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A Framework to Study the Psycholinguistic Effects of the Grammaticalization of the Future: Empirical Ground Work and Health-Psychological Applications

Dissertation zur Erlangung der Doktorwürde an der Philosophischen Fakultät der Universität Freiburg (CH)

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SUMMARY

The link between language and thought has fascinated researchers well beyond the disciplinary boundaries of psycholinguistics. In 2013, an economics paper by M. K. Chen emerged that found a correlation between grammatical differences in how people refer to the future across countries and their propensity to save for their retirement. The paper was harshly challenged and criticized for its lack of experimental research. Nevertheless, the idea seemed compelling and some researchers began to experimentally investigate this claim. Most of these studies remained within the realm of behavioral economics and their experiments yielded inconclusive results.

In light of this unresolved issue, this thesis focused on changing the experimental approach and applying psycholinguistic methodology, which may be better equipped to identify cognitive mechanisms that could be affected by the grammaticalization of the future. So, the first aim of this thesis was to formulate a theoretical framework that would allow us to hypothesize how grammatical differences in referring to the future influence our mental representations of future events. To achieve this goal, we proposