Subjective causality in Dutch revisited

Prosody, connectives, and word order

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i. Abstract

In this thesis, the relation between type of causality and prosodic marking, connective choice, and word order in Dutch has been investigated. The results show that type of causality is not associated with word order or the connective that is used. All three Dutch forward causal connectives (cf. 'so') – *dus*, *daarom*, and *daardoor* – can be used to express all types of causality. Concerning prosodic marking, non-volitional objective causality causes longer connective duration and is associated with more frequent production of pauses. Type of causality did not affect F0, pause duration, speech rate, or declination reset. These findings do not correspond with prior research by Hu et al. (2019, 2022), who found that there is a trade-off between the use of prosodic and morphosyntactic means in expressing type of causality. The findings do not correspond with the hypotheses of the current study either, as a slower speech rate, longer connectives and pauses, and higher F0 values were expected to be associated with subjective causality. The results were obtained from a revised version of the dialogue experiment that was introduced by Hu et al.

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1. Introduction

Consider the pair of sentences in (1). Many readers would interpret this pair causally, in such a way that Anna takes good care of her plants because she is a biologist, in accordance with Sanders's (2005) causality-by-default hypothesis. In addition, connectives such as *so* and *because* are commonly used to express causality, among other things. In this thesis, I will focus on the expression of causality in Dutch through three means: connective use, prosodic marking, and word order in Dutch. I do so by revisiting earlier work by Hu et al. (2022) and altering their method in such a way that it fits the Dutch language better than in the original study.

(1) Anna is a biologist. She takes good care of her plants.

Hu et al. (2019, 2022) have conducted innovative cross-linguistic research on the prosody (i.e., melody and rhythm of speech) of causal coherence relations. Generally, there are two types of causality: objective and subjective. The term *objective causality* refers to the type of causality that can be observed in the physical world: an event or act causes a consequence to happen, cf. (2a). *Subjective causality*, on the other hand, refers to epistemic reasoning: a certain event or observation causes the speaker to make an assumption or draw a conclusion, cf. (2b) (Sanders et al., 1992). The distinction between objectivity and subjectivity is described in more detail in Chapter 2.

(2) a. She doesn't want to live on an island, so she stays on the mainland.
b. She doesn't want to live on an island, so she dislikes the sea.

In a language such as English, one and the same connective can be used to express both types of causality. By contrast, a language such as Mandarin uses distinct connectives for both types of causality. Hu et al. (2019, 2022) have found that in English, prosodic marking is used to express a difference between subjectivity and objectivity while speakers of Mandarin communicate the type of causality through specialised connective use and not through prosody. In Dutch, some speakers use specialised causal connectives while others use those same connectives in a non-specialised way. Hu et al. (2022) have found that specialised connective use is associated with a lack of additional prosodic marking of type of causality in Mandarin and Dutch. In accordance with the Functional Hypothesis (Haan, 2010), Hu et al. (2022) conclude that there is a trade-off between the use of lexicon and the use of prosody. Speakers presumably use their resources economically and do not encode information in their speech that is not necessary for the listener to understand them correctly.

Building on Hu et al.'s (2022) work on Dutch, I have revisited their findings through an attempt at improving their method (see Chapters 3 and 4), for three reasons. First, theoretical considerations concerning the processing time of subjective causality give reason to expect prosodic marking of those processing times. (Canestrelli et al., 2013; Wei et al., 2019). Secondly, prosodic marking is an unavoidable aspect of language use (Fletcher, 2013; Beckman & Venditti, 2013). And thirdly, the fact that listeners do not know whether speakers are using specialised or non-specialised connectives also gave cause to revisiting Hu et al.'s (2022) work. The current study was expected to provide prosodic evidence for the higher processing times associated with the perception of subjective causality (Wei et al., 2019). In addition, higher fundamental frequency (F0) was expected to be observed in the second clauses of subjective causal relations, the causal connectives were expected to be specialised but not limited to their prototypical use cases, and VSO word order was expected to be associated with objective causality.

2. Theoretical background

2.1 Causal coherence relations and connectives

As explained in the introduction, one of the crucial themes in this thesis is causal coherence relations and the role of connectives. In a broader sense, causal relations belong to the domain of discourse structure. A discourse consists of multiple discourse segments. Discourse segments are at least one clause long, but they are often longer, expanding to full sentences or even paragraphs. Longer discourse segments can also consist of multiple discourse segments. They always have to be meaningful in isolation, but the hierarchical relations that exist between them give a discourse its coherence (Sanders et al., 1992; Tyler, 2013). For example, in (2'a), S1 forms its own discourse segment and so does S2, but the combination of these two segments forms a discourse segment as well and it can be used in a larger discourse structure.

Sanders et al. (1992) propose a categorisation of these coherence relations, using four primitives: basic operation, source of coherence, order of the segments, and polarity. *Basic operation* refers to the kind of relation between the two discourse segments, which can either be additive – i.e., a relation with *and* or *but* – or causal – i.e., a relation with *because*, *so*, *although*, etc. From this point of view, every coherence relation is at least additive, and if an implication relation exists between the two segments, it is also causal. In this paradigm, temporal relations, for example, are additive, and if the first segment causes the second, it is a causal relation.

Source of coherence refers to the question whether the relation exists between the propositions or claims of the two segments, as in (2'a), or between the illocutions (the intended meaning behind what is literally said) expressed by the discourse segments, as in (2'b). The causal relations that are based on the illocutions of either of the segments can also be characterised as being construed in the speaker's mind. The speaker has knowledge of discourse segment S1, which makes them conclude discourse segment S2. In case of the former, the relation has a semantic source of coherence, and in case of the latter, the relation has a pragmatic source of coherence. Following Pander Maat and Sanders (2000), semantic causality will be referred to as *objective causality* and pragmatic causality will be referred to as *subjective causality*.

(2') a. She doesn't want to live on an island$_{S1}$, so she stays on the mainland$_{S2}$.
b. She doesn't want to live on an island$_{S1}$, so she dislikes the sea$_{S2}$.

The third primitive, *order of the segments*, refers to whether the order in which the segments are uttered corresponds to the order in which they take place. In (3a), S1 expresses the reason for S2, while in (3b), the consequence is expressed before the reason. When the order of events corresponds to the order of uttering, the relation is said to be of basic order. When the two do not correspond, the relation is of non-basic order. Finally, *polarity* refers to the question whether the positive or the negative versions of discourse segments function in the basic operation. Examples of positive and negative relations are given in (4a) and (4b), respectively (taken from Sanders et al., 1992, p. 10).

(3) a. John is tired$_{S1}$, so he goes to bed$_{S2}$.
b. John goes to bed$_{S1}$ because he is tired$_{S2}$.

(4) a. Because he had political experience$_{S1}$, he was elected president$_{S2}$.
b. Although he didn't have any political experience$_{S1}$, he was elected president$_{S2}$.

Connectives are often used to express coherence relations. Since this thesis revolves around causality, only causal connectives will be discussed here. In English, the two most frequently used connectives are *so* and *because*. *So* is used in forward (basic order) and *because* in backward (non-basic order) causality. There are other connectives, but they are significantly less common in regular language use. For example, *therefore*, is also a forward causal connective but it is practically only used in academic writing (Andersson & Sundberg, 2021). Unlike in other languages, in English, source of coherence is not encoded in connectives. English does not distinguish between connectives that can only be used to express subjective causality and those that only express objective causality: they are *non-specialised*. In example (2'), *so* is used to express an objective causal relation in (2'a) and also to express subjective epistemic reasoning in (2'b). However, in languages such as Dutch, Mandarin, German, and French, connectives are either prototypically objective or prototypically subjective. They are *specialised*. In Dutch, *dus* ('so') [1] is a subjective forward causal connective, while *daardoor* ('as a result') and *daarom* ('that's why') are objective forward causal connectives. Similarly, *want* ('since')[2] is a subjective backward causal connective, and *doordat* ('as a result of') and *omdat* ('because') are objective backward causal connectives. Examples of these connectives are given in (5) and (6), respectively (Stukker & Sanders, 2012; Pander Maat & Sanders, 2000).

(5) a. Het regent, daardoor zijn de straten nat.
It's raining, as a result the streets are wet

b. Het regent, daarom verplaatsen we de picknick.
It's raining, that's why we'll reschedule the picnic.

c. Het regent, dus mag ik je auto lenen?
It's raining, so can I use your car?

(6) a. De straten zijn nat doordat het regent.
The streets are wet as a result of the fact that it's raining.

b. We verplaatsen de picknick omdat het regent.
We'll reschedule the picnic because it's raining.

c. Mag ik je auto lenen? Want het regent.
Can I use your car? Since it's raining.

As stated before, the prototypical usage of these three forward causal connectives in Dutch relies on the distinction between objectivity and subjectivity, which should be thought of as a gradual rather than a categorical distinction. This difference in source of coherence is described in depth by Pander Maat and Sanders (2000). They argue that both subjectivity and objectivity can be divided in two more categories. Objectivity encompasses both volitional (cf. (5b) and (6b)) and non-volitional causality (cf. (5a) and (6a)), while subjectivity encompasses epistemic reasoning (cf. (2'b)) and speech acts (cf. (5c) and (6c)). Non-volitional causality can be characterised in terms of 'cause-consequence' or 'consequence-cause'. Relations with volitional causality, on the other hand, are of the type 'reason-intentional action' (or 'intentional action-reason' in case of the non-basic order). Moreover, Pander Maat and Sanders (2000) claim that the

[1] Glosses for *daardoor*, *daarom* and *dus* have been taken from Pander Maat & Sanders (2000).
[2] Glosses for *omdat* and *want* have been taken from Sanders & Spooren (2015).

effect of subjectivity on the domains of use of Dutch causal connectives can be described more precisely through their distance to the *Subject of Consciousness* (SOC). The SOC is the entity responsible for the reasoning required by subjective causality. They have found that there is no SOC present in non-volitional causality, as, in case of cause-consequence relations "the causality is located outside of this SOC" (Pander Maat & Sanders, 2000, p. 77). These relations tend to be expressed by *daardoor* ('as a result'). Volitional causality, relations of the type reason-intentional action, does involve an SOC, but there is some distance between the speaker and the SOC. These relations are often expressed through *daardoor* ('that's why'). In subjective causality, i.e., causal relations that consist of epistemic reasoning or speech acts, there is virtually no distance between the SOC and the speaker. Those relations tend to be expressed by *dus* ('so'). In some volitional causal relations, the distance between SOC and speaker is very small, those cases tend to involve *dus* as well. This shows that, although Dutch causal connectives are said to be specialised, their use cases are not necessarily limited to their prototypical specialisations. This is also supported by studies on backward causality in Dutch. Stukker and Sanders (2012) and Sanders and Spooren (2015) describe how *want* ('since') is non-prototypically used in objective causality because the relation might require a more subjective flavour. The same was found for the non-prototypical use of *omdat* ('because') in an epistemic (subjective) relation. A schematic overview of the most common uses of Dutch forward causal connectives is given in Table 1. In spoken Dutch, *dus* is used most often, followed by *daarom*. *Daardoor* is used the least. According to SUBTLEX-NL, a corpus of Dutch subtitles (Keuleers et al., 2010), *dus* has a Zipf frequency (i.e., log10(frequency per million words * 1000)) (Zipf, 1932; Corral et al., 2015) of 6.14, *daarom* of 5.48, and *daardoor* of 4.40.

Table 1

Common forward causal connectives in Dutch, their Zipf frequencies (Keuleers et al., 2010), and their uses (Pander Maat and Sanders, 2000).

Connective	Zipf frequency	Use
Daardoor	4.40	Content non-volitional relations.
Daarom	5.48	Content volitional relations. Occasionally epistemic relations.
Dus	6.14	Epistemic, summary, paraphrase relations. Occasionally content volitional relations.

The degree of subjectivity and the presence of an SOC can be encoded linguistically. Cue phrases and modal verbs such as *I think* and *may* signal subjectivity and active involvement of an SOC (Pander Maat & Sanders, 2000; Wei et al., 2019). The interaction between the distance between an SOC and the speaker on one hand, and the use of a certain connective on the other hand has been demonstrated by Wei et al. (2019). Using a visual world paradigm, they found that listeners tend to look at the picture of a speaker longer than at the picture of the event that is described whenever a connective is used that is associated with little distance between speaker and SOC. In earlier research, Canestrelli et al. (2013) had already shown that the prototypically subjective causal connective *want* ('since') is associated with longer processing times than the prototypically objective causal connective *omdat* ('because'). Wei et al.'s (2019) study forms evidence for the idea that longer processing times are due to the involvement of an SOC.

In addition to their differences in prototypical use cases, Dutch causal connectives also differ in their grammatical function. The prototypically objective connectives that involve no or distanced SOCs are subordinating connectives. They are followed by a word order that is typical

of subordinate clauses, i.e., VSO for *daardoor* and *daarom*, and SOV for *doordat* and *omdat*. On the other hand, prototypically subjective connectives, which involve little distance to the SOC, are coordinating. They are followed by the word order that is typical of main clauses (SVO). *Dus* is an exception in this respect, as it can be followed both by SVO and by VSO, although SVO is more common. Moreover, in spoken Dutch *omdat* is also used as a coordinating connective (with main-clause SVO instead of subordinate-clause SOV). Persoon et al. (2010) state that this coordinating *omdat* does not replace coordinating *want*. They argue that it has a function of its own and that it expresses relations that contain both subjective and objective characteristics. Given that all coordinating connectives (*omdat*, *want*, and *dus*) express at least partially subjective relations, it might well be that main clause word order is a way to express subjectivity in itself. Research by Evers-Vermeul (2005) also suggests that a change in word order after a connective is associated with a change in meaning.

In short, discourse structure relies on the coherence relations that exist between discourse segments, which are either additive or causal. Causal coherence relations can be characterised in terms of their subjectivity, or the distance between the speaker and the SOC. In Dutch and multiple other languages, but not in English, causal connectives are specialised to express a certain degree of subjectivity, although non-prototypical uses are allowed as well. Besides, word order is suggested to index subjectivity. In the next section, the interaction between discourse structure and prosody is described.

2.2 Prosody-discourse interface

In spoken language, discourse structure is often marked by prosodic patterns. Prosodic patterns are created vocally by manipulating fundamental frequency of the voice (henceforth, F0; perceived as pitch), intensity (perceived as loudness), pause durations, and speech rate. Two examples of this type of research are given below.

Tyler (2013) has conducted research on the way the hierarchy of discourse structure is prosodically marked, specifically providing evidence for unambiguous discourse structure in this respect. In his study, he used Segmented Discourse Representation Theory (SDRT) (Asher & Lascarides, 2003). SDRT divides a discourse in segments and identifies the rhetorical relations that hold resulting in a hierarchical discourse structure. In an experiment, participants were given a newspaper article that they first had to read silently and then analyse for themselves. After that, they were asked to read the article out loud. With this experiment, the author aimed to investigate whether the participants would use their prosody to mark "the amount of structure intervening between sequential segments of a discourse" (Tyler, 2013, p. 106) (*Boundary size*), and whether discourse segments relate to the preceding segment through coordination or subordination, as specified by the SDRT representation of the newspaper article. Tyler found that larger discourse boundaries (i.e., a larger amount of structure intervening) are associated with longer pause duration, higher maximum F0, higher maximum intensity, and higher speech rate. Moreover, coordinated discourse segments tend to be produced with higher F0 and intensity and to be preceded by a longer pause than subordinated segments. This effect has been shown to depend on the boundary size. When a preceding discourse boundary is absent or very small, the prosodic patterns that mark coordination and subordination significantly differ, but do not when the preceding discourse boundary is large. Note that discourse boundaries are not the same as prosodic boundaries that mark intonation phrases (e.g., Krivokapić & Byrd, 2012). Discourse boundaries are prosodically marked but do not necessarily coincide with prosodic structure.

The SDRT yields discourse structures that rely on the relations that hold between their discourse segments. It differs from Rhetorical Structure Theory (RST) (Mann & Thompson, 1988),

which relies on features of the discourse segments themselves. According to RST, each discourse segment is either a nucleus or a satellite and removing all satellites from a text would not disrupt the information flow but rather result in a summary of the text. In SDRT, a segment could be subordinating to one segment and coordinating to another, while in RST, a segment is either a nucleus or a satellite: it cannot have multiple functions (Tyler, 2013). Den Ouden et al. (2009) also investigated prosodic marking of discourse structure in newspaper articles that are read aloud, but they used the RST for their representation of the text's structure. Their main findings show that discourse segments that occupy a higher place in the discourse hierarchy are associated with longer pauses and higher maximum F0, but that speech rate is not affected by hierarchy. This effect varies between speakers. Den Ouden et al. (2009) also analysed their speech data for any effects of source of coherence, as described in the taxonomy of Sanders et al. (1992) but no effects on prosody nor interaction effects with hierarchy were found. They did, however, not consider aspects that are typical of a prosodic distinction between subjective and objective relations, such as a declination reset. Besides, they indicate that they doubt their classification of subjectivity. Section 2.3 provides more information about other studies that focused specifically on the prosodic marking of source of coherence.

In short, the studies by Den Ouden et al. (2009) and Tyler (2013) show that prosody is used to reinforce unambiguous discourse structures. Prosodic marking has a communicative function (more on this in Section 2.4). The speakers themselves do not need the prosodic marking to comprehend the text, they add it to facilitate listeners' comprehension of it. Similarly, Van Heuven (2017) describes how different types of questions (Wh-, yes/no-, and declarative questions) in Dutch are all characterised by distinct prosodic marking. Although Wh- and yes/no-questions are syntactically recognisable as questions, they still receive prosodic marking that sets them apart from regular statements. Within the category of questions, all prosodic patterns differ from each other (Van Heuven, 2017). Again, the prosodic patterns are communicative devices that help listeners processing the linguistic input.

Summarising, research in the prosody-discourse structure interface has shown that discourse structure is marked prosodically. There is evidence for prosodic marking of hierarchy in discourse (nucleus-satellite in RST, coordinating-subordinating in SDRT) and of the amount of structure intervening between discourse segments (boundary size in SDRT). In addition, different types of questions have been shown to be marked by distinct prosodic patterns. Both of these lines of research are practical examples of the uncontroversial idea that using prosody is inherent to spoken language and crucial to successful speech communication (Fletcher, 2013; Beckman & Venditti, 2013). The next section expands on prosody-discourse interface theme by discussing studies on the prosodic marking of source of coherence.

2.3 Prosody of subjectivity

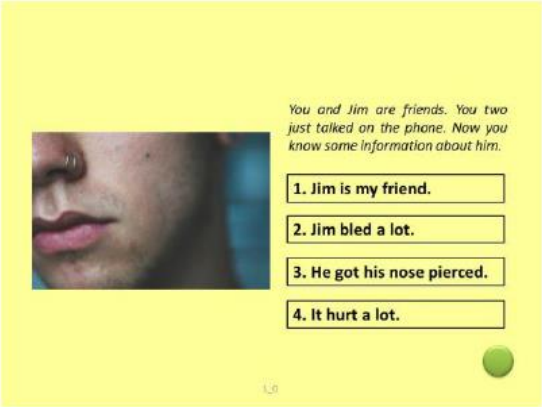
Contrasting with Den Ouden et al.'s (2009) study, in which no effect of source of coherence on the use of prosody was found, there is evidence from other studies that subjective causal relations employ a prosodic pattern that is different from the prosodic patterns of objective causal relations. In this light, Couper-Kuhlen (1996) discusses the concept of *declination reset*. *Declination* refers to the phenomenon of gradually declining F0 over the course of an intonation phrase, which is the largest phonological unit within an utterance and contains multiple smaller phonological units in itself (Hirst & Di Cristo, 1998). *Declination reset* thus means that the declination of one intonation phrase ends and a new intonation phrase starts, typically after an inhalation pause, after which declination will start again, from a higher point than where the previous intonation phrase ended ('t Hart et al., 1990). Couper-Kuhlen (1996) describes the

declination reset as “intonational coordination” and a lack of declination reset as “intonational subordination” (Couper-Kuhlen, 1996, p. 402). She investigated 200 instances of *because* in spoken language from British and American face-to-face family chat, radio phone-in programs, and public debate on television. In these speech samples she found that what is here referred to as *subjective causality* comes with a declination reset around the connective while what is here referred to as *objective causality* does not.

Hu et al. (2019) have investigated the prosodic marking of *because* in an experimental setting, with a wider variety of prosodic parameters and using statistical evidence to validate their findings. They found that subjective causality is characterised by a wider pitch range and a longer pause than objective causality. In the experiment, the participants were asked to carry out a dialogue task. They answered questions with the help of information presented to them on PowerPoint slides (see Figure 1). Answering the questions also involved producing a causal relation between phrase 2 and phrase 3 (cf. Figure 1). Half of the stimuli elicited objective causality, while the other half elicited subjective causality. The causal relations produced by the participants were analysed for minimum and maximum F0, speech rate, the duration of the pause between the two segments, and pitch reset between the two segments.

Figure 1

Example of a PowerPoint slide shown to the participants of Hu et al. (2019, p. 2446).



The results that followed from the analysis showed that subjective causal relations were uttered with higher maximum and lower minimum F0 than objective causal relations. This suggests that speakers used a wider pitch range for subjective causals in an attempt to engage their interlocutors. The effect was mainly observed in the causal relations’ first segments. Speech rate was not affected by subjectivity, which is surprising because subjective causality requires reasoning about observations in order to make a claim. The reasoning was expected to be reflected by lower speech rate. This might, however, have been caused by the experimental design. The participants did not produce spontaneous speech, so they might not have needed to spend as much effort on reasoning about the relation between the two segments. Moreover, the pause preceding *because* was longer in the subjective condition than in the objective condition. The long pause can be interpreted as evidence of subjective causality relying on effortful reasoning about the relation between claim and argument. There was, however, no difference between objectivity and subjectivity in terms of the difference in F0 between first segment offset and second segment onset (Hu et al., 2019).

As described above, the fact that English causal connectives are not specialised does not necessarily mean that listeners do not know whether the speaker expresses a subjective or an objective causal relation. Instead, there are prosodic cues that inform the listener about the

source of coherence. Hu et al. (2022) have investigated whether these prosodic cues are also available in languages with specialised causal connectives, i.e., in Mandarin Chinese and in Dutch. They found that Mandarin does not use any prosodic means to distinguish between the different sources of coherence and that in Dutch specialised prosodic marking was only used when speakers did not use specialised connectives. Hu et al. (2022) conclude that there is a trade-off between the use of prosodic and lexical means, resulting in specific prosodic marking for subjectivity only if non-specialised connectives are used. In the study on Mandarin and Dutch, the same method as in Hu et al.'s (2019) study on English was used, but this time it was modified to be used on forward causality (basic order, cause-consequence). In Mandarin, *keijan* ('so') is used subjectively and *yushi* ('as a result') is used objectively. Unlike Dutch *dus*, *keijan* is not used to express volitional causality: its use is limited to the epistemic domain and occasionally speech acts (Li, 2014). The Uniform Information Density Hypothesis states that speakers tend to keep their rate of information transfer as constant as possible (Levy & Jaeger, 2007). Besides, the Functional Hypothesis (Haan, 2001) states that there is a trade-off relationship between the use of prosody and the use of morphosyntax. From this point of view, prosody is seen as a way to reinforce insufficient information transfer through morphosyntactic means (Functional Hypothesis) and as a way to prepare listeners for an unexpected causal relation that requires some reasoning (Uniform Information Density Hypothesis).

Based on these two theories, Hu et al. (2022) expected a trade-off between the use of specialised connectives and the use of specific prosodic patterns in Mandarin and Dutch. More specifically, speakers of Mandarin were expected to employ similar prosodic patterns for subjectivity and objectivity because the difference in source of coherence is already encoded in the connectives. The results confirm this hypothesis. In Mandarin, subjectivity does not affect the duration of the pause before the connective, nor does it affect speech rate or minimum and maximum F0 in the first segment. For Dutch, Hu et al. (2022) hypothesised that the use of prosody would depend on the use of *dus* ('so'). Given that *dus* can be used both as a specialised and as a non-specialised connective, it could employ a specific subjective prosodic pattern only when it is used in its non-specialised version. Moreover, speakers who tend to use *dus* as a specialised connective were hypothesised to employ less specialised subjective prosodic patterns than speakers who tend to use non-specialised *dus*. This hypothesis is confirmed by the results, which showed that the prosody of the substantial group of speakers who use *dus* as a non-specialised connective is affected by subjectivity. Subjectivity is characterised by lower maximum F0 in the second segment of the causal relation. There was no effect of subjectivity on maximum F0 in the first segment, nor on speech rate in either of the clauses, nor on pause duration before the connective. In the second group, i.e., the group of speakers who used *dus* as a specialised connective, no evidence for subjectivity influencing F0 or speech rate was found. There might, however, be an effect of subjectivity on pause duration and on the duration of the connective itself but the results are not univocal and cannot provide substantial evidence for this finding. The difference in prosody between specialised and non-specialised *dus* supports the hypothesised trade-off relationship between prosody and lexicon. Moreover, each speaker's preference for *dus* as a specialised connective was captured in an odds ratio. This odds ratio was tested for interaction with the effect of subjectivity on prosody. The results show that such an interaction effect might be found in speech rate in the second clause, but the evidence is very weak (Hu et al., 2022).

In short, the results of both studies of Hu et al. (2019, 2022) support the idea that there is a trade-off relationship between the use of specialised connective words (lexicon) and the use of prosody. The source of coherence of a causal relation (subjectivity vs. objectivity) can be

expressed prosodically, but that is not the case when the source of coherence is encoded in the connective itself already. However, there are a number of peculiarities to the Dutch version of Hu et al.'s (2022) method, which will be discussed further in Chapter 3. In turn, the current study seeks to verify whether Hu et al.'s (2022) results for Dutch are reproducible with an improved method for eliciting spoken responses. The rationale for and a detailed description of the new method are given in Chapters 3 and 4.

2.4 Prosody and emotional valence

In addition to prosodic marking specific to the source of coherence, causal relations can also be marked prosodically according to the emotional valence of the message they communicate. Although prior research suggests differences between subjectivity and objectivity in the way emotional valence is expressed (Morera et al., 2010), it is not yet clear whether there is an intrinsic difference between subjective and objective causality in the degree to which they are likely to express a message with higher levels of emotional valence. It would, however, be plausible to expect stronger emotional valence in subjectivity than in objectivity, considering that subjectivity entails more speaker involvement. As a result, subjective causality would be more likely to express opinions and feelings than objective causality.

Just like source of coherence, emotional valence is often marked prosodically. In that case, prosody both communicates speaker emotion and elicits an emotional reaction in the listener (Pell & Kotz, 2021; Van Berkum et al., in press). Banse and Scherer (1996) have investigated the acoustic-prosodic properties of 14 emotions that differ in strength and valence. They have found that groups of related emotions tend to be expressed with comparable prosodic characteristics, but that all emotions are expressed differently. In later research, Hammerschmidt and Jürgens (2007) distinguish between six different emotional states. Their conclusion is comparable to the one of Banse and Scherer (1996), namely that it is not possible to identify an emotion based on one prosodic characteristic but rather by a set of prosodic characteristics. No two emotional states are exactly the same, but they do overlap on some points. Besides male and female speakers differ in their expression of most emotions.

In a broader sense, Freese and Maynard (1998) have studied the way prosody is used to express whether a message contains good or bad news, which is not inherent to the message itself. Instead, it depends on the interlocutors' concerns, perspectives, and identities. That is why a phrase like "John is at home" could both be good and bad news, depending on the context. An overview of the prosodic correlates of message valence is also given by Freese and Maynard (1998); sentences with positive valence (good news) are characterised by high pitch, wide pitch range, key words that are produced loudly, normal voice quality, and high speech rate, with the tendency to speed up as the utterance progresses. On the other hand, sentences with negative valence (bad news) tend to be produced with low pitch, narrow pitch range, breathy or creaky voice, key words that are sometimes produced quietly, and low speech rate, with the tendency to slow down as the utterance progresses.

Concerning the perception of affective prosody, high cue saliency, i.e., the emotional state is expressed with prosodic characteristics that are as close as possible to the stereotypical prosodic representation of the emotion at hand, requires less effortful signal processing than lower cue saliency. When the signal is ambiguous, it requires more resources to be processed and more activity is observed in the inferior frontal gyrus (Leitman et al., 2010). Moreover, Pell and Kotz's (2021) literature review underlines the crucial role of prosody in both social and pragmatic communication.

In summary, subjective causality is likely to communicate stronger emotional valence than objective causality. Prosody has been shown to express both speaker emotion and the valence of messages. In addition, salient cues to what emotion is conveyed reduce the efforts the listener has to make to evaluate the speaker's utterance.

3. Current study

3.1 Rationale

In Section 2.3, Hu et al.'s (2019, 2022) research on the relation between specialised causal connectives and the effect of subjectivity on prosody has been discussed. They have found that, in Dutch, subjectivity only receives a distinct prosodic pattern when *dus* ('so') is used as a non-specialised connective. In that case, subjectivity is characterised by a lower maximum F0 in the second segment of the causal relation. In the group of speakers who strictly use *dus* as a specialised subjective connective, no distinct prosodic marking of subjectivity has been found, except for a weak indication of subjectivity influencing connective duration. These results are accounted for by means of a trade-off relation between lexicon and prosody, based on the Functional Hypothesis (Haan, 2001) and the Uniform Information Density Hypothesis (Levy & Jaeger, 2007). However, there are three reasons to reconsider Hu et al.'s (2022) findings for Dutch.

In the first place, the studies by Wei et al. (2019) and Canestrelli et al. (2013) on connective processing show that causal relations that involve an SOC are associated with more effortful processing than causal relations that do not. As a result, subjective relations would have been expected to be associated with the speaker slowing down as well. Subjective causal relations would thus be expected to be produced with lower speech rate, longer connective duration or a longer pause preceding the connective, reflecting the time and effort epistemic reasoning takes on the speaker's side, even if the speaker uses a specialised connective.

In the second place, the studies by Den Ouden et al. (2009) and Tyler (2013) show that unambiguous discourse structure in written language still receives prosodic marking when read out loud. Their results indicate that prosody is not only used to disambiguate between different potential meanings of a lexical item. This is also confirmed by the findings of Van Heuven (2017) concerning the prosodic production of questions. The purposes of prosodic marking are broader than disambiguation. As Leitman et al.'s (2010) study shows for affective prosody, using the right prosodic features saves listeners time and effort in evaluating what is communicated. Similarly, subjectivity would be expected to be marked prosodically at all times, following a cooperative communicative principle, even if the connective used is not ambiguous.

Finally, in Hu et al.'s (2022) analysis, the uses of *dus* were analysed in two groups, one of speakers who used it as a specialised connective and one of speakers who used it as a non-specialised connective. However, in everyday communication, listeners do not have access to both the subjective and the objective version of a causal relation. They do not know whether the speaker is using *dus* in its specialised or non-specialised version. Hu et al. (2022) thus investigated the prosody of subjectivity with the choice for a certain connective as an <u>independent</u> variable. However, it is also possible to consider the choice for a certain connective as a <u>dependent</u> variable that changes depending on the source of coherence expressed by the relation. Indeed, Hu et al. (2022) did find very weak support for an effect of subjectivity on connective duration in the group of specialised *dus*-users. Using an improved method, stronger evidence might be found for this effect, which would mean that subjectivity is always prosodically marked, even when lexical means are unambiguous.

As argued above, it would be useful to verify whether Hu et al.'s (2022) results are reproducible with a different method. In their experimental method, there are two peculiarities that might have affected their results. In the first place, the participants were given two full clauses that they had to combine into one sentence using a connective, see example (7) (adapted from Hu, 2021). Both clauses have SVO as their word order while *daardoor* requires the use of VSO. However, *dus* can be combined with both SVO and VSO. In their experiment, the word order

might have been a confounding factor. It might have incited the participants to using *dus*, as it makes the use of *daardoor* more taxing.

(7) a. Jim heeft een neuspiercing laten zetten.
Jim had his nose pierced.
b. Hij bloedde erg.
He bled a lot.

Secondly, the participants were instructed to use either *dus* ('so') or *daardoor* ('as a result'), while there is a third common option, namely *daarom* ('that's why'). As mentioned in Section 2.1, *daardoor* is used to express non-volitional causal relations, *daarom* to express volitional causal relations and occasionally epistemic relations, and *dus* is used with epistemic relations and speech acts, and occasionally volitional causality. In addition, *daarom* is more frequently used than *daardoor* but less frequently than *dus*. When only *daardoor* and *dus* are available to choose from, a middle option is missing, both in terms of subjectivity and in terms of frequency. As a result, participants might have been placed in quite an unnatural situation where they did not have a connective at their disposal for every part of the subjectivity scale. Prototypically speaking, only the outer ends of the scale were covered by *daardoor* and *dus*.

3.2 Research questions and hypotheses

From the remarks on Hu et al.'s (2022) study on the prosodic marking of subjectivity in Dutch, three research questions arise. The first two are similar to the questions investigated by Hu et al. (2022):

(1) What is the effect of subjectivity on prosodic features?
(2) How does subjectivity affect the choice for a connective?

The other research question is new:

(3) How does source of coherence affect word order following *dus*?

With relation to the first question, using the revised method described in the next section, subjectivity is hypothesised to affect prosodic marking. This hypothesis is based on the observation that epistemic relations that involve an SOC are associated with longer processing times (Canestrelli et al., 2013; Wei et al., 2019). The longer processing times could be reflected in, for example, lower speech rate, longer pause duration, or longer connective duration. That would mean that the speaker would slow down in expressing subjective causality, similar to how listeners are slower to perceive subjective causal relations. Moreover, listeners do not know whether speakers are using specialised or non-specialised Dutch. Therefore, speakers would be expected to provide them with prosodic information about the source of coherence. Finally, prosody has been found to reinforce unambiguous discourse structure (Den Ouden, 2009; Tyler, 2013). This finding indicates that prosody does not only have a disambiguating function: it can also reinforce unambiguous structures. This is expected to be reflected in the production of more and larger declination resets (Couper-Kuhlen, 1996), which also entails higher F0 in the second clause of the causal relation.

Secondly, adding stimuli that elicit volitional causal relations with *daarom* would diminish *dus*'s position in certain cases, as it is situated in between *dus* and *daardoor* in terms of

degree of subjectivity. Besides, *dus* is expected to occur less in case of objective causality, as free word order choice is expected to favour the use of *daardoor* in objective cases. The final distribution is expected to be comparable to Table 1 (Chapter 2) which gives an overview of the use of *dus*, *daarom*, and *daardoor* as described by Sanders and Spooren (2015).

In the third place, an interaction is expected between subjectivity and the word order used after *dus*. Main clause word order (SVO) is hypothesised to be associated with subjectivity, given that *want* is a subjective connective that can only be followed by SVO, and that coordinating *omdat* also expresses partially subjective causality (Persoon et al., 2010). Besides, Couper-Kuhlen (1996) found a declination reset at the beginning of the second clause in cases of subjective causality. Both the declination reset and main clause word order are cues of starting a new sentence. Therefore, *dus* is expected to be followed by main clause word order in cases of subjective causality and by subordinate clause word order (VSO) in cases of objective causality.

4. Method

The method used in this study is adapted from Hu et al. (2019, 2022). Just as in their experiment, the participants carried out a dialogue task. However, in the current experiment, the stimuli were different, as no full clause was given for the second part of the causal relation. Instead, the participants were given keywords with which they were instructed to formulate the second clause. The current analysis partially overlaps with Hu et al.'s: the effect of subjectivity on connective use is investigated and comparable prosodic measures are considered. However, the current study additionally observes declination reset, the production of pauses following the connective, and mean F0 instead of minimum F0. In addition, the results are analysed in terms of the effect of subjectivity on word order. Moreover, Hu et al. (2022) made a distinction between the speakers who used *dus* as a specialised connective and those who did not. In the current study, this distinction is not made. Instead, the utterances are analysed by their source of coherence, without considering connective choice as a predictor.

The study has been approved by the Faculty Ethics Assessment Committee – Humanities of Utrecht University (reference 22-066-02).

4.1 Participants

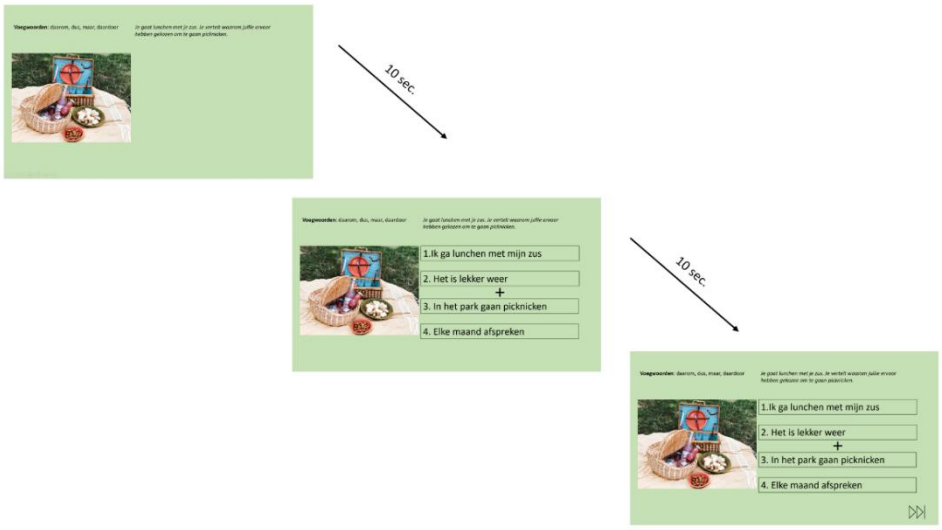
The participants were native speakers of Dutch, recruited through the Utrecht Institute of Linguistics (UiL) OTS participants database. In total, 32 speakers (8 male, 24 female) aged 19 to 64 (median age: 24) participated in the experiment. Two of them were left-handed, none of them had dyslexia. They were paid €12,50 for their participation. One male participant was excluded from analysis because he had trouble carrying out the task as intended.

4.2 Stimuli

The stimuli were comparable to those of Hu et al. (2022) and they were presented in a PowerPoint slideshow. First, a few lines introducing the context, a list of the connectives that the participants could use, and a picture were shown. The short introductions all ended with a phrase following the structure of "You know X about person Y and you say what you think about them" in case of subjective causality and with a phrase along the lines of "Event X took place, you explain how that could have happened" in case of objective causality. After ten seconds, the four text boxes appeared on the screen. After another ten seconds, an arrow appeared in the bottom right of the screen to signal to the participant that the experimenter was ready to ask the first question. The first box contained the answer to the experimenter's first question, the second and the third box had to be combined into the answer to the experimenter's second question, and the fourth and last box was the answer to the last question. To combine the second and the third box into one answer, the participants had to use *daardoor* ('as a result'), *daarom* ('that is why'), *dus* ('so'), or *maar* ('but'). Moreover, in the third and fourth box only keywords were given. The participants were instructed to combine those keywords into full sentences. Only keywords were given in the third box in order to ensure that the participants could freely choose their preferred word order. The fourth box also contained keywords as to not draw too much attention to the keywords in the third box. Figure 2 shows an example stimulus slide.

Figure 2

Timeline of stimulus presentation.



Among the stimuli, there were 14 subjective causal relations, as in (8), and 28 objective causal relations, of which 14 could be classified as non-volitional, see (9), and 14 as volitional causality, see (10). For each type of causality, half of the causal relations had a second segment with positive emotional valence, the other half had a second segment with negative valence. Emotional valence was kept constant in that way in order to control for an effect of the sentence's valence on its prosodic realisation. As discussed in Section 2.4, speaker emotion and the valence of a message tend to be prosodically marked. Besides, there were 40 fillers that elicited the use of *maar*, see (11). In the group of fillers, 13 second segments had positive valence, 12 had negative valence, 15 were neutral. A complete list of all stimuli can be found in Appendix A.

(8) *Q: Wie is Jan? (Who is Jan?)*
1. Jan is mijn buurman (Jan is my neighbour)
Q: Hoe gaat het met hem? (How is he doing?)
2. Ik zag hem net lopen (I just saw him walking by)
3. Nog gezond zijn (Still being well)
Q: Ken je hem goed? (Do you know him well?)
4. Soms over de schutting praten (Talk over the fence sometimes

(Prototypical response for 2 + 3: Ik heb hem net nog zien lopen, dus hij is nog gezond (I just saw him walking by, so he is still well.))

(9) *Q: Wat heb je in het weekend gedaan? (What did you do this weekend?)*
1. Ik ben naar een festival geweest (I went to a music festival)
Q: Was het festival goed georganiseerd? (Was the festival well organised?)
2. De muziek was erg hard (The music was very loud)
3. Piep in oor hebben (Ringing ears)
Q: Vond je het verder wel leuk? (Did you enjoy it otherwise?)
4. Volgend jaar weer willen gaan (Want to go again next year)

(Prototypical response for 2 + 3: De muziek stond te hard, daardoor heb ik een piep in mijn oor. (The music was too loud, as a result, my ears are ringing.))

(10) *Q: Heb je plannen voor vanmiddag? (Do you have plans for the afternoon?)*
1. Ik ga lunchen met mijn zus (I'll have lunch with my sister)

Q: Waar ga je dat doen? (Where will you do so?)
2. Het is lekker weer (The weather's nice)
3. In het park gaan picknicken (Have a picnic at the park)

Q: Doen jullie dat vaker? (Do you do that often?)
4: Elke maand afspreken *(Meet every month)*

(Prototypical response for 2 + 3: Het is lekker weer, daarom gaan we picknicken in het park. (The weather's nice, that's why we'll have a picnic at the park.))

(11) *Q: Wat doet Noah? (What is Noah doing?)*
1. Noah eet spruitjes (Noah's eating Brussels sprouts)

Q: Houdt hij van spruitjes? (Does he like them?)
2. Hij vindt ze niet lekker (He doesn't like them)
3. Ze wel opeten (Eating them anyway)

Q: Wat vindt hij wel lekker? (What does he like?)
4. Wel van tomatensoep houden (Do like tomato soup)

(Prototypical response for 2 + 3: Hij vindt ze niet lekker, maar hij eet ze wel op. (He doesn't like them, but he eats them anyway.))

Although Hu et al. (2019, 2022) designed their stimuli in pairs, with a subjective and an objective counterpart for each item, that is not the case in the current study. Hu et al.'s stimuli were paired in order to analyse the differences between those participants who used *dus* in both versions of the stimulus and those who used it as a specialised connective, treating the choice for a certain connective as an independent variable. However, in the current study, subjectivity does not vary within, but it varies between items. The results are analysed grouped by source of coherence instead of by item and no comparison is made between users of specialised and users of non-specialised *dus*. With subjectivity varying between items, the effect of subjectivity on prosodic marking is analysed regardless of the connective used. Instead, connective choice is treated as a dependent variable that can change depending on the source of coherence and the speaker's preferences.

4.3 Procedure

Before starting the experiment, two pilot studies were conducted to test the suitability of the materials and the feasibility of the task. After the first pilot study, a plus sign was added between box 2 and box 3 to signal that those had to be combined into one sentence, as shown in the last phase of Figure 2, because the first pilot participant indicated that the lack of visual signals confused her. In addition, the written instructions were adapted. The instructions now explicitly stated that adding any other lexical information to the keywords in box 3 and 4 was not allowed, except for what was needed to ensure the grammaticality of the phrase. After the revisions, two participants took part in the second pilot. As a result of observations made in the second pilot, a few spelling mistakes were corrected and the written instructions were once again adapted. Since one of the participants in the second pilot regularly added *ik denk* ('I think') and *waarschijnlijk*

('probably'), the importance of not adding extra words was emphasised once more. The other pilot participant carried out the task as expected.

The main experiment started off with a practise session, consisting of five items. After that, the participant and the experimenter went through the first 41 items of the actual experiment. Then, a short break of 1-2 minutes followed, after which the experimenter asked to continue with the experiment. There were two versions in which the stimuli were presented. Half of the participants were presented with version 1, the other half of the participants with version 2. Version 1 contained all items in a randomised order, except for 4 fillers that were intently placed at the beginning of the experiment, 4 at the end and 2 after the break that occurs midway the experiment. The inverted order of version 1 formed version 2. The two versions were created to avoid effects of order and fatigue on the speakers' responses.

The participants' speech was recorded with the mouthpiece of a Beyerdynamic DT 292/80 Ohm headset. The experiment took place in a sound attenuated booth at the UiL OTS phonetics lab.

4.4 Pre-processing

The target items were annotated in the full recordings with the help of Praat's TextGrids (Boersma & Weenink, 2022). For each target item, both clauses of the causal relation were annotated separately, with the second clause starting at the connective (Hu et al., 2019). In addition, connective and pause durations were annotated separately on a second tier. The third tier contained intervals that corresponded to the last syllable of the first clause and the first syllable of the second clause. These intervals were used to compute the declination reset. Besides the annotation of the recordings in Praat (Boersma & Weenink), a Microsoft Excel spreadsheet was used to indicate the word order and the connective that the speaker used for each item. For word order, only SVO and VSO were mentioned explicitly, variations on these word orders were rare and collected in one residual category. Concerning the connectives, only *daardoor*, *daarom* and *dus* were mentioned in the dataset. Whenever speakers used a combination of the allowed connectives, *maar* or any other connective, their response was marked as 'other'. In addition, some speakers appeared to add the verb *zullen* ('would') to express subjective causality, see (12), despite the fact that they were instructed to only add whatever was needed to make the sentence grammatically correct. This shows that, according to those speakers who used it, this lexical information can be seen as an indispensable to mark subjective causality. Upon this observation, an additional variable was added to provide information about the speakers' use of *zullen*, namely whether they used it always, never, or sometimes in a subjective causal relation.

(12) Hij komt nooit naar college, dus hij <u>zal</u> lui zijn.
He never comes to class, so he <u>would</u> be lazy.

ProsodyPro (Xu, 2013) was used to extract mean and maximum F0 from the intervals marked on the first tier of each TextGrid, corresponding to both clauses of the causal relation. All values were converted to semitones relative to 110 Hz, using the `R` package `hqmisc` (Quené, 2022), using R (R Core Team, 2020) in RStudio (RStudio Team, 2022). In the second place, a Praat script to compute speech rate was used on this tier as well. Both for speech rate and mean F0 there were a number of missing values. Those were corrected by hand. Speech rate was expressed in seconds per syllable (Average Syllable Duration (ASD), e.g., Crystal & House, 1990; Quené, 2008). On the second tier, a Praat script that could extract durations was used to compute the duration of each connective as well as the pauses preceding and following the connective. Finally, another Praat

script was used to get the mean F0s for all marked intervals on the third tier, corresponding to the last syllable of the first clause and the first syllable of the second clause in order to compute the declination reset. After running the script on all sound files, the missing values were corrected again. Next, the frequencies were converted to semitones again. Then, the difference between the first syllable of the second clause and the last syllable of the first clause was computed for each item. Differences smaller than one semitone were excluded and counted as absence of declination reset. In addition, items in which no pause was produced between the first and the second clause were marked as containing no declination reset as well, as declination resets require pauses ('t Hart et al., 1990).

4.5 Analysis

The effect of source of coherence on connective choice, word order, and mean and maximum F0 in both clauses, declination reset between the clauses, speech rate in both clauses, and the durations of the connective and the pauses preceding and following the connective was investigated. For both pause durations and declination reset, there were two variables. The first one was a binary one, indicating whether a pause or declination reset had taken place. If that was the case, the second variable contained the size of the declination reset in semitones or the duration of the pauses in milliseconds.

The relation between source of coherence and the dependent variables listed above was investigated through multi-level modelling, also known as mixed-effects modelling, using the function `lmer` in the `lme4` package for `R` (Bates et al., 2015) in RStudio. Quené and Van den Bergh (2004, 2008) have shown that such models are useful for (psycho)linguistic research as they account for both between-speaker and between-item variation. In addition, no normal distribution of the data is assumed and incomplete datasets can be analysed. In the current study, multi-level models with crossed random effects are used, as random intercepts are added both for speakers and for items. That was done to account for correlated responses within speakers or within items. Also, random slopes based on source of coherence were added to the speaker-based random intercepts to account for the varying ways in which speakers might respond to differences in source of coherence. The speaker-factor includes the speakers' participant number, their biological sex, and whether they use the verb *zullen* ('would') to mark subjectivity (i.e., always, never, or sometimes). The item-factor includes item number, the emotional valence of the message they convey (i.e., positive or negative), and their intended source of coherence (i.e., non-volitional, volitional, or subjective causality). Four different models were used, gradually building up to the model including random slopes based on `condition` (source of coherence) and random intercepts based on `speaker` and `item`, they are given in (13)-(17).

```
(13)  Model 0 <- lm(response_variable ~ 0 + as.factor(condition))
(14)  Model 1 <- lmer(response_variable ~ 0 + as.factor(condition) + (1|speaker)
(15)  Model 2 <- lmer(response_variable ~ 0 + as.factor(condition) +
     (1 + as.factor(condition)|speaker))
(16)  Model 3 <- lmer(response_variable ~ 0 + as.factor(condition) +
     (1 + as.factor(condition)|speaker) + (1|item))
(17)  Model 3b <- lmer(response_variable ~ (1 + as.factor(condition)|speaker) +
      (1|item))
```

The relations between source of coherence and the production of pauses, the production of declination resets, connective choice, and the word order following *dus* were not analysed through multi-level modelling, since multi-level models do not allow for categorical response variables. That is why these relations were investigated through descriptive statistics and chi-squared tests. That means that for these analyses, potential clustering of responses within items or participants was ignored, just like participants' sensitivity to source of coherence.

5. Results

In this chapter, the results of all analyses described in Section 4.5 are presented. In Section 5.1 the relation between source of coherence and prosodic marking is discussed. Section 5.2 is about the relation between source of coherence and connective use. The relation between source of coherence and word order is described in Section 5.3. Finally, since multiple models are used to investigate the effect of source of coherence on the response variables, potential correlation between the dependent variables is not considered. That is why a correlation matrix is provided in 5.4. All figures in this chapter were made using the `ggplot2` package for `R` (Wickman, 2016).

5.1 The effect of source of coherence on prosody

In the first place, the effect of source of coherence on **mean F0** has been analysed. In the first clause, the mean F0 is 8.19 semitones relative to 110 Hz. Comparing Models 0, 1, 2, and 3, as given in (13)-(16), to each other with a Likelihood Ratio Test (LRT) shows that Model 1 is the best model for this variable, see Table 3 in Appendix B. That means that speaker responses were only grouped within speakers and not within items and that they were not dependent on random slopes either. The model reports 8.05 semitones as the average mean F0 for subjective causality, 8.24 for volitional causality, and 8.27 for non-volitional causality. However, all of their confidence intervals are overlapping (i.e., 6.42, 9.69 for subjectivity, 6.61, 9.88 for volitionality, and 6.64, 9.91 for non-volitionality), so there is no effect of source of coherence on mean F0 in the first clause. In clause 2, the mean F0 is a bit lower than in the first clause, namely 6.38 semitones relative to 110 Hz. A comparison of the models yields Model 1 as the best model again (cf. Table 4, Appendix B). The estimates are 6.25 semitones for subjective causality (CI: 4.66, 7.84), 6.44 semitones for volitional objective causality (CI: 4.85, 8.04), and 6.45 semitones for non-volitional objective causality (CI: 4.86, 8.04). The confidence intervals are thus overlapping and the conditions do not differ enough to show an effect of source of coherence on mean F0 in the second clause.

In the second place, the effect of source of coherence on **maximum F0** has been investigated. The average maximum F0 is 11.32 semitones relative to 110 Hz in the first clause. For this variable, Model 3 is the best model (cf. Table 5, Appendix B); it is better than Model 1 but Model 2 is not better than Model 1. That means that some of the responses can be attributed to item-specific characteristics but that speakers' sensitivity to source of coherence does not play a role in their maximum F0. The estimate for subjective causality is 11.24 semitones (CI: 9.62, 12.86), for volitional objective causality it is 11.29 (CI: 9.73, 12.84), and for non-volitional objective causality it is 11.45 (CI: 9.86, 13.04). Those values are very close together and the confidence intervals overlap considerably, so there is no effect of source of coherence on maximum F0 in the first clause. In the second clause, the average maximum F0 is lower than in the first clause, namely 9.95 semitones relative to 110 Hz. In this case, Model 2 is the best model (cf. Table 6, Appendix B). Model 2 yields the following estimates: 11.24 semitones for subjectivity (CI: 9.64, 12.84), 11.29 semitones for volitionality (CI: 9.76, 12.82), and 11.45 semitones for non-volitionality (CI: 9.88, 13.02). As with the other F0-related measures, the values for each condition are very close to each other and the confidence intervals are overlapping. As a result, there is no effect of source of coherence on maximum F0 in the second clause.

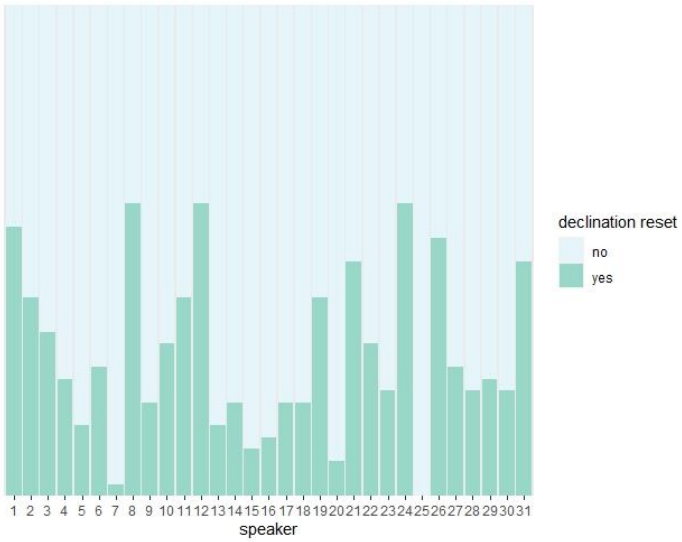
Additionally, the effect of source of coherence on **speech rate** (expressed as average syllable duration, ASD) was investigated. In the first clause, the mean speech rate was 0.29 seconds per syllable. A comparison of the models showed that Model 3 was significantly better than Models 1 and 2 (cf. Table 7, Appendix B). That means that speakers' sensitivity to source of coherence does not affect their speech rate in the first clause, but that their responses are clustered within items. The mean ASD for subjectivity is 0.30 (CI: 0.27, 0.33), for volitionality it is

0.28 (CI: 0.26, 0.31), and for non-volitionality it is 0.29 (CI: 0.26, 0.31). The means of the three different conditions are very close to each other and the confidence intervals are overlapping. As a result, there is no effect of source of coherence on speech rate in the first clause. In the second clause, the mean speech rate is 0.32 seconds per syllable. The best model was Model 2 (cf. Table 8, Appendix B), meaning that responses were clustered within speakers and that they depended on the speakers' sensitivity to source of coherence. Model 2 yields the following ASDs for each of the conditions: 0.29 seconds per syllable (CI: 0.27, 0.32) for subjective causality, 0.33 (CI: 0.29, 0.37) for volitional objective causality, and 0.33 (CI: 0.30, 0.36) for non-volitional objective causality. As in the first clause, the ASDs are close together and the confidence intervals overlap, so there is no effect of source of coherence on speech rate in the second clause either.

In the fourth place, the effect of source of coherence on **whether declination was reset**, and if so, **the size of the declination reset** was investigated. As stated in Chapter 4, for the purpose of this study, a declination reset was defined to occur whenever there was both a pause of at least 10 ms between the first and the second clause and a pitch distance of at least 1 semitone between the last syllable of the first clause and the first syllable of the second clause. This is a rather liberal definition of declination reset, note that if a more conservative definition was used, the results would of course be different. Declination resets as defined here were produced in 29% of the responses. A chi-squared test showed that whether a declination reset was produced was not associated with source of coherence (χ^2 (2) = 0.84, p = .66). Instead, its production was associated with individual speakers (χ^2 (30) = 181.51, p < .001). Note that these analyses do not take into account that responses may be correlated within speakers or items, while this clustering is considered in the multi-level models. As shown in Figure 3, there is considerable variation between speakers. Some of them produce a declination reset in about half of the cases, while there are also speakers who (almost) never produce a declination reset. Concerning the size, the average declination reset was 5.55 semitones relative to 110 Hz. Comparing the three models to each other with an LRT yielded Model 1 as the best model (cf. Table 9, Appendix B). That means that responses are grouped within participants, as previously shown by the chi-square test, but not within items or participants' susceptibility to source of coherence. According to Model 1, the estimate for subjectivity was 5.95 semitones (CI: 4.81, 7.08), for volitional causality it was 5.52 semitones (CI: 4.36, 6.68), and for non-volitionality it was 5.74 semitones (CI: 4.62, 6.87). The declination reset sizes barely differed per source of coherence and the confidence intervals are overlapping. Therefore, there is no effect of source of coherence on declination reset size.

Figure 3

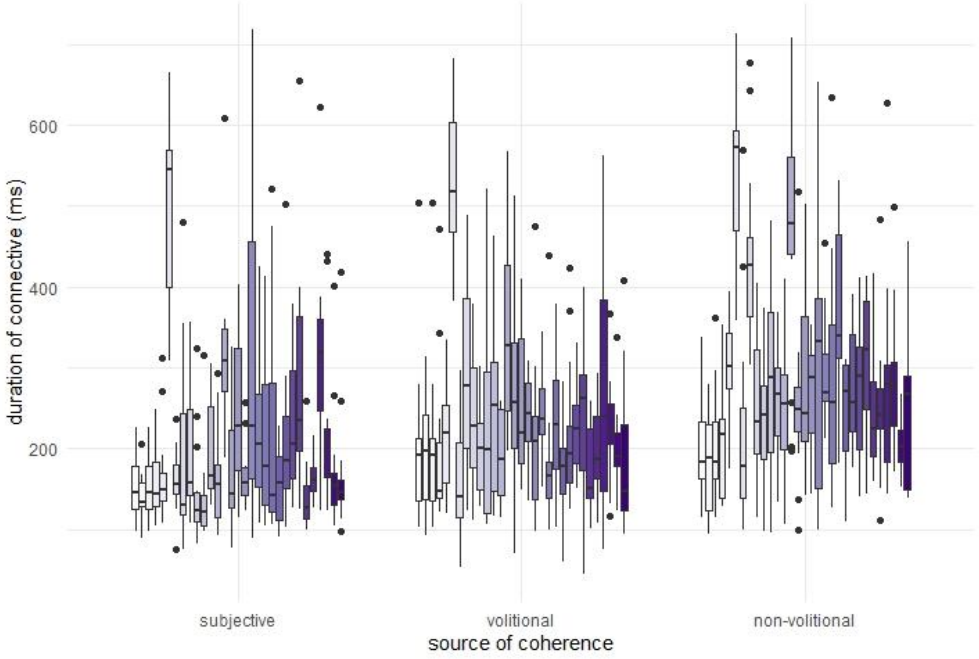
Binary representation of whether a declination reset took place, grouped by speaker.



In addition, the effect of source of coherence on **connective duration** was investigated. The average connective has a duration of 239 ms. In this case, Model 3 is the best model (cf. Table 10, Appendix B), which means that speaker responses are grouped within items and speakers, and that they are affected by the speakers' susceptibility to source of coherence. Model 3 yields the following estimates: 205 ms (CI: 172, 239) for subjective causality, 231 ms (CI: 200, 262) for volitional objective causality, and 281 ms (CI: 247, 316) for non-volitional objective causality. That means that there only is a difference between subjectivity and non-volitionality. There is no significant difference between subjectivity and volitionality or between volitionality or non-volitionality. To verify whether the difference between subjectivity and non-volitionality is caused by an effect of source of coherence, Model 3 (cf. (16)) was compared to Model 3b (cf. (17)) with an LRT (Faraway, 2016). The LRT showed that Model 3 was better than Model 3b ($p < .001$), so source of coherence significantly affects connective duration. This result is represented by Figure 4 where the distribution of connective lengths over speakers and conditions is given. As shown in Figure 4, there is variation between speakers in the way they differentiate between the different types of causality in terms of connective duration but for most of them non-volitional causality has the longest connectives.

Figure 4

Connective duration in ms, grouped by source of coherence. Each boxplot represents a speaker.



Finally, the effect of source of coherence on the **occurrence of pauses** and **duration of pauses** was investigated, both for pauses produced before the connective and pauses produced after the connective. Before the connective, a pause was produced in 81% of the responses. A chi-squared test showed that whether a pause was produced preceding the connective was associated with source of coherence (χ^2 (2) = 16.88, p < .001). As shown in Figure 5, fewest pauses are produced in the condition of volitional causality, more in the subjective condition, and the most pauses are produced in the non-volitional condition. Whether a pause was produced was also associated with individual speaker behaviour (χ^2 (30) = 217.11, p <.001). As Figure 6 shows, there were speakers who produced a pause before every connective but there were also speakers who produced a pause before only half of the connectives. The average duration of the produced pauses was 323 ms. In this case, Model 1 is better than Model 0, but Model 2 is not better than Model 1 while Model 3 is better than both Model 1 and Model 2 (cf. Table 11, Appendix B). As a result, responses are grouped within speakers and items but are less dependent on speakers' sensitivity to source of coherence. Model 3 yields the following estimates: 294 ms (CI: 230, 358) for subjectivity, 319 ms (CI: 253, 385) for volitionality, and 306 ms (CI: 230, 383) for non-volitionality. The confidence intervals are all overlapping and the average pause durations are highly similar to each other. As a result, there is no effect of source of coherence on the duration of pauses preceding connectives.

Figure 5

Binary representation of whether a pause was produced before the connective, grouped by source of coherence.

