# On the cancellation of cessation inferences

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**Abstract** A past tense stative predicate usually licenses the inference that the state that predicate describes no longer obtains. However, this inference can be cancelled in certain types of questions. This squib proposes an account for this cancellation effect which is based on standard question semantics in conjunction with the assumption that interrogatives contains a speech act operator and can be exhaustified.

**Keywords:** Statives, Cessation, Tense, Interrogatives, Exhaustification

## 1 Data

### *1.1 CI cancellation*

Past tense in stative sentences triggers "cessation inferences," henceforth CIs, which say that the described state does not hold at the present. This is evidenced by the deviance of (1-a) and (1-b).

(1) a. #Zwei war eine Primzahl
two was a prime number
'Two was but no longer is a prime number'

b. #Die Studenten wussten, dass zwei eine Primzahl war
the students knew that two a prime number was
'The students knew that two was but no longer is a prime number'

As indicated by the English paraphrase, (1-a) implies that two has been prime in the past and is non-prime at the present. Likewise, (1-b) implies that two has been prime in the past of the students' belief and is non-prime at the time of their belief. The expressed meanings are deviant, presumably because they contradict the common knowledge that every natural number is eternally prime or eternally non-prime (cf. Magri 2009).

The deviance of (1-a) and (1-b) contrasts with the non-deviance of (2-a) and (2-b), in which the past statives come with interrogative force instead of declarative force.

(2) a. War zwei (nochmal) eine Primzahl?
was two (again) a prime number
'Was two a prime number again?'
b. Die Studenten wussten, welche Zahl eine Primzahl
the students knew which number a prime number
war
was
'The students knew which number was a prime number'

Sentence (2-a) has a reading in which it does not imply that two has ceased to be a prime number. Likewise, (2-b) has a reading in which it does not imply any number to have been prime at one time and non-prime later. Thus, CI may be cancelled in these sentences. It should be noted that some contextual support might be needed for the non-deviant reading to come out. For (2-a), imagine a "memory lapse" context where the issue of two's primehood was raised and settled but then the questioner forgot the answer given to her and has to inquire again. For (2-b), imagine a "math test" context where students have to tell which number of the pair $\langle 1, 2 \rangle$ is prime and where, after evaluating the results, the teacher utters (2-b).

This paper purports to explain the distribution of CI cancellation. We start our discussion by showing what is *not* involved in this explanation.

## 1.2 *CI cancellation is not a reference time effect*

Ordinary statives can be interpreted relative to a reference time (Klein 1994). That is, past statives can be claims about a contextually given time in the past (below, the time the answerer looked into the room).

(3) A: What did you notice when you looked into the room?
B: There was a book on the table. It was in Russian.
$\not\leadsto$ The book on the table ceased to be in Russian

But note that the copula sentences in (1) and (2) exemplify a different kind of statives from (3-B). We will call them "analytic statives," as they express truths which obtain by virtue of logic and are pressuposed to be timeless. Naturally, then, analytic statives cannot be claims about a restricted time span. This is evidenced by the contrast in (4). The question in (4-A) fixes a past reference time, viz. the time after the first stop of the bus. Nevertheless, the past tense version of the last conjunct of (4-B) would still trigger the cessation inference that its present tense counterpart is false, i.e. that it is, currently, not the case that $40-7=33$.

(4) Q: Why are you so sure that exactly thirty-three seats were empty after the first stop?
A: Well, the bus I drove that day had forty seats, seven passengers entered the bus at the first stop, and forty minus seven {is | #was} thirty-three.

This means that the deviance of (1-a) and (1-b) cannot be obviated by fixing a past reference time, and the non-deviance of (2-a) and (2-b) is not a reference time phenomenon.

## 1.3 CI cancellation is not a sequence of tense effect

The non-deviance of (2-b) is not a "sequence of tense" (SOT) effect: as the contrast between the past tense version of (5-a), repeated from (1-b) above, and its English counterpart in (5-b) shows, German is a language without SOT.

(5) a. #Die Studenten wussten, dass zwei eine Primzahl war
the students knew that two a prime number was
b. The students knew that two was a prime number

Assuming that inferences of **know**-complements are inherited by the matrix sentence, the deviance of (5-a) is due to the inference that two was, but no longer is, a prime number, which contradicts common knowledge.

Moreover, we find question-induced CI cancellation even under present tense attitude verbs: in the math test context, the question in (6), posed by one of the students to her classmate, does not imply cessation of the prime number property.

(6) Weißt du, welche Zahl eine Primzahl war?
know you which number a prime number was
'Do you know which number was a prime number?'

### 1.4 CI cancellation is not an effect of interrogatives per se

It is not the case that questions in German simply do not trigger CIs: (7) is deviant, as it implies that two is no longer prime or no longer not prime.

(7) #Die Studenten wussten, ob zwei eine Primzahl war
the students knew whether two a prime number was
'The students knew whether two was a prime number'

This means that the non-deviance of (2-a) and (2-b), repeated below, may have entirely different sources.

(8) War zwei (nochmal) eine Primzahl?
was two again a prime number
'Was two a prime number again?'

(9) Die Studenten wussten, welche Zahl eine Primzahl war
the students knew which number a prime number was
'The students knew which number was a prime number'

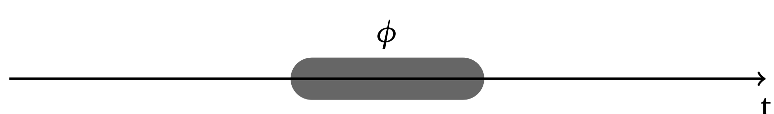
## 2 Theory

### 2.1 The Temporal Profile of Statives

Following Musan (1995); Altshuler & Schwarzschild (2013) (henceforth A&S), we take CIs to be scalar implicatures. We assume A&S's generalization, the *Temporal Profile of Statives* (TPS).

(10) *Temporal Profile of Statives* (TPS)
For any tenseless stative clause $\phi$ and world $w$, if $\phi$ is true in $w$ at moment $m$, then there is a moment $m'$ preceding $m$ at which $\phi$ is true in $w$ and there is a moment $m''$ following $m$ at which $\phi$ is true in $w$.

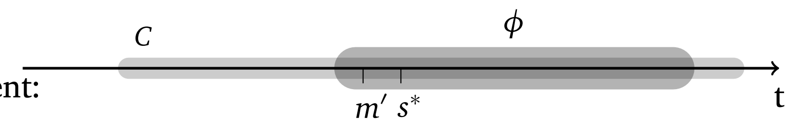
This means that every (convex) interval $\{m : \phi \text{ is true in } w \text{ at moment } m\}$ is open on both sides, for each stative sentence $\phi$.



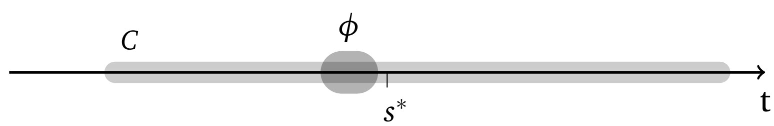
The tense operators PAST and PRESENT denote the functions in (11-a) and (11-b), where $C$ is a domain restriction representing the reference time. We assume that in the syntax, tense is adjoined to a pronominal element that is assigned the value of $C$ by the context.

(11) a. $[\![\text{PAST}]\!] \quad = [\lambda C \lambda p \lambda t \lambda w. \exists t'(t' \prec t \wedge t' \in C \wedge p(t')(w) = 1)]$
b. $[\![\text{PRESENT}]\!] = [\lambda C \lambda p \lambda t \lambda w. \exists t'(t' = t \wedge t' \in C \wedge p(t')(w) = 1)]$

It follows from these assumptions that for any (left-open) $C$ that includes the speech time $s^*$, $[\![\text{PRESENT}]\!](C)([\![\phi]\!])(s^*)$ will asymmetrically entail $[\![\text{PAST}]\!](C)([\![\phi]\!])(s^*)$ in a non-trivial way. Specifically, given the TPS, if $[\![\text{PRESENT}]\!](C)([\![\phi]\!])(s^*)(w) = 1$, then there is a moment $m' \in C$ preceding $s^*$ such that $[\![\phi]\!](m')(w) = 1$, which means $[\![\text{PAST}]\!](C)([\![\phi]\!])(s^*)(w) = 1$.

