Proceedings of SALT 34: 197–212, 2024

New data on the 'triggering problem' for presuppositions*

Nadine Bade
University of Potsdam

Abstract The paper addresses the question which entailments of complex expressions are more likely to become presupposed meaning (the 'triggering problem') by discussing new experimental evidence. Exploiting a word learning paradigm based on visual animations (Bade, Schlenker & Chemla 2024), the experiment discussed tests the predictions of different theories for change of state verbs. The findings suggest that initial states are more likely to be presupposed, whereas result states are spontaneously construed as asserted meaning. Results also show that the change of state itself can be more or less at-issue, depending on whether the result or initial state is salient.

Keywords: presuppositions, triggering, experimental

1 Introduction

The theoretical starting point of this paper is the 'triggering problem' for presuppositions, which is concerned with the questions which entailments of complex expressions become presupposed rather than asserted meaning, and why. Different theories have discussed a variety of factors for the division of labor between presupposition and assertion for different lexical presupposition triggers. The focus of the current paper is on the prediction for change of state verb like 'stop'. The paper uses a new experimental paradigm combining world learning with visual animations to test different predictions of theories for what factors are involved in presupposition triggering for this case. The results from two experiments suggest that initial states are more likely to be presupposed meaning, whereas result states are spontaneously analyzed as part of the asserted meaning. The change of state itself is mostly treated as asserted/'at-issue' content when the initial state is made salient, but displays the behavior of a presupposition when the result state is made salient during the learning phase. Section 2 provides the theoretical and experimental background of the paper. In Section 3 an experiment is discussed that tests the prediction of existing theories. Section 4 discusses the results and their implications. A conclusion and outlook is given in Section 5.

* This research was funded by the German Research Foundation (DFG) through the Priority Program ViCom, project 'Pragmatic reasoning with (non-)visual alternatives'.

2 Background

2.1 Theoretical background

Under a pragmatic view presuppositions are background assumptions speakers take for granted by relying on common knowledge and shared belief (Stalnaker 2002). They are representations of epistemic states of speakers, whereas under a semantic view presuppositions are properties of sentences (Karttunen 1973). The semantic view can be captured by assuming that sentences with 'trigger' words introducing the presupposition denote partial functions. They are only defined for contexts that entail the presupposition of the presupposition trigger. One such 'trigger' word is the aspectual verb 'stop', which introduces at least three meaning components, see (1).

(1) Peter stopped smoking.

a. Peter smoked in the past. PRESUPPOSITION

b. Peter stopped smoking. ASSERTION

c. Peter does not smoke now. ASSERTION

Whereas (1a) has been analyzed as the presupposition of the sentence in (1), (1c) and (1b) have been treated as asserted meaning. This division has been suggested based on the first meaning component being unaffected by embedding under downward-entailing operators such as negation, whereas the other two meaning components do not remain stable under negation, see (2).

(2) Peter did not stop smoking.

a. Peter smoked in the past.

b. Peter did not stop smoking.

c. Peter still smokes.

The question behind the 'triggering problem' is why the empirical situation is as described, since the specific division of labor between presupposition and assertion seems arbitrary.

Different theories take different approaches to the empirical pattern described in (2) and (1). More specifically, they differ with regard to how much they consider the source of presupposition triggering to be semantic or pragmatic in nature. Under a strictly lexical approach, presuppositions are learned as part of the meaning of a given word. More conceptual views do not take this lexical property to be arbitrary or accidental but consider it to be rooted in conceptual biases. Abrusán (2011)'s refers to the concept and notion of *topic times* to explain that past states are more likely construed as presupposed meaning. More specifically,

she considers all entailments that are *not* about the topic time to become presuppositional. This algorithm is restricted to verbal presupposition triggers, as the temporal dependence is less clear for other trigger types. Schlenker (2021) takes a broader approach and bases his triggering algorithm on the likelihood of previous beliefs. More specifically, those entailments that the hearer "typically antecedently believes" when learning that the assertion is true come out as presuppositions under his approach. Since one is more likely to have antecedent beliefs about past states, the pattern in (1) and (2) for aspectual verbs is accounted for.

Abrusán (2011) stresses that her view is one where assertions are those meaning components the sentence is mainly *about*. This insight that there are main and secondary points of sentences is also taken up by a solely pragmatic view on presupposition triggering (Simons, Tonhauser, Beaver & Roberts 2011; Simons, Beaver, Roberts & Tonhauser 2016; Tonhauser, Beaver & Degen 2018). Under this view, presuppositions are a special type of *non-at-issue meaning*, which is defined as content that is not addressing the current Question Under Discussion (QUD) (Roberts 1996). Stability under negation illustrated in (2) is the result of non-at-issue meaning becoming invisible to entailment canceling operators and thereby turning into *projective content*. The behavior can be better illustrated for "stop" with another environment that presuppositions usually project out of, which is the possibility modal "might" (as part of the so called family of sentences test, (Chierchia & McConnell-Ginet 2000)). That is, when Peter ever having been a smoker is part of the at-issue meaning through a contextual question, see context in (3), the meaning component that he used to smoke need not project. That is, the sentence in (3a) does not come with an inference that Peter actually ever smoked. However, if the context makes clear that 'used to smoke' is not at-issue, as in the context given (4), the meaning that Peter used to be a smoker does project in (4a). The main insight of this view is that meaning components can become projective content when made non-at-issue through information structure and contextual questions.

(3) Why is Peter so nervous?

a. Maybe he stopped smoking.

(4) Peter seems nervous, when did he have his last cigarette?

a. Maybe he STOPPED$_F$ smoking.

Under a more hybrid view (Abusch 2002, 2010), the lexical meaning of words plays a role in that they come with certain alternatives; however the triggering process itself is pragmatic in nature. Abusch (2002, 2010) considers a conversational triggering mechanism for "stop" and other so called 'softer' presupposition triggers. She argues that the presupposition of "stop" is that the disjunction of "stop"

and its alternative "continue" is true. Since this disjunction entails the initial state this meaning component will come out as presuppositional, see (5).

(5) Peter did not stop smoking.

a. **Assertion:** Peter stopped smoking. Alternatives = {stop, continue}

b. **Presupposition:** Peter stopped smoking or continued smoking.

c. (5b) ⇒ Peter used to smoke.

In sum, different theories highlight different factors for which entailments display presuppositional (projection) behavior. Under strictly lexical accounts, the presupposition is learned as part of the lexical meaning of the triggering word. Under conceptual views like Schlenker (2021)'s and Abrusán (2011)'s entailments that are based on previous beliefs or are about past times come out as presuppositions. Contextual views (Tonhauser et al. 2018) consider information structure to be the underlying reason for a given meaning component to become projective content. More hybrid views rely on lexical alternatives for a contextual triggering mechanism that results in the presupposition that the disjunction of these alternatives is true (Abusch 2010).

2.2 Experimental background

The method used in the experiment described below builds on a new paradigm described in Bade et al. (2024), which combines a word learning task based visual animations with the covered box paradigm (Huang & Snedeker 2009). The method uses two insights of the literature on presupposition triggering: (i) the observation that non-linguistic input, such as gestures and animations, seemingly trigger presuppositions (see Schlenker (2021) for an overview), and (ii) the success of the covered box paradigm in studying non-literal meaning, especially presuppositions, as it avoids judgments about literal truth, see e.g. Bill (2015); Romoli & Schwarz (2015). The three experiments reported consist of two parts, a learning and a testing phase. In the first phase, participants learned a new word "wug" based on animations that showed upward movement (meaning component A = change of state) of an object (a circle) from a red line (meaning component B = initial state). After the learning phase, participants were tested on their understanding of the word using the covered box method. That is, they were faced with overt animations making one, none, or both of the meaning components true and a covert animation. The two animations were paired with sentences containing "wug". The task was to choose the overt animation if the sentence accurately described it, and to choose the covered animation otherwise. Bade et al. (2024) find that the animation condition that falsifies the meaning component 'from red' shows behavior that is in line with an

analysis as a presupposition, whereas upward movement looks more like asserted meaning. In their Experiment 2 participants were put in different training groups, both were trained with positive ("The circle wugs.") and negative ("The circle does not wug.") sentences. The first group learned that 'not wugging' is downward movement from red, whereas the second group learned that 'not wugging' is upward movement not from red. Their results suggest that training against the bias to treat the initial state (the red line) as a presupposition (training group 1) has a different effect than training that is in line with this bias. In Experiments 1 and 3, the authors use embedding under negation and quantified statements ("None"/"Every") to test for projection behavior. They find that meaning component B 'from the red line' shows projection behavior in these environments that is in line with the analysis as a presupposition, whereas meaning component A 'upward movement' looks more like asserted meaning when embedded. Overall they having converging evidence that (i) participants use limited input from the learning phase to construe one meanings as presuppositional and the other as assertive, rather than entertaining a conjunctive analysis (ii) that the suggested method might be fruitful in further testing the predictions of different theories for what factors are involved in presupposition triggering. Section 3 describes a new set of data which builds on these findings and addresses some issues with the original set-up.

3 Experiment

The Experiment described in this section mostly follows the methodology of Experiment 3 discussed in Bade et al. (2024). The original set of results are based on data highlighting the importance of the result state, whereas the following discussion centers around a comparison of initial versus result states.

3.1 Method

3.1.1 Procedure

The Experiment consisted of a teaching and a testing phase. During the teaching phase participants learned a new word through visual animations. They saw a sentence with a new word "wug" and animations describing its meaning. Their task was to watch the animations as often as they liked to learn the meaning of "wug". In a second phase, participants were asked about their interpretation of "wug". They saw sentences and animations again, but this time an overt animation was paired with a covered one (the covered box). Their task was to choose the overt animation if it showed an instance of 'wugging', and the choose the CB (covered box) if they thought it was not. The furthermore were asked about how certain they were

about their choice on a scale ranging from 0% to 100% certain. A screenshot of the teaching and testing phase are given in Figure 1.

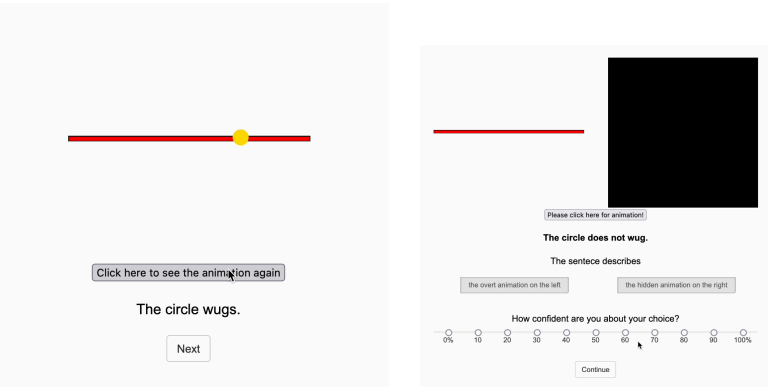


Figure 1 **Left**: Screenshot of the teaching phase showing the beginning of the animation for the 'initial' group. **Right**: Screenshot of the testing phase before the 'Please click here for the animation' button was clicked.

3.1.2 Stimuli

The initial group was taught through animations that 'wugging' is upward movement (meaning component A) *from* a red line (meaning component B). The result group was taught that 'wugging' is upward movement (meaning component A) *to* a red line (meaning component B). They each saw four different instances of wugging paired with the sentence "The circle wugs.". The position of the circle on the red line and travel distance from or to it varied to avoid additional assumptions regarding what 'wugging' entails. Participants could watch each of these four animations as many times as they wished by clicking on the 'Click here to the animation again' button. These animations served as the 'true' controls in the testing phase, see first row in Table 1. One target animation (target A) falsified meaning component B (results/initial state is the red line), see the second row in Table 1. The second target animation falsified upward movement, meaning component A, see the third row in Table 1. There was a 'false' control animation which made both meaning components false, see the final row of Table 1.