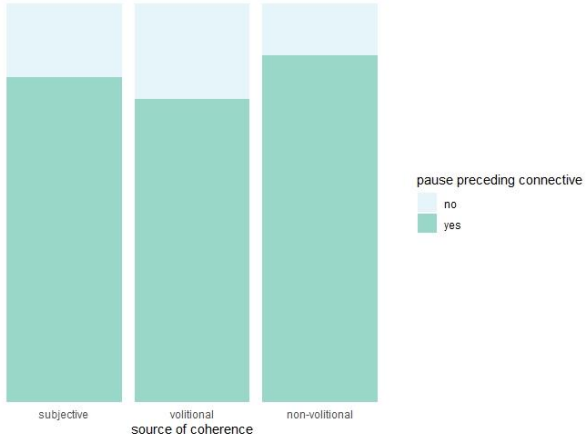
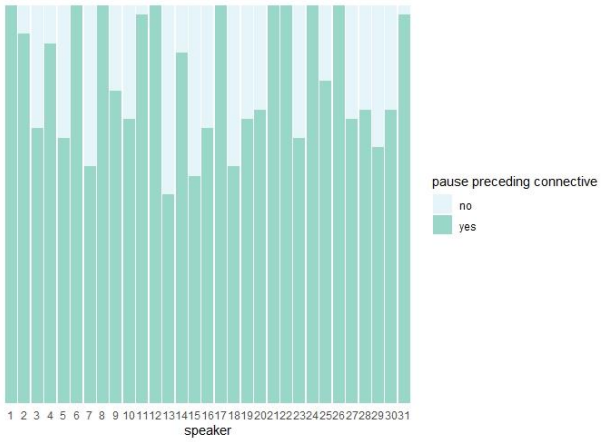


Figure 6

Binary representation of whether a pause was produced before the connective, grouped by speaker.

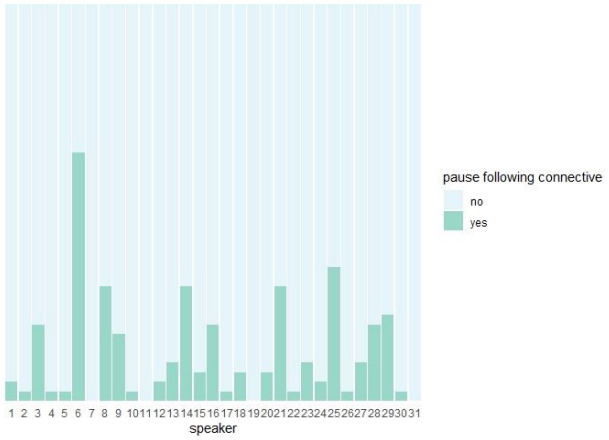


The production of a pause after the connective was considerably less common than the production of a pause before a connective, as it only occurred in 12% of the responses. A chi-squared test showed that whether a pause was produced after that the connective was not associated with source of coherence (χ^2 (2) = 4.87, p = .09). Another chi-squared test showed that the production of a pause following the connective might be associated with individual speaker responses (χ^2 (30) = 228.86, p <.001), but due to the small number of pauses produced (152 out of 1302 items) that estimation may be incorrect. As shown in Figure 7, there were high levels of between-speaker variation. There were four speakers who never produced a pause after the connective and only one who produced a pause following a connective in more than half of the cases. The average duration of the pauses produced after a connective was 282 ms. For this variable, Model 2 was the best model (cf. Table 12, Appendix B), so responses were grouped within speakers – similar to the chi-squared test – and they depend on speakers' susceptibility to source of coherence. Model 2 yields 234 ms as the estimate for subjective causality (CI: 136.16, 332.72), 237 ms (CI: 185.74, 287.82) for volitional causality, and 183 ms (CI: 134.92, 231.49) for non-volitional causality. Although subjective causality has a wider confidence interval that allows

for longer pauses than the other conditions, the confidence intervals are still overlapping and the average pause durations are close together. As a result, there is no effect of source of coherence on the duration of pauses following connectives.

Figure 7

Binary representation of whether a pause was produced after the connective, grouped by speaker.



5.2 The relation between source of coherence and connective use

Moreover, the relation between source of coherence and **connective use** was investigated. Instead of using *daardoor*, *daarom*, or *dus* to express causality, some participants deviated from the instructions and used different connectives, such as *waardoor* ('as a result of which') and *omdat* ('because'). Others used *maar* ('but') or a combination of multiple connectives, e.g., *dus daarom* ('so that's why'), where *dus* is used in a conclusive sense instead of a causal sense. All of them were grouped into one category, called *other*. They made up very little of the total amount of responses, only 1.6%, and most speakers did not use them. Concerning the intended connectives, *dus* was used 55% of the time, followed by *daardoor* (27%). *Daarom* was used the least, making up 17% of the total responses. These frequencies are not comparable to the frequencies found in the SUBTLEX-NL corpus (Keuleers et al., 2010). A chi-squared test showed that which connective was used was associated with the condition (χ^2 (6) = 468.5, p <.001) and also with individual speakers' behaviour (χ^2 (90) = 216.45, p < .001). In Figure 8, between-speaker variation is shown. Figure 9 shows the distribution of connectives over the three types of causality. As shown there, all connectives have been used for every source of coherence, especially *dus* is highly prevalent. In the subjective condition, 81% of the causal relations were made using *dus*. *Daardoor* is used in 10% of the cases, and *daarom* is used in 7% of the cases. In the volitional condition, 55% of the responses contain *dus*, 33% of the responses contain *daarom*, and 12% of the responses contain *daardoor*. The non-volitional causal relations were expressed through *daardoor* in 59% of the cases, through *dus* in 28% of the cases, and through *daarom* in 11% of the cases. These results indicate that although *dus* is mainly used to express subjectivity and *daardoor* to express non-volitionality, the connectives are not fully specialised and they are not always used in accordance with their prototypical distribution.

Figure 8

Connective choice grouped by speaker, with the number of occurrences of each connective.

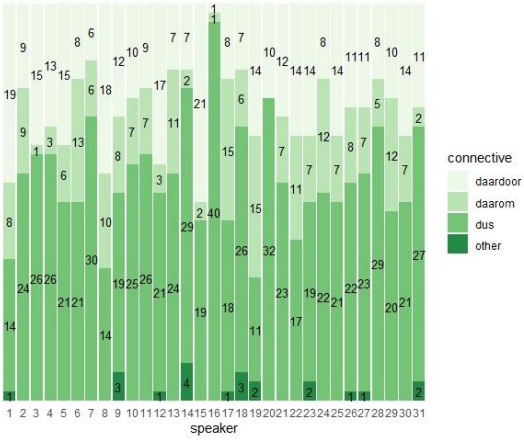
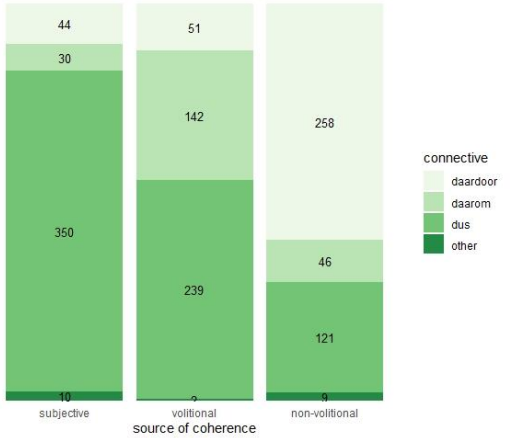


Figure 9

Connective choice grouped by source of coherence, with the number of occurrences of each connective.



5.3 The relation between source of coherence and word order

The last research question was about the relation between source of coherence and **word order**. In general, VSO was used in 49% of the responses, SVO in 46% of the responses, and other word orders in the remaining 5%. The other word orders included VO and OVS. However, *daardoor* and *daarom* only allow to be followed by VSO. Since those connectives are associated with objective causality more than with subjective causality (see Section 5.2, Figure 9), VSO was associated with objective causality while SVO was associated with subjective causality (χ^2 (4) = 195.03, p <.001), see Figure 10. After *dus* speakers can choose whether they want to use SVO or VSO. As shown in Figure 11, SVO is used most often. A chi-squared test shows that there is no association between the type of causality and the word order that is used after *dus* (χ^2 (4) = 6.05, p = .20). As a result, the association between source of coherence and word order as shown in Figure 10 is due to the connectives that are used and that require VSO and is not the result of an actual effect of type of causality on word order.

Figure 10

Word order grouped by source of coherence, with the number of occurrences of each word order.

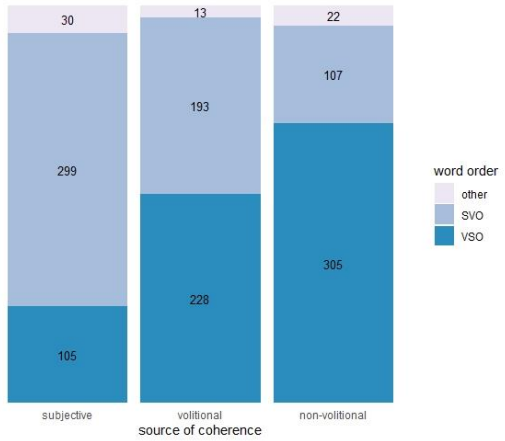
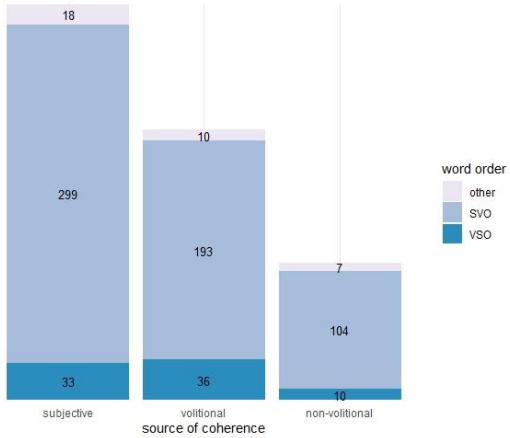


Figure 11

Word order following dus*, grouped by source of coherence, with the number of occurrences of each word order. The height of the bars represents the number of occurrences of* dus *per source of coherence, cf. Figure 9.*



5.4 Correlations between dependent variables

As explained before, the analyses of the relations between source of coherence and all of the response variables were carried out without taking into account that the response variables might correlate with each other. Therefore, a correlation matrix is given in Table 2. Since there were two categorical variables and the numerical variables were not normally distributed. As Table 2 shows, all F0-related measures are correlated with each other. Interestingly, the duration of the first pause correlates negatively with mean and maximum F0, meaning that shorter pauses are associated with lower F0.

Both speech rates also correlate with each other. Other duration-related measures, i.e., connective duration and the length of the second pause, also correlate positively with speech rate in the second clause.

Thirdly, connective choice correlates with connective duration and with word order in the second clause. Connective choice also correlates with mean F0 in both clauses and with maximum F0 in the first clause. Connective duration, on the other hand, only correlates negatively

with mean F0 in the first clause, although connective length and connective choice correlate positively with each other.

In addition, word order correlates positively with connective length, meaning that VSO is associated with longer connectives and SVO with shorter connectives. This is in accordance with the word orders that are associated with the connectives and with the correlation between connective duration and connective choice. *Dus* is most commonly followed by SVO and *daardoor* and *daarom* by VSO. In addition, *dus* is associated with shorter connective duration than *daarom* and *daarom* is associated with shorter durations than *daardoor*. Word order also correlates positively with the length of the first pause, meaning that SVO is associated with shorter pauses than VSO.

Table 2

*Overview of correlations between the dependent variables. Spearman's correlation coefficient is used. Significance codes: ^ = p < .001, * = p < .05*

	Mean F0 c1	Mean F0 c2	Max. F0 c1	Max. F0 c2	ASD c1	ASD c2	Decl. reset size	Connective length	Length pause 1	Length pause 2	Word order	Connective choice
Mean F0 c1	x											
Mean F0 c2	.85^	x										
Max. F0 c1	.85^	.75^	x									
Max. F0 c2	.75^	.79^	.78^	x								
ASD c1	-.004	-.02	-.05*	-.04	x							
ASD c2	-.02	.01	.005	.0005	.08*	x						
Decl. reset	.05	.08	.08	.06	.04	-.03	x					
Connective length	-.06*	-.03	-.02	-.03	-.02	.13^	-.02	x				
Length pause 1	-.23^	-.17^	-.18^	-.15^	-.03	.09*	-.10	.22^	x			
Length pause 2	0.14	.07	.04	.07	.02	.18*	-.18	.08	.02	x		
Word order	-.02	-.03	-.02	-.02	.02	.04	.004	.49^	.12^	.04	x	
Connective choice	.08*	.09*	.07*	.05	-.02	.03	.07	.58^	.08	.06	.74^	x

6. Discussion

6.1 Discussion of results

The aim of this study was to investigate whether Hu et al.'s (2022) results concerning the prosodic and lexical marking of subjective causality in Dutch could be reproduced. In short, their results were not replicated but the hypotheses of the current study were not confirmed either. Instead, no effect of source of coherence on F0, declination reset, the duration of pauses or speech rate was found. There is a potential effect of source of coherence on the production of pauses before the connective and on the duration of connectives, separating non-volitional objective causality from subjective causality.