Present:


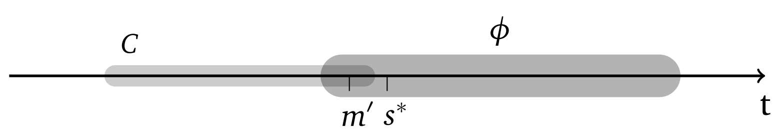

Conversely, assuming continuity of time, if $[\![\text{PAST}]\!](C)([\![\phi]\!])(s^*)$ is true then the TPS can always be satisfied without $\phi$ being true at $s^*$.

Past:



Thus, if a speaker conveys $[\![\text{PAST}]\!](C)([\![\phi]\!])(s^*)$, she implicates that the stronger alternative $[\![\text{PRESENT}]\!](C)([\![\phi]\!])(s^*)$ is false.

## 2.2 *Reference time effects*

If a domain restriction $C$ does not include the speech time $s^*$, there will be no moment $m$ such that $m = s^*$ and $m \in C$, which means that $[\![\text{PRESENT}]\!](C)([\![\phi]\!])(s^*)(w) = 0$ for any $w$.




Thus, if $s^* \notin C$, the cessation implicature of $[\![\text{PAST}]\!](C)([\![\phi]\!])(s^*)$ will be trivial, as it says that $[\![\text{PRESENT}]\!](C)([\![\phi]\!])(s^*)$, which by assumption is false at every world, is false at the world of evaluation.

## 2.3 The Condition on domain restrictions

Coming back to analytic statives, we take the cessation implicature of these sentences to show that they allow for temporal specification and the notion of truth at a moment of time. We propose to derive the fact that past analytic statives always trigger cessation implicatures from three assumptions: (i) past analytic statives have the TPS (Altshuler & Schwarzschild 2013); (ii) the domain restriction $C$ in past analytic statives always includes the speech time $s^*$; (iii) implicature computation is mandatory and contextually blind (Magri 2009).

Among these assumptions, (ii) has not been independently motivated. While we must leave this task to future research, we do hypothesize that (ii) follows from a more general condition on domain restrictions.

(12) Condition in domain restrictions
If a domain restriction is necessarily vacuous, it must be trivial.

In all worlds, tenseless analytic statives are eternally true or eternally false. Hence, the domain restriction $C$ of a past analytic stative $\phi$ is necessarily vacuous, as varying the extension of $C$ cannot alter the extension of $\phi$. By (12), $C$ must be trivial, i.e. must include all moments of time, among them $s^*$. Thus, past analytic statives always trigger a cessation implicature, which is always non-trivial. Consequently, past analytic statives are always deviant.

## 2.4 Questions semantics

We adopt the following rather standard assumptions about questions (cf. Stenius 1967; Ross 1970; Karttunen 1977; Heim 1994; Krifka 2001): (i) The semantic value of a question is the set of its possible answers (Hamblin 1958); (ii) to ask a question is to state a request, and to know a question is to know the true answers to it; (iii) a question $q$ is parsed as [ANS $q$] as the complement of **know**, and as [QUEST $q$] as a matrix clause.

The function of ANS is to map $Q$ to the conjunction of all true members of $Q$. For QUEST, we assume that it is (syntactically) decomposed into an imperative operator MAKE and a 'I know the answer' component (cf. Sauerland & Yatsushiro 2017):

(13) MAKE [I-KNOW [ANS $q$]]

Thus, QUEST maps a set of possible answers $Q$ to the proposition that the speaker requests that the hearer make known all the true members of $Q$.

### 2.5 Exhaustification

We assume that scalar implicatures are derived in grammar by a syntactically represented exhaustification operator, $\mathbf{exh_A}$ (Chierchia 2004; Fox 2007; Chierchia et al. 2012) whose simplified definition is given below.

(14) $\text{exh}_A(\phi) \Leftrightarrow \phi \wedge \forall\psi \in A(\psi \rightarrow (\phi \rightarrow \psi))$

Moreover, we follow Romoli (2012) and assume that the factive presupposition of **know** is in fact an entailment which arises from exhaustification. Specifically, $know(x,\phi) \Leftrightarrow \phi \wedge believe(x,\phi)$, which entails (15-a) and (15-b).