3.1.3 Participants

101 people participated in the Experiment via Prolific (51 in the 'initial'/50 in the 'result' group). They received 7,50GBP/h as compensation. They were internally

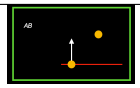
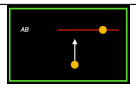
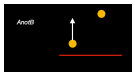
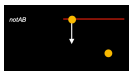
animation type	target/control	initial group	result group
A B	true control		
A not B	target A		
not A B	target B		
not A not B	false control		

Table 1 Illustration of the animation conditions for each group. Framed in green are the animation conditions participants in the different groups were trained on.

prescreened for being native speakers (first language) of English. 9 participants from the 'initial' and 5 participants from the 'result' group were excluded from the analysis because they responded to fewer than 66% of the AB 'true' control animations correctly. Data from 87 participants were analyzed.

3.1.4 Design

Three factors were manipulated in the Experiment. The between-subjects factor TRAINING GROUP had two levels: participants were either taught that 'wugging' is movement *to the red line* ('result' group), or their were taught that 'wugging' is movement *from the red line* ('initial' group). In addition, there were four critical ANIMATION TYPES (AB, AnotB, notAB, notAnotB) for each group, see Table 1. The animations made either one (notAB/AnotB = targets), both (AB = 'true' control), or none (notAnotB = 'false' control) of the meaning components of "wug" true. A further manipulation regarded the POLARITY of the test sentences: they either contained negation ("The circle does not wug."), or not ("The circle wugs."). The factors POLARITY and ANIMATION TYPE were fully crossed to produce 8 critical within-subjects conditions. Participants saw four items per condition in the experiment (32 items in total). Two dependent measures were analyzed: the rate of CB choices, and the level of confidence.

3.2 Predictions

More generally, SENTENCE POLARITY should reverse the response pattern for a target animation compared to a 'true' control animation if that target animation fal-

sifies the assertion but not the presupposition of "wug" . That is, whereas, with positive sentences, CB choices should be low for 'true' controls and high with negative sentence (see pattern (a) in Figure 2), the opposite should be true for an animation falsifying an assertive meaning component, see pattern (d) in Figure 2. The target animation falsifying the assertion should thus pattern with 'false' controls, making both meaning components false, see pattern in (b) in Figure 2. If a target animation falsifies a presupposed meaning component, however, we should observe a pattern where CB choices are high, irrespective of sentence POLARITY, see pattern (c) in Figure 2.[1]

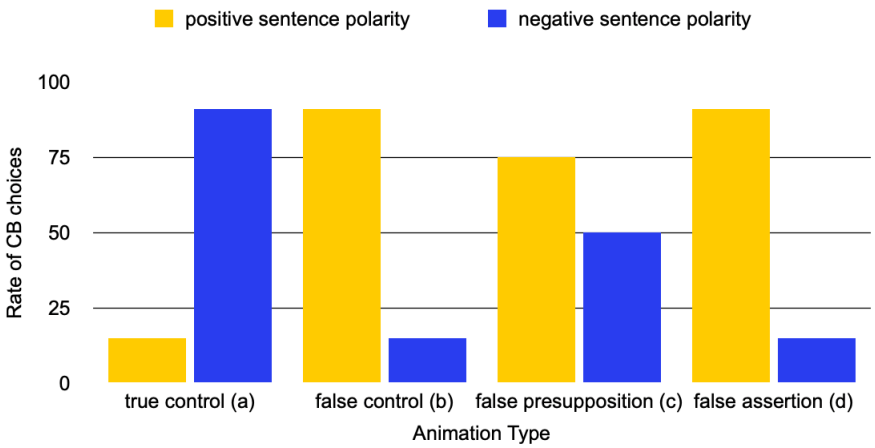


Figure 2 Predicted response patterns for when both meaning components are true = (a), for when both meaning components are false = (b), for when only presupposed meaning is falsified by the animation = (c), for when only asserted meaning is falsified by the animation = (d).