The first research question was similar to one of the research questions of Hu et al. (2022): What are the effects of subjectivity on prosodic features? The results of the current experiment were hypothesised to provide prosodic evidence for the longer processing times that are associated with subjectivity through longer pauses and connectives, and lower speech rate. Additionally, speakers were expected to produce more declination resets (Couper-Kuhlen, 1996) and higher F0s in the second clauses of subjective causal relations than in the second clauses of objective causal relations. The current results provide no support for these hypotheses. There is no effect of source of coherence on mean and maximum F0, nor on the production or size of declination resets. The finding that none of the F0 measures were affected by source of coherence is consistent with the finding that they all correlate with each other. Whether a declination reset was produced appeared to be speaker-dependent, not condition-dependent. Source of coherence did not affect speech rate or pause duration either. These variables also correlate with each other. However, source of coherence did affect whether a pause was produced before the connective and on connective duration. Although the production of pauses and longer connectives were hypothesised to be associated with subjective causality, in reality they appeared to be associated with non-volitional causality. Because the relation between pause production and source of coherence was tested with a chi-squared test, it is unclear whether the differences between the three types of causality are significant. For the relation between connective duration and source of coherence, there was no significant difference between subjective and volitional causality or between volitional and non-volitional causality, but non-volitional connectives are significantly longer than subjective connectives. As shown in Table 2 (Section 4.5), connective duration correlates with connective choice in such a way that *dus* is associated with the shortest durations and *daardoor* with the longest durations. Since *dus* is most often used to express subjective causality and *daardoor* to express non-volitional objective causality, it is likely that this result would be reproducible when analysing the same data with a model that considers the correlations presented in Table 2. In conclusion, there is no specific prosodic marking for subjective causality but non-volitionality might be marked by more frequent production of pauses and longer connectives.

The second question was also similar to one of the research questions of Hu et al. (2022): How does subjectivity affect the choice for a connective? The proportion of responses containing *dus* was expected to diminish in favour of *daarom*, since *daarom* prototypically covers the middle part of the subjectivity scale. The results of the current study show that connective choice is associated with both speaker preference and source of coherence. *Dus* is mostly used to express subjective and volitional causality while *daardoor* is mainly used to express non-volitional causality. But all connectives are used in all conditions, none of them are fully specialised. In Hu et al.'s (2022) study, volitional and non-volitional causality were considered as one category of objective causality. Their participants used *daardoor* to express 65% of the objective causal relations and *dus* for the remaining 35%. Those results are comparable to the current results for

non-volitional causality (59% *daardoor*, 28% *dus*, 11% *daarom*), where *dus* has been used less in favour of *daarom*. But they are not comparable to the current results for volitional causality (55% *dus*, 33% *daarom*, 12% *daardoor*). The current results for subjective causality also differ from Hu et al.'s results. Their speakers used *dus* to express 98.7% of the subjective causal relations and *daardoor* for the remaining 1.3%. In the current study, 81% of the subjective causal relations contained *dus*, 10% contained *daardoor*, and 7% contained *daarom*. These results show that the position of *dus* has decreased, but not only in favour or *daarom*. It could be the case that *daardoor* and *daarom* are used more in the current study than in Hu et al.'s study because there was no fixed word order influencing the participants' choice for a connective. In general, *daarom* was used least and *dus* was used the most. Since connective use shows strong variation between speakers, it is unlikely that some speakers strictly use certain connectives in their specialised form while others do not do so. Following the Functional Hypothesis (Haan, 2001) and the Uniform Density Hypothesis (Levy & Jaeger, 2007), Hu et al. (2022) concluded that there is a trade-off between lexicon and prosody. Speakers who use non-specialised connectives, use prosodic marking to indicate which type of causality they mean to express, while speakers who use specialised connectives do not need to vary their prosody depending on the source of coherence. By contrast, the results of the current study are not in accordance with the Hu et al.'s conclusion. Hu et al. used Bayesian statistics while multi-level modelling was used in the current study. It is possible but not very likely that a change in statistical method has caused a change in results. Except for potential connective lengthening and more frequent pause production in case of non-volitional causality, no effect of source of coherence on prosodic features has been found. At the same time, no evidence for connective specialisation has been found. Summarising, Dutch does not use specialised connectives nor prosodic marking to indicate which type of causality is expressed, according to the current results.

The third question was new and not previously investigated by Hu et al. (2022) or other researchers: How does source of coherence affect word order following *dus*? Based on work by Persoon et al. (2010), who have found that *omdat* (prototypically objective 'because') followed by SVO gives *omdat* a slightly more subjective meaning, *dus* + SVO was expected to be associated with subjective causality and *dus* + VSO was expected to be associated with objective causality. The current results do indeed indicate that VSO is used more often in objective causal relations, but that is due to *daarom* and *daardoor* requiring VSO. When comparing the word order following *dus* across the three types of causality, it becomes clear that *dus* + VSO is not necessarily associated with objective causality. *Dus* + SVO is most commonly used, regardless of the source of coherence.

In conclusion, the current study does not provide support for a specific word order, nor for specialised connectives, nor for prosodic marking, as characteristics of subjective causality in Dutch. Non-volitional causality is expressed through a more frequent production of pauses before the connective, but those pauses are also produced more often than not in the other types of causal relations. Moreover, connective lengthening is a characteristic of non-volitional causality, but connective duration correlates with connective choice. It could be that other prosodic cues, not investigated in this study, may be associated with the source of coherence, e.g., final lengthening of last syllable of the first clause and/or decreasing speech rate towards the end of the first clause. Another possible indication of subjective causality could be lexical marking as discussed in Section 4.4. In the current study, the use of the modal verb *zullen* ('would') to mark subjective causality was linked to the random factor of `speaker` instead of being analysed for its own relation to prosodic marking or to the use of connectives and word order. A final possibility

is that type of causality is derived from broader contextual cues instead of from cues within the spoken form of the causal relation itself.

6.2 Methodological limitations

One of the main limitations of the current study was the difficulty of the experimental task. Several participants indicated that they had trouble understanding the task at first and that they felt as if they were producing causal relations in a way they would normally not. It is possible that the difficulty and unfamiliarity of the task lead to unnatural speech production. For example, there were multiple speakers who, at times, produced pauses that of > 1000 ms. These pauses are very long and might have been caused by the participants needing some time to figure out the second part of the sentence and how to arrange the keywords into the right order. Similarly, there might be other unknown aspects that were affected by the difficulty of the task.

Secondly, the general nature of the experimental task might conflict with the research goals. In the experiment, the volitional and subjective causal relations that the speakers were asked to produce, might not have aligned with the speakers' own epistemic reasoning and the decisions they would have made. They essentially had to empathise with the reasoning of an unknown other person. The speakers could have envisioned different second parts of the causal relation than they were provided with. As a result, it is plausible that speakers would have voiced their own reasoning differently than they did with the "second-hand" volitionality and epistemic reasoning in the current study.

The third disadvantage of this method was the use of keywords as 'ingredients' for the second clause. The groups of keywords were presented with the verb in its infinitival form at the end of the group of keywords. Importantly, Dutch infinitival verbs have same form as their inflected counterparts that are used with plural subjects. In that sense, it could seem as if the keywords were sentences with OV as their word order that missed a plural subject. SOV is also a valid word order for subordinate clauses, e.g., in a clause following *omdat* ('because'). It is possible that this property was a confounding factor in the process of deciding on word order. At the same time, it was not possible to present the keywords in a different way, as infinitival verbs are by rule positioned at the end of a sentence in Dutch. Additionally, both SVO and VSO require the verb to move up in the syntactic tree and be placed before the object, so it is unclear how large the potential effect on word order really is.

6.3 Recommendations for further research

Given the difficulty of the experimental task and the methodological limitations of the current study described above, it might be useful to investigate the way causality is expressed in Dutch – or other languages – in, for example, a corpus of spoken language. Researching the same questions in a corpus might give a more 'natural' impression of how speakers express causality in their everyday communication when they voice their own (epistemic) reasoning.

Furthermore, this thesis touched upon a number of subjects that could not be investigated within the limits of the current study but that do provide interesting occasions for further research in the field of causal coherence relations. In the first place, in the stimuli of this study *emotional valence* was counterbalanced across the conditions but not tested for its effect on the prosodic marking of and its interaction with source of coherence. Since subjectivity is associated with speakers' inner reasoning and maybe even emotional responses, it is plausible that stronger valence is associated with subjective causality.

In the second place, this domain of research might benefit from a study on the prosody of implicit causal relations, i.e., causal relations without a connective. From the results of the current

study cannot be inferred that source of coherence is never marked prosodically. To investigate whether there is or is not an effect of source of coherence on prosody, it would be useful to investigate speakers' behaviour in implicit causal relations. It could be the case that they feel the need to emphasise the message they are trying to convey through prosody when they have limited lexical means at hand.

Finally, the topic of double connectives was mentioned briefly in Section 5.2. Some speakers used two connectives in the same sentence, e.g., *dus daarom* ('so that's why'), *dus daardoor* ('so as a result') or *en dus* ('and so'). It seems likely that *dus* is used to introduce a conclusion here instead of a consequence. Similarly, *en* seems to introduce a conclusion instead of an additive relation. To my knowledge, this phenomenon has not yet been researched before and it would be interesting to investigate how double connectives that together introduce both a conclusion and a consequence relate to different types of causality.

7. Conclusion

This thesis focused on the replication of the results of Hu et al.'s (2022) study on subjective causality in Dutch. They had found that there was a trade-off between the use of prosody and the use of lexicon in Dutch. In the current study, Hu et al.'s method has been revised in an attempt to simulate a more natural conversational situation. Based on previous studies on causal relations, source of coherence, and connective use, the results of this thesis were expected to show that Dutch does not use specialised connectives and that it uses prosodic marking to indicate which type of causality is expressed. In addition, *dus* followed by VSO was expected to be associated with objective causality.

However, the hypotheses of the current study were not confirmed by the results. Instead, there appeared to be no prosodic indicators of source of coherence in the speakers' responses – except for unlikely effects of non-volitional causality on connective lengthening and more frequent pause production –, word order following *dus* was not influenced by source of coherence, and the connectives appeared to be mainly non-specialised. As a result, it seems that the participants in the current study did not explicitly encode the source of coherence in their speech. As discussed in Section 6.2, it is plausible that the experimental task is not compatible with research on the production of subjective and objective causality. In conclusion, this method is not recommended to be used for further research on the expression of causal coherence relations. Moreover, it remains unclear whether or not there is a trade-off between lexicon and prosody in the expression of subjective causality.

8. References

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Appendix A
Overview of the stimuli that were used in the experiment.