(15) a. $know(x,\phi) \Rightarrow \phi$
b. $\text{exh}_A(know(x,\phi)) \Rightarrow \phi$

From (15-a) we obtain (16-a). Now, Romoli crucially assumes (16-b), i.e. that $\phi$ is a scalar alternative of $know(x,\phi)$ and, therefore, that $\neg\phi$ is a scalar alternative of $\neg know(x,\phi)$. This entails (16-c).

(16) a. $\neg\phi \Rightarrow \neg know(x,\phi)$
b. $\phi \in \text{Alt}(know(x,\phi))$, $\neg\phi \in \text{Alt}(\neg know(x,\phi))$
c. $\text{exh}_A(\neg know(x,\phi)) \Rightarrow \phi$

Together (15-b) and (16-c) account for the observation that **know** factively "presupposes" its complement: both $know(x,\phi)$ and its negation gives rise to the inference that $\phi$ is true.

# 3 Explanation

### 3.1 The deviant examples

We assume that (1-a) and (1-b), repeated below, are parsed as given in (17-a) and (17-b), respectively.

(1) a. #Zwei war eine Primzahl
two was a prime number
'Two was but no longer is a prime number'

b. #Die Studenten wussten, dass zwei eine Primzahl war
the students knew that two a prime number was
'The students knew that two was but no longer is a prime number'

(17) a. $\text{exh}_{A_1}$ [zwei war eine Primzahl]
b. $\text{exh}_{A_2}$ [die Studenten [wussten [dass zwei eine Primzahl war]]]

Furthermore, we assume the alternative sets in (18) (where we omit the prejacent). Note that $A_2$ is the union of the alternatives of **wussten** and the scalar alternatives of its complement (Romoli 2012).

(18) a. $A_1$ = {zwei ist eine Primzahl}
b. $A_2 = \left\{\begin{array}{l}\text{die Studenten [wussten [dass zwei eine Primzahl ist]]}\\ \text{dass zwei eine Primzahl war}\\ \text{dass zwei eine Primzahl ist}\end{array}\right\}$

By the assumptions in §2.3, the LFs in (17) entail that two has been prime in the past and is non-prime at the present. This explains the deviance of (1-a) and (1-b).

For (7), repeated below in (19), we assume the parse in (20-a), following the assumptions made in §2.4, and the alternative set in (20-b), in accordance with (18-b).

(19) #Die Studenten wussten, ob zwei eine Primzahl war
the students knew whether two a prime number was
'The students knew whether two was a prime number'

(20) a. $\text{exh}_{A'_2}$ [die Studenten [wussten [ANS [ob zwei eine Primzahl war]]]]
b. $A'_2 = \left\{\begin{array}{l}\text{die Studenten [wussten [ANS [ob zwei eine Primzahl war]]]}\\ \text{ANS [ob zwei eine Primzahl war]}\\ \text{ANS [ob zwei eine Primzahl ist]}\end{array}\right\}$

Thus, because of the fact in (21), the deviance of (7) follows in the same way as the deviance of (1-b).

(21) $[\![$ANS [**ob zwei eine Primzahl** {**war** | **ist**}]$]\!]$
= $[\![$**dass zwei eine Primzahl**{**war**|**ist**}$]\!]$

### 3.2 The non-deviant examples: (embedded) wh-questions

To explain the contrast between (7)/(19) and (22) (repeated from above), we note that the latter example contains a **which**-question.

(22) Die Studenten wussten, welche Zahl eine Primzahl war
the students knew which number a prime number was
'The students knew which number was a prime number'

Importantly, **which**-phrases can range over the members of a conceptual cover (Aloni 2001). Conceptual covers are "methods of identification." Technically, they are sets $C$ of individual concepts $f$ such that in each world $w$, each individual $d$ (of the discourse domain $D$) is the instantiation of one and only one individual concept in that world.

(23) Condition on conceptual covers
$\forall w \forall d \in D \exists ! f \in C. f(w) = d$

That is, the embedded **wh**-question in (22) can have the following denotation, where $g$(C) is a conceptual cover.