More specifically, according to conceptual views, there should be a conceptual bias for treating initial states as presupposed meaning whereas result states should be construed more often as at-issue, asserted meaning. Under Abrusán (2011)'s account this is because result states are about the *topic time* whereas initial states are not. According to Schlenker (2021)'s more general proposal, one is more likely to have antecedent beliefs about initial than result states learning upon learning about the change of state. As a result, the meaning component 'from the red line'

1 Previous experiments on presuppositions exploiting the CB paradigm suggest that how high the actual rate of CB choices is assumed to be for presupposition failure depends a lot on the stimuli, mode of presentation and the task. As a new word is tested in the current set-up, the CB rate was not expected to be at ceiling. This expectation is also based on previous findings, see Bade et al. (2024) for more details.

should show presuppositional behavior whereas the meaning component 'to the red line' should not.

Without further assumptions, contextual views predict no distinction between result and initial states in terms of which of the two is more likely construed as at-issue/non-at-issue (and, accordingly, projective) meaning. Participants are consistently taught that the red line is relevant for the meaning of "wug" through animations. It is furthermore visually salient. That is, without additional stipulations regarding which components are inherently more likely to be focused or not, both meaning components should be treated as asserted, at-issue meaning and a conjunctive analysis be entertained by participants. A critical point raised from contextual approaches to triggering in view of the original results reported in Bade et al. (2024) was that participants may have translated "wug" as 'moves upward from red'. This phrasing might impose a certain information structure where 'from red' as an adjunct is more likely treated as non-at-issue, projective content. If this is true the same should hold for the group that learns that "wug" is about the result state. That is, if there is a bias to treat 'from/to red' as non-at-issue meaning due to both meaning syntactically and semantically speaking being modifiers both should show presuppositional behavior.

Furthermore, nonce words such as "wug" do not come with lexical alternatives, and there are no additional pointers in the training phase regarding the presuppositional status of one of the two meaning components. As a result, hybrid or lexical views do not predict that one of the two should be construed as a presupposition.

In terms of statistical analysis, all theories predict an interaction between ANIMATION CONDITION and SENTENCE POLARITY within the two groups. However, whereas negation should affect target animation conditions (AnotB, notAB) in the same way according to contextual, lexical and hybrid views, it should affect them differently according to conceptual views. That is, according to the latter view, the animation conditions falsifying 'from red' should not be affected by sentence polarity (high rate of CB choices with and without negation) whereas animation conditions falsifying upward movement and 'onto red' should be affected (negation should lead to low CB choices).

3.3 Analysis and results

Rates of CB choices were analyzed using logistic regression with generalized linear mixed effect models and the *glmer* function of the `lme4` package in R (Bates, Mächler, Bolker & Walker 2015). For the confidence ratings, a cumulative link model analysis for ordinal data was used with the package `ordinal` in R (Christensen 2013). To test for the presence of an interaction, model comparisons via log likelihood ratio tests between the model including the interaction term ANIMATION

CONDITION*SENTENCE POLARITY and the model without it were performed (both models included by-subject random intercepts). Contrasts were looked at through pairwise comparisons between negative and positive sentences for each animation type with the `emmeans` package in R (Bonferroni corrected for multiple comparisons), see Lenth (2023).

Initial group The results for CB choices for the initial group are given in Figure 3. The analysis shows that including the interaction term between ANIMATION TYPE and SENTENCE POLARITY is justified by the data for CB choices ($\chi^2(3) = 283.8, p < .0001$). Pairwise comparisons reveal that there is a difference between positive and negative sentences for the animation condition 'from red – not upward' ($\hat{\beta} = -4.557, p < .0001$), but not for the animation condition 'not from red – upward' ($\hat{\beta} = 1.411, p = 1$). For the former animation, CB choices were significantly lower when the sentence contained negation. The results for confidence ratings are given in Figure 4. Including the interaction term was not justified by the date for confidence ratings ($p = .2308$).

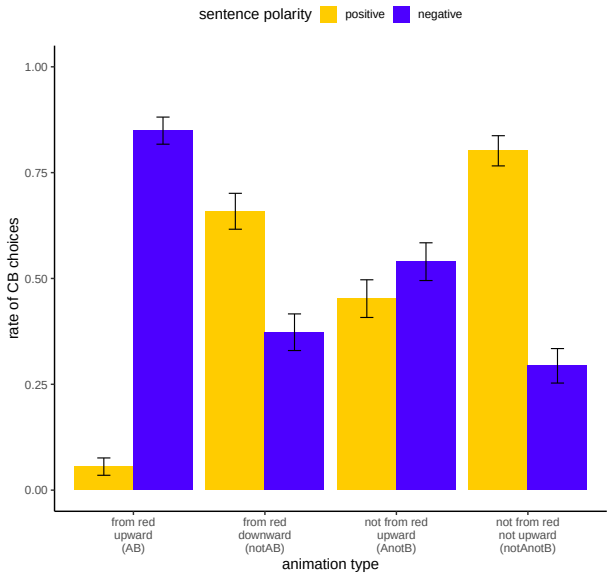


Figure 3 Rate of covered box choices by ANIMATION CONDITION and SENTENCE POLARITY for the group that learned "wug" is upward movement FROM red.

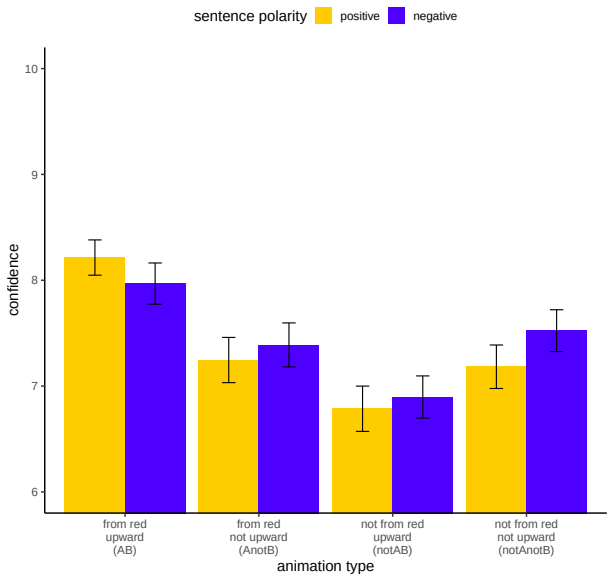


Figure 4 Level of confidence by ANIMATION CONDITION and SENTENCE POLARITY for the group that learned "wug" is upward movement FROM red.

Result group The results for CB choices the result group are given in Figure 5. The analysis shows that including the interaction term between ANIMATION CONDITION and SENTENCE POLARITY is justified ($\chi^2(3) = 392.29, p. < 0001$). There is no significant contrast between negative and positive sentences for the animation falsifying upward movement ($\hat{\beta} = 2.438, p = .2362$), however for the animation making 'onto red' false ($\hat{\beta} = -6.165, p < .0001$). Results for confidence ratings are given in Figure 6. Including the interaction term into the cumulative link model is also justified by the data ($p < .0001$). Pairwise comparisons reveal that participants are significantly more confident in their choices with negative than positive sentences with 'true' controls ($\hat{\beta} = -0.4894, p < .02$). No such difference between sentence polarities is found for the other animation conditions.

3.4 Summary

When the meaning component 'from the red line' in the 'initial' group is falsified by the animation, there is no significant difference between the rate of CB choices with negative and positive sentences. This is characteristic of presuppositions. If the meaning component 'upward' is falsified by the animation in the 'initial' group, the response patterns reverses compared to 'true' control animations. That is, for

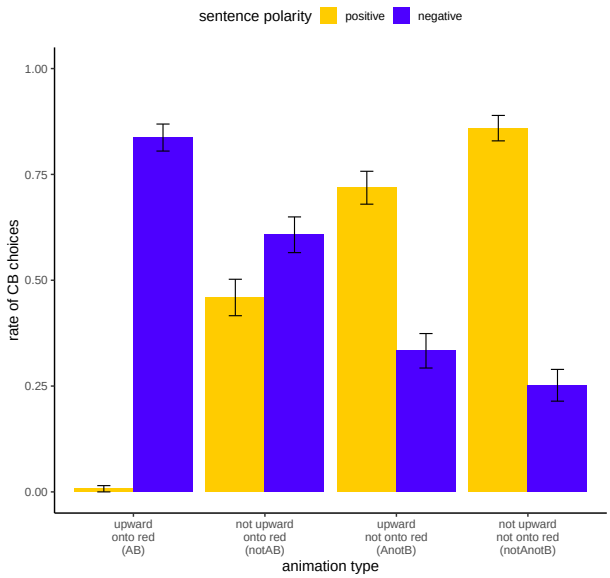


Figure 5 Rate of covered box choices by ANIMATION CONDITION and SENTENCE POLARITY for the group that learned "wug" is upward movement TO red.

the former animation type, CB choices are significantly higher with positive than negative sentences. The same behavior is found for the animation condition that falsifies the meaning 'onto the red line' in the 'result' group. For this group, there is no significant difference between positive and negative sentence polarity for the animation condition that falsifies upward movement. Numerically speaking, the results from confidence ratings suggest that participants in the result group are more confident about the 'upward – not to red' animation than the 'not upward – to red' animation, whereas in the initial group participants are more confident about the 'not upward – from red' animation condition than the 'upward – not from red' animation condition. Since these results are subtle, more data are needed to find robust effects for the level of confidence.

4 Discussion

We find further evidence that participants divide new complex meanings into asserted versus presupposed, projective content based on very limited input. The findings speak to the success of the new methodology suggested for testing theoretical questions regarding presupposition triggering mechanisms.

More specifically, we find that results states are more likely to be construed

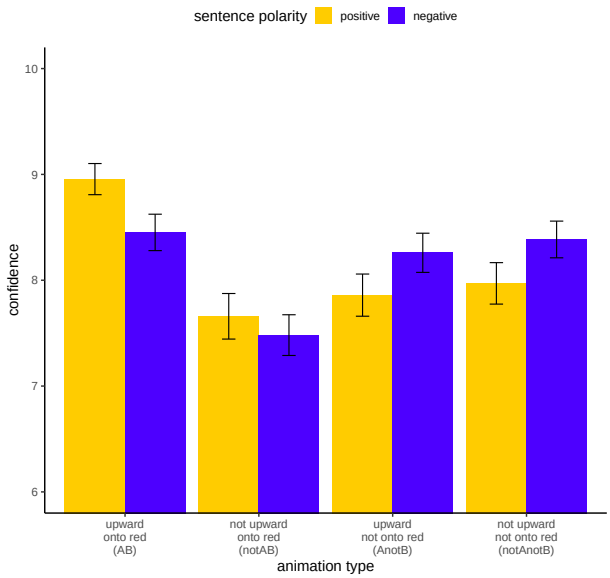


Figure 6 Level of confidence by ANIMATION CONDITION and SENTENCE POLARITY for the group that learned "wug" is upward movement FROM red.

as at-issue/asserted content whereas initial states are more likely to be presupposed/projective meaning. The results found for the initial group are a replication of Experiment 1 reported in Bade et al. (2024). The results further show that the direction of movement looks like asserted meaning when the red line is the *initial* state, but has the signature of presupposed meaning when the red line is the *result* state.