Subjective causality

1. Ik zag hem net lopen / nog gezond zijn
2. Hij komt nooit naar college / lui zijn
3. Ze is het enige kind van haar ouders / verwend zijn
4. Zij geven zelf ook vaak feestjes / het niet erg vinden
5. Hij draagt altijd zwarte kleren / waarschijnlijk somber persoon zijn
6. Hij luistert vaak naar metal / waarschijnlijk niet van Bach houden
7. Hun auto staat voor de deur / buren thuis zijn
8. Zij draagt nooit make-up / niks om haar uiterlijk geven
9. Zij haalt hoge cijfers / studie makkelijk vinden
10. Hij praat vaak met haar / haar leuk vinden
11. Hij praat altijd over zijn hoge cijfers / arrogant zijn
12. Zij heeft haar werk meestal snel af / hard kunnen werken
13. Hij gaat graag wildkamperen / van avonturen houden
14. Hij heeft een drukke baan als kok / geen tijd hebben om het gras te maaien

Volitional causality

1. Het is lekker weer /in het park gaan picknicken
2. Het is voorjaarsvakantie / kinderen thuis zijn
3. Ik ben graag buiten / regelmatig gaan hardlopen
4. Hij wil met haar trouwen / van plan zijn haar ten huwelijk te vragen
5. Toen ik wakker werd, was ik nog moe / besluiten uit te slapen
6. De koekjes waren verbrand / ze weg moeten gooien
7. Al zijn vrienden zijn op vakantie / zichzelf moeten vermaken
8. Op Schiermonnikoog is weinig te beleven / zou er niet willen wonen
9. Er is een braderie / meer mensen op de been
10. Zij ziet opa en oma graag / er wekelijks op bezoek gaan
11. Zij vindt dit feestje niet leuk / vroeg naar huis gaan
12. Hij vindt zijn werk niet leuk / altijd te laat op kantoor zijn
13. Zij kan niet koken / altijd magnetronmaaltijden eten
14. Zij is onzeker / onopvallende kleren dragen

Non-volitional causality

1. Het regent al de hele dag / de straten nat zijn
2. De aarde draait om haar as / verschil tussen dag en nacht bestaan
3. Op de maan is er minder zwaartekracht / er hoger kunnen springen
4. De muziek was erg hard / piep in oor hebben
5. Hij dronk hete thee / zijn tong verbrand hebben
6. Haar computer is vastgelopen / al haar werk kwijtgeraakt zijn
7. Ik geef ze genoeg water / hete zomers overleven
8. Zij werkt erg veel / bijna geen vrije tijd hebben
9. Ik had een drukke dag met veel afspraken / geen tijd hebben
10. Ik had de wekker niet gehoord / verslapen hebben
11. Ik heb er hard voor geleerd / vragen niet moeilijk vinden

12. Het vriest al een paar dagen / ijs stevig genoeg zijn
13. Hij rijdt nu vaker/ ervaren bestuurder geworden zijn
14. Hij maakt elke dag een wandeling / goed ter been blijven

Fillers

1. Hij vindt ze niet lekker / wel opeten
2. Ze is niet naar de winkel om de hoek / naar de markt gegaan zijn
3. Hij woonde eerst in Groningen / pas verhuisd zijn
4. Dat ligt niet in Nieuw-Zeeland / hoofdstad van Australië
5. Hij woont dichtbij / bijna altijd te laat komen
6. Ze wonen allemaal ver weg / broer om de hoek wonen
7. Ze heeft wel ijs gekocht / vergeten het in de vriezer te zetten
8. Ik ben wel op vakantie geweest / niet tot rust gekomen zijn
9. Er is wel een vuurtoren / buiten werking zijn
10. Er is nog wel vertraging / alle treinen weer rijden
11. Hij houdt wel van wandelen / niet ver lopen
12. We zouden gaan zwemmen / nu te moe zijn
13. Zij heeft altijd een boek bij zich / er nooit in lezen
14. Hij zingt goed mee in het koor / geen goede solist zijn
15. We zijn nog niet klaar voor het concert / goede kant op gaan
16. Loofbomen verliezen in de winter hun bladeren / naaldbomen groen blijven
17. Het liefst ga ik met de fiets / vandaag de auto nemen
18. Ik houd het meest van de romantiek / ook van barokmuziek houden
19. Het grootste deel komt van de kringloopwinkel / paar dingen van IKEA hebben
20. Nederlandse roodborstjes overwinteren elders / Scandinavische hierheen komen
21. Sommige kinderen leren dat in groep 2 / meesten in groep 3 beginnen
22. We hebben geen theedoeken meer op voorraad / nog wel handdoeken hebben
23. Er zijn veel meren in Finland / ook veel bossen zijn
24. Eerst dronk ik alleen thee / sinds kort ook koffie lusten
25. Het duurt lang / wel leuk spel zijn
26. Bijna alle Waddeneilanden zijn Fries / Texel in Noord-Holland liggen
27. Het regent nog / wel minder hard waaien
28. We hebben een paar tenoren / niet veel zijn
29. Ik mis het vliegen / blij meer thuis zijn
30. Hij vond het minder leuk / wel lang gebleven
31. Zij woont nu in de stad / liever naar een dorp verhuizen
32. Ze gaan meestal naar Frankrijk / dit jaar naar Italië gaan
33. Marie werkt hard / weinig bereiken
34. De dag is al bijna voorbij / nog niet klaar zijn met werken
35. Ik heb niks met kinderen / neefje wel leuk vinden
36. Ik wilde eerst pasta koken / toch voor curry gekozen
37. Zij houdt niet van jazz / Ella Fitzgerald wel leuk vinden
38. Dit huis heeft geen tuin / wel een balkon hebben
39. Ik houd wel van chocola / witte niet lekker vinden
40. Havermelk wordt steeds populairder / koemelk nog steeds meest verkocht worden

Appendix B

The outcomes of the best multi-level models as discussed in Chapter 5 are given here. All tables were made using the function `tab_model` from the `sjPlot` package for `R` (Lüdecke, 2021).

Table 3

Outcome of Model 1 for mean F0 in clause 1.

	meanf0c1st		
Predictors	*Estimates*	*CI*	*p*
condition [1]	8.05	6.42 – 9.69	<**0.001**
condition [2]	8.24	6.61 – 9.88	<**0.001**
condition [3]	8.27	6.64 – 9.91	<**0.001**
Random Effects			
σ^2	2.43		
$\tau_{00\ speaker}$	21.44		
ICC	0.90		
$N_{speaker}$	31		
Observations	1302		
Marginal R^2 / Conditional R^2	0.000 / 0.898		

Table 4

Outcome of Model 1 for mean F0 in clause 2.

	meanf0c2st		
Predictors	*Estimates*	*CI*	*p*
condition [1]	6.25	4.66 – 7.84	<**0.001**
condition [2]	6.44	4.85 – 8.04	<**0.001**
condition [3]	6.45	4.86 – 8.04	<**0.001**
Random Effects			
σ^2	3.70		
$\tau_{00\ speaker}$	20.12		
ICC	0.84		
$N_{speaker}$	31		
Observations	1302		
Marginal R^2 / Conditional R^2	0.000 / 0.845		

Table 5

Outcome of Model 3 for maximum F0 in clause 1.

		maxf0c1st	
Predictors	*Estimates*	*CI*	*p*
condition [1]	11.24	9.62 – 12.86	**<0.001**
condition [2]	11.29	9.73 – 12.84	**<0.001**
condition [3]	11.45	9.86 – 13.04	**<0.001**
Random Effects			
σ^2	6.63		
$\tau_{00\ item}$	0.27		
$\tau_{00\ speaker}$	20.08		
$\tau_{11\ speaker.as.factor(condition)2}$	0.29		
$\tau_{11\ speaker.as.factor(condition)3}$	0.02		
$\rho_{01\ speaker.as.factor(condition)2}$	-0.42		
$\rho_{01\ speaker.as.factor(condition)3}$	-0.53		
ICC	0.75		
$N_{speaker}$	31		
N_{item}	42		
Observations	1302		
Marginal R^2 / Conditional R^2	0.000 / 0.747		

Table 6

Outcome of Model 2 for maximum F0 in clause 2.

		maxf0c2st	
Predictors	*Estimates*	*CI*	*p*
condition [1]	9.62	8.24 – 11.00	**<0.001**
condition [2]	10.15	8.89 – 11.41	**<0.001**
condition [3]	10.09	8.75 – 11.42	**<0.001**
Random Effects			
σ^2	9.86		
$\tau_{00\ speaker}$	14.61		
$\tau_{11\ speaker.as.factor(condition)2}$	0.46		
$\tau_{11\ speaker.as.factor(condition)3}$	0.44		
ρ_{01}	-0.57		
	-0.29		
$N_{speaker}$	31		
Observations	1302		
Marginal R^2 / Conditional R^2	0.006 / NA		

Table 7

Outcome of Model 3 for speech rate in clause 1.

	speechratec1		
Predictors	*Estimates*	*CI*	*p*
condition [1]	0.30	0.27 – 0.33	**<0.001**
condition [2]	0.28	0.26 – 0.31	**<0.001**
condition [3]	0.29	0.26 – 0.31	**<0.001**
Random Effects			
σ^2	0.01		
$\tau_{00\ item}$	0.00		
$\tau_{00\ speaker}$	0.00		
$\tau_{11\ speaker.as.factor(condition)2}$	0.00		
$\tau_{11\ speaker.as.factor(condition)3}$	0.00		
$\rho_{01\ speaker.as.factor(condition)2}$	-1.00		
$\rho_{01\ speaker.as.factor(condition)3}$	-1.00		
ICC	0.22		
$N_{speaker}$	31		
N_{item}	42		
Observations	1302		
Marginal R^2 / Conditional R^2	0.004 / 0.219		

Table 8

Outcome of Model 2 for speech rate in clause 2.

	speechratec2		
Predictors	*Estimates*	*CI*	*p*
condition [1]	0.29	0.27 – 0.32	**<0.001**
condition [2]	0.33	0.29 – 0.37	**<0.001**
condition [3]	0.33	0.30 – 0.36	**<0.001**
Random Effects			
σ^2	0.03		
$\tau_{00\ speaker}$	0.00		
$\tau_{11\ speaker.as.factor(condition)2}$	0.00		
$\tau_{11\ speaker.as.factor(condition)3}$	0.00		
ρ_{01}	0.99		
	0.99		
ICC	0.16		
$N_{speaker}$	31		
Observations	1302		
Marginal R^2 / Conditional R^2	0.008 / 0.162		

Table 9

Outcome of Model 1 for size of declination reset.

	resetsize		
Predictors	*Estimates*	*CI*	*p*
condition [1]	5.95	4.81 – 7.08	**<0.001**
condition [2]	5.52	4.36 – 6.68	**<0.001**
condition [3]	5.74	4.62 – 6.87	**<0.001**
Random Effects			
σ^2	22.85		
$\tau_{00\ speaker}$	3.99		
ICC	0.15		
$N_{speaker}$	30		
Observations	374		
Marginal R^2 / Conditional R^2	0.001 / 0.150		

Table 10

Outcome of Model 3 for duration of connective.

	connectiveduration		
Predictors	*Estimates*	*CI*	*p*
condition [1]	205.37	172.13 – 238.61	**<0.001**
condition [2]	231.10	199.83 – 262.37	**<0.001**
condition [3]	281.16	246.53 – 315.78	**<0.001**
Random Effects			
σ^2	6765.41		
$\tau_{00\ item}$	1476.94		
$\tau_{00\ speaker}$	5128.89		
$\tau_{11\ speaker.as.factor(condition)2}$	578.30		
$\tau_{11\ speaker.as.factor(condition)3}$	1702.71		
$\rho_{01\ speaker.as.factor(condition)2}$	-0.46		
$\rho_{01\ speaker.as.factor(condition)3}$	-0.16		
ICC	0.49		
$N_{speaker}$	31		
N_{item}	42		
Observations	1281		
Marginal R^2 / Conditional R^2	0.069 / 0.526		

Table 11

Outcome of Model 3 for duration of pause preceding connective.

	pause1duration		
Predictors	*Estimates*	*CI*	*p*
condition [1]	293.88	229.85 – 357.92	**<0.001**
condition [2]	319.21	253.30 – 385.11	**<0.001**
condition [3]	306.36	229.84 – 382.88	**<0.001**
Random Effects			
σ^2	73683.21		
$\tau_{00\ item}$	4863.14		
$\tau_{00\ speaker}$	15603.79		
$\tau_{11\ speaker.as.factor(condition)2}$	2142.75		
$\tau_{11\ speaker.as.factor(condition)3}$	5244.51		
$\rho_{01\ speaker.as.factor(condition)2}$	-0.08		
$\rho_{01\ speaker.as.factor(condition)3}$	0.51		
ICC	0.26		
$N_{speaker}$	31		
N_{item}	42		
Observations	1062		
Marginal R^2 / Conditional R^2	0.001 / 0.262		

Table 12

Outcome of Model 2 for duration of pause following connective.

	pause2duration		
Predictors	*Estimates*	*CI*	*p*
condition [1]	234.44	136.16 – 332.72	**<0.001**
condition [2]	236.78	185.74 – 287.82	**<0.001**
condition [3]	183.21	134.92 – 231.49	**<0.001**
Random Effects			
σ^2	30025.85		
$\tau_{00\ speaker}$	23555.59		
$\tau_{11\ speaker.as.factor(condition)2}$	17548.18		
$\tau_{11\ speaker.as.factor(condition)3}$	11685.20		
ρ_{01}	-1.00		
	-1.00		
$N_{speaker}$	27		
Observations	151		
Marginal R^2 / Conditional R^2	0.022 / NA		