguistic experiments, stimuli are often presented shorn of any context to allow for better comparisons between conditions. However, this may render the stimuli highly unnatural. As we saw time and again in the section *Alternatives in Different Linguistic Domains*, context is crucial in the interpretation and relevance of alternatives. If our aim is to understand real-time processing of alternatives, we will have to resort to studies embedding stimuli in naturalistic contexts to closely mimic the way these alternatives are encountered in everyday language use.

Alternatives in the Lab

For experimental studies, it is always challenging to operationalize the main concepts. Oftentimes, a researcher has to make choices that are justified more by experimental design and considerations of doability than by the theory. In this section, we discuss how alternatives can be, and have been operationalized in experiments and what influence this may have on experimental results, focusing on the contributions to this Research Topic.

A first operationalization choice concerns whether alternatives are contextually given or not, and if they are given, whether this is through the linguistic or the situational context, for example by visual co-presence. Doyle et al. (2019)^{RT} established alternative sets by placing pairs of (toy) objects on a table and naming them. In a subsequent shopping task involving negative and positive instructions, one object was the target and the other its alternative. Thus, the alternatives were operationalized by co-presence in the situation context. To illustrate, the objects on the table could be an orange and a coconut, and the instruction could be: *The next item is not the orange*, which creates the propositional alternative set *{The next item is not the orange; The next item is the orange}*. Given the context, an inferential step is necessary from *not-the orange* to *the-coconut*.

Both the visual and the linguistic context were manipulated by Kronmüller and Noveck (2019)^{RT} in their study of alternatives in relation to conventionalization (section *Negation and Counterfactuals*). The alternatives were determined through co-presence in the current pictorial display and through displays presented previously.

Discourse context as a provider of alternatives is central in Grubic and Wierzbica (2019)^{RT}, who explored the requirements for alternatives for the interpretation of the German focus particle *auch* ('too'). The authors found that alternatives are most likely propositions but that these propositions need not necessarily be salient in the discourse context since comprehenders go to great lengths to identify—and accommodate—relevant propositions. Destruel et al. (2019)^{RT} in their study on clefts also provide alternatives in the linguistic context. Overall, this operationalization choice is closest to Rooth's (1992) assumption that focus interpretation introduces an anaphoric variable, which requires an antecedent in the preceding discourse.

Often, visual displays are not used for actually introducing alternatives but for testing what the mental representation of a

listener might look like, for instance in Orenes et al. (2019)^{RT} and Braun and Biezma (2019)^{RT}. The authors presented what they thought the participants' mental representation of alternatives might be in pictorial form or as words on the screen. For the counterfactuals tested by Orenes et al. (*If there had been oranges, there would have been pears*), the actual world is one without oranges and without pears ($\neg p \& \neg q$). This is the representation the participants were expected to form. In the corresponding target picture, oranges and pears were crossed out. The target alternative picture corresponding to the counterfactual world was one with oranges and pears ($p \& q$). As the authors highlight, a distractor picture, which contained apples and strawberries, would also have been consistent with $\neg p \& \neg q$, i.e. *no oranges, no pears*. However, their data suggest that participants preferred an explicit cancellation, as depicted in crossed out oranges and pears. Thus, the mental representation of the alternative set is essentially one of negation alternatives.

In Braun and Biezma's study on contrastively marked topics, the display consisted of different words, one of which was an alternative to the sentence subject. This alternative had been determined empirically in a *not X, but Y* task where participants continued sentence fragments like *Not the gymnast had gotten blisters but the . . .*. Thus, the authors tried to predict a likely relevant alternative and presented this in the visual environment. If participants look at the alternative more often than at controls, the authors conclude that the alternative has been activated. One caveat in these types of design is that one cannot know whether participants would have activated the particular alternative had it not been presented in the context: the activation could have been triggered retro-actively by the visual presentation. A similar problem arises with lexical decision tasks that are employed to gauge alternative activation through a contrastive accent (here: Yan and Calhoun, 2019^{RT}). A useful way to think about focus alternative activation is to assume that focus creates a placeholder for alternatives.² This placeholder can be filled either anaphorically from elements in the preceding context, or it can be linked with a likely candidate that is presented after the fact.

Visual presentation of alternatives as a means to find out about participants' mental representation is also employed by Kochari et al. (2020)^{RT}, who investigated the processing of generic sentences with bare plural subjects. As mentioned in the section *Generics and Plural Definites*, they argue that for the interpretation of generics, three different types of alternatives are important, two of which they test in their experiments: alternatives relevant for the absolute reading of generics (predicate alternatives), and alternatives relevant for the relative reading (subject alternatives). In the experiments, two pictures were presented: one for the target sentence (Beetle type A mostly with dots), and one depicting an alternative subject without the property at issue (Beetle type B without dots). The authors found that the alternative picture indeed was taken into

account to judge the truth of the generic, albeit by only part of the participants.

Sometimes, alternative sets are not provided in the experimental setup but are assumed to be created through inferential processes on the basis of characteristics of the expressions for which alternatives are relevant. For instance, if a scalar term like *some* is presented, participants are supposed to infer the strengthened meaning on the basis of a linguistically determined scale. Hence, the alternative set and its members need not be experimentally manipulated. Instead, what is usually manipulated are the combinations of utterances and pictures that are used to assess whether participants have interpreted an implicature or not. An interesting facet (e.g., Feng and Cho, 2019^{RT}) are negated scalar expressions due to the combination of scalar and negation alternatives. The alternative set in this case seems to consist of the non-negated (affirmative) semantic meaning, as well as the negative semantic meaning and its strengthened meaning, in line with two-step theories of negation processing.

Experimental displays without 'explicit' alternatives have also been used for the investigation of homogeneity. Tieu et al. (2019)^{RT} presented pictures of a set of the same objects (e.g., hearts) either in a single color or in different colors. Participants judged the felicity of sentences with plural definites like *The hearts are yellow* for a picture of red and yellow hearts. The experiment was carried out in French with French-speaking children. Crucially, the authors employed a set of critical comparisons to determine how the plural definites are interpreted. These included sentences with the scalar expressions *none*, *some*, and *all*. Thus, scalar alternatives do not become relevant through direct, explicit juxtaposition. Still, they are obviously contextually present in this setup. Similarly, Beltrán et al. (2019)^{RT} and Haase et al. (2019)^{RT} in their investigations of neural processing mechanisms during negation processing do not use explicit alternatives. However, Haase et al. used stimuli which had alternatives across experimental trials as they contained co-hyponyms to the hyperonym *professions*. So this study, too, involved a discourse context providing alternatives.

The studies by Haase et al. (2019)^{RT} and Yan and Calhoun (2019)^{RT} illustrate another design choice. As we saw, researchers often provide possible co-hyponyms in order to probe whether alternatives are active. There is nothing in the definition of alternatives that requires this relationship and, in fact, for focus alternatives, a number of studies have tested explicitly whether alternatives have to be co-hyponyms (Gotzner, 2015; Kim et al., 2015; Jördens et al., 2020): The answer is *no*. Still, it is interesting to ask why co-hyponymy is often used as a convenient shortcut in the operationalization of alternatives. First, Rooth's focus semantic value is often 'translated' for empirical purposes as the set of propositions obtained by replacing the focused element with an alternative of the same semantic type such that the proposition is still sensible. Co-hyponyms are well suited for this: If I can carry out an action (cut, squeeze, bake) with an individual, I can usually carry out that action with individuals which are denoted by co-hyponyms. Co-hyponyms are used particularly often for testing contrastive focus. Repp (2010)

²This idea goes back to Steven Crain.

discusses the notion of contrast and cites Kiss's (1998) requirement that contrastive focus needs a complementary alternative set with clearly identifiable elements. This means that the alternative set has to be closed and that alternatives need to be mentioned in the context. Co-hyponymy might contribute to identifiability: If a given hyperonym has only very few hyponyms, the alternative set is easily identifiable. The closed-set argument might apply to all co-hyponym relationships, but it may be easier for some than for others.

Alternatives for All? Individual Differences

An important aim in any field of research is to formulate generalizable conclusions that hold for a well-defined population. However, it has become clear that "all language users" or even "all adult native language users" defines the population too broadly. While it is relatively uncontroversial that native language speakers differ from language learners and children differ from adults, the insight has gradually emerged that even within the group of native, adult language users, subgroups can be found who process a given linguistic phenomenon differently (Kidd et al., 2018). Thus, the challenge becomes to describe and understand the dimensions along which the population is grouped. For instance, in the field of scalar implicatures, so-called logical comprehenders and pragmatic responders emerge. While logical responders do not draw the implicature, interpreting, for example, an utterance containing the scalar term *some* as *some-and-possibly-all*, pragmatic responders do, interpreting the term as meaning *some-and-not-all* (Noveck and Posada, 2003; Bott and Noveck, 2004 (Exp. 3); Bott et al., 2012; Tomlinson and Bott, 2013; Spychalska et al., 2016). In this final section, we investigate if groups can be identified also for the processing of other alternative-related phenomena.

Five of the contributions in this Research Topic address individual differences, either in passing or as a research question in its own right. They fall into two categories with regard to how they look at individual difference. Either groups were defined beforehand (children vs. adults: Doyle et al.; L1 vs. L2 speakers: Feng and Cho) or emerging groups were described (Orenes et al., Kochari et al.). Tieu et al. are a special case in that they hypothesized the existence of three groups, but did not know how exactly these might be represented in the population they tested.