Overall, these findings are more in line with conceptual views, where a triggering algorithm predicts a bias for certain meaning components to come out as presuppositions. More specifically, the results from both groups suggest that temporal precedence plays a role for what entailments are considered presupposed (projective) content. The fact that the change of state itself can become presuppositional is slightly more surprising under Abrusán (2011)'s variant of a conceptual view. As both upward movement and ending on the red line are about the *topic time*, they should come out as asserted meaning according to her account. Under Schlenker's account entailments are more likely to be construed as presupposed meaning when upon learning about the asserted meaning (moving upwards in the 'initial' group/arriving at red for the 'result' group), one typically believed/had knowledge of the truth of that meaning component (starting from red for the 'ini-

tial' group/upward movement for the 'result' group). To test his theory directly, one would need to look at what happens when people have no or little evidence of one event preceding the other during the learning phase.

The results are at first glance harder to reconcile with theories relying on contextual factors or alternatives for predicting which entailments become presupposed or non-at-issue meaning. The teaching phase revealed nothing about potential alternatives, the QUD or the information status of the two meaning components. Even with the assumption that "wug" is translated into "moves upward from/to red" and the additional stipulation that modifiers are inherently more likely to convey background information/be unfocused, the contrast between result and initial states is not explained. A contextual approach could make sense of the data if some QUDs are more likely given the visual scenario (e.g. "Where did the circle move?"). If the answer is "upward" in the 'initial group', 'from red' could be considered non-at-issue information. If the answer is 'to red', the information that it moved 'upward' might be considered non-at-issue content. However, this would require that contextual questions are evoked through the visual context and animation alone, as nothing in the sentence itself suggest this QUD. More independent and explicit criteria, despite focus placement, are needed for what likely QUDs are to put contextual views to the test. If it turns out that QUD generation is also influenced by visual or conceptual biases, conceptual and contextual factors might interact in presupposition triggering.

More generally, a combination of complex factors might be at play in predicting what entailments become presupposed or non-at-issue content. Rather than seeing the approaches to the 'triggering problem' discussed above as competing, they could be viewed as highlighting these different factors. The current paradigm, as well as modifications and extension thereof, might prove to be fruitful in determining and quantifying what the exact role of each of the factors is.

5 Conclusion and outlook

Using a word learning paradigm paired with visual animations the current experiment tested the predictions of different theories for which factors play a role in presupposition triggering. The data show that initial states are less affected by embedding under negation than result states when they form parts of a new complex word meaning. This finding is more in line with an analysis of the former as a presupposition.

The results suggest that the paradigm is suitable to further investigate what the role of different factors is in presupposition triggering. For example, to directly asses the role of at-issueness and alternatives, the training phase could be manipulated accordingly. That is, training could involve alternatives, negation or other

types of embedding indicating a certain information structure of the sentence. Another possibility is to work with different modes of presentation of the sentences, especially auditory presentation.

However, to draw clear theoretical conclusions, more open questions regarding the paradigm itself need to be addressed first. One open question regards the possibility to extend the methodology to other trigger types. Animations might be less suitable to teach new types of factives or determiners, for example. Furthermore, more insights into the covered box method and additional measures (e.g. confidence ratings) are needed to identify a specific signature of presuppositions within the current set-up. This also regards the role of different embeddings used in the testing phase. As mentioned above, negation is very much interacting with information structure and might be interpreted as meta-linguistic, especially when negation itself focused. Another test case for presuppositional behavior might be the availability of accommodation processes. Within the current paradigm one could test for the possibility of accommodation by exposing participants to animations giving partial information (masking the initial/result state) in the testing phase. A further point that remains unclear from the data reported here and in Bade et al. (2024) is what role individual behavior plays. Most participants are not consistent in their choice of the CB when faced with presupposition failure. This variation might interact with the varying degrees to which the CB is chosen across different experiments testing for presuppositions. Further refinement of the methodology which allows for insights into why the CB is chosen for a given trigger and environment is needed to fully evaluate the findings and determine unique characteristics of presuppositions within experimental settings.

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Postdoctoral Researcher
Dr. Nadine Bade
Karl-Liebknecht-Strasse 24–25
University of Potsdam
14476 Potsdam
nadine.bade@uni-potsdam.de