(24) $[\![\textbf{welche}_{\text{C}}\ \textbf{Zahl eine Primzahl war}]\!]^{g} =$
$= \{p \mid \exists f \in g(\text{C}). p = [\lambda w. f(w) \text{ was prime in } w]\}$

In our math test context (students have to tell which number of the pair $\langle 1, 2 \rangle$ is prime), the discourse domain is the set in (25-a), and we assume that the set $C_D$ in (25-b) is a contextually available conceptual cover of this domain.

(25) a. $D = \{1, 2\}$
b. $C_D = \begin{Bmatrix} [\lambda w. \text{the odd number on the test sheet in } w] \\ [\lambda w. \text{the even number on the test sheet in } w] \end{Bmatrix}$

Thus, if $g(\text{C}) = C_D$, the **wh**-question of (22) denotes the following set.

(26) $[\![\textbf{welche}_{\text{C}}\ \textbf{Zahl eine Primzahl war}]\!]^{g} =$
$= \begin{Bmatrix} [\lambda w. \text{the odd number on the test sheet in } w \text{ was prime in } w] \\ [\lambda w. \text{the even number on the test sheet in } w \text{ was prime in } w] \end{Bmatrix}$

We note in this connection that the sentences that express the propositions in (26) do not trigger a deviant cessation implicature:

(27) The {odd | even} number on the test sheet was prime

Furthermore, we note that variants of (22) and (27) that don't allow for an interpretation relative to a conceptual cover have a deviant cessation implicature, see (28).

(28) a. #The students know which number of one and two was prime
b. #(The students know that) the smallest even natural number was prime

Finally, the sentences that allow for an interpretation relative to a conceptual cover do have a cessation implicature, viz. the implicature that the test sheet ceased to exist (in the immediate utterance situation). This is evidenced by the oddness of the past tense variants of the sentences in (29-a) and (29-b) in the context of the leading sentence.

(29) Take a look at the math test sheet here.
a. The odd number (on the sheet) {is | #was} prime
b. Do you know which number (on the sheet) {is | #was} prime?

This "lifetime effect" follows from the assumption that [$x$ is on the sheet at time $t$] is a soft trigger for the proposition that the sheet exists at time $t$ (cf. Musan (1995)).

## 3.3 *The non-deviant examples: (unembedded) "remind me" questions.*

According to what we said in §2.4, (2-a), repeated below in (30), is parsed as given in (31).

(30) War zwei (nochmal) eine Primzahl?
was two again a prime number
'Was two a prime number again?'

(31) exh$_A$ [MAKE [I-KNOW [ANS [Q [zwei eine Primzahl war]]]]]

We assume that MAKE, like its overt counterpart, is a soft trigger for the meaning component that its complement proposition is not true at the time of the request (i.e. at $s^*$). That is, MAKE entails the negation of it complement and has [**not** S] as an alternative.

(32) a. $[\![\text{MAKE}]\!](\phi) \Rightarrow \neg\phi$
b. **not** S $\in$ Alt(MAKE S)

For complements that contain a scalar item, we assume again that the alternative set includes the (negation of the) scalar alternatives. Thus, the alternative set A in (31) has the following extension.

(33) A = { nicht [I-KNOW [ANS [Q zwei eine Primzahl ist]]], nicht [ANS [Q zwei eine Primzahl war]], nicht [ANS [Q zwei eine Primzahl ist]] }

The following holds for the elements of A in (33).

(34) a. **nicht** [I-KNOW [ANS [Q **zwei eine Primzahl ist**]]] is not innocently excludable since its negation contradicts the (entailment of the) prejacent.
b. **nicht** [ANS [Q **zwei eine Primzahl war**]] is innocently excludable.
c. **nicht** [ANS [Q **zwei eine Primzahl ist**]] is also innocently excludable.

Thus, overall we derive that (31) entails the answer to the present tense counterpart of the embedded question.

(35) ⟦(31)⟧ = ⟦MAKE [I-KNOW [ANS [Q [**zwei eine Primzahl war**]]]]⟧∧
∧⟦ANS [Q **zwei eine Primzahl ist**]]⟧

That is, we correctly derive that (30)/(31) doesn't trigger a deviant cessation implicature that 2 has been prime in the past and ceased to be prime at the present.

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