Starting with the first category, recall that Doyle et al. (2019)^{RT} investigated negation processing with a shopping task. Adults and children selected one item from a set of two and put it in a shopping cart. Both their response latencies and their eye movements were measured. The authors observed that both adults and children looked more often at the non-target when hearing a negative than a positive sentence (e.g., for *The next item is not an apple* they looked more often at the apple than they looked at the non-apple for *The next item is an apple*). However, children were slower in their responses. The authors conclude that children's processing of negation is not yet as effective as that of adults (cf. Nordmeyer and Frank, 2014). Feng and Cho (2019)^{RT} compared direct and indirect scalar implicatures (*sometimes* → not always; *not always* → sometimes) for native

speakers of English and L2 English learners with a covered box paradigm. Participants were presented with a visible picture and an invisible one (the covered box) and chose either, depending on the meaning they assign to a sentence they hear. The groups behaved remarkably similar. The only significant difference was obtained when a no-inference picture was chosen for the indirect scalar implicature. In this case, non-native speakers were more likely to select the visible picture (i.e., to suspend the inference) than native speakers. Both these acquisition studies support the assumption that there exists a developmental path to a certain manner of processing. Children and L2 learners differed from adults/native speakers in the most effortful condition only, suggesting that they had not yet reached mastery with the computation of these meanings.

As mentioned, Tieu et al. (2019)^{RT} predefine three groups in their study on plural definites but what they find is on the one hand different groups, and on the other hand unexpected individual differences. Recall that adults display a truth-value gap for the use of plural definites in non-homogeneous situations (*The beetles are red* is neither true nor false if only some beetles are red; section *Generics and Plural Definites*; Križ and Chemla, 2015). Tieu et al. reason that young children might fall into the following groups: The "homogeneity group," whose performance equals that of adults, the "existential group," who accepts the affirmative description but rejects the negative one (→ there are some beetles that are red), and the "universal group," who accepts the negative description but rejects the affirmative one (→ it is not the case that all the beetles are red). Tieu et al. observe that adults are not as uniform a group as was previously assumed: a small number of adults interpreted the utterances universally. Children fell either into the "homogeneity" or the "existential group." With even more fine-grained group assignments, the authors identified three groups of children: those who interpreted the plural existentially and did not compute scalar implicatures, those who made the homogeneity assumption and computed scalar implicatures (= adult-like), and those who have adult-like homogeneity readings while not computing scalar implicatures. An interesting question is whether these groups in the child population will all develop into the adult "homogeneity group" or whether a certain group is more likely to end up interpreting these utterances universally, just as a small subgroup of adults did.

In the study by Orenes et al. (2019)^{RT} on counterfactuals, the focus on individual differences also was *post-hoc* and it was driven by the observation that confidence intervals by participants were much larger than those by items. As mentioned in the section *The Time Course of the Activation of Alternatives During Processing*, participants' looks to the picture representing the factual world ($\neg p \& \neg q$) and to the picture representing the counterfactual world ($p \& q$) started to rise quickly upon presentation of a counterfactual. After indicative conditionals, in contrast, only looks to the $p \& q$ picture were observed. A post-hoc analysis revealed that one group of participants showed exactly the same looking behavior for indicative conditionals and counterfactuals: they looked more at the $p \& q$ picture. The other group looked at both pictures (or only at $\neg p \& \neg q$). Orenes et al. argue that the participants who only looked at the $p \& q$ picture for both types of

conditionals did not retrieve the correct meaning for the counterfactual target sentence. Kulakova and Nieuwland (2016b) have traced some of the individual differences in processing counterfactuals back to differences in the participants' abilities to understand the communicative intentions of others.

Finally, Kochari et al. (2020)^{RT} observed considerable variation between individual participants in their study on generics. As briefly mentioned above, they found that the alternative picture required for the relative meaning of the generic (= subject alternatives) was only considered by one group of participants. The other group interpreted the generic with an absolute meaning, independently of the presence of a picture which would license the relative reading.

In sum, there are several independent challenges when investigating individual variation. First, individuals who do not understand a target structure as intended need to be eliminated from the sample and, ideally, an explanation needs to be found for why they do not process the structure as intended. Second, researchers need to determine whether the remaining individuals all reach their interpretation in the same way or whether there are different pathways to (correct) understanding. And there are many more potential challenges surrounding individual differences in language processing, whose scope we are only beginning to understand.

CONCLUSION

This review has discussed the notion of alternatives in meaning interpretation in several linguistic domains. We have argued that there is good reason to believe that there are indeed different "types" of alternatives, which are subject to different conditions,

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and which may interact. Although discourse context is crucial for all types of alternatives, it is probably only semantically required for focus alternatives, as focus alternatives are licensed via anaphoric context conditions. However, we saw that the accommodation of focus alternatives is possible and that in the absence of context, lexical-semantic relations like co-hyponymy are exploited. Furthermore, the desire to create coherent discourses also guides the search and selection of alternatives. We have also argued that the precise mechanisms of the on-line activation of alternatives is highly controversial and that the evidence often is inconclusive. Factors influencing this state of affairs are on the one hand the operationalization of the notion of alternatives in experimental settings, and on the other hand individual variation, which poses challenges both for descriptive generalizations and for theoretical modeling. We hope to have made a contribution to the field of alternatives research that inspires future work which intersects aspects of grammar and processing to an even greater extent than the last decade has already seen.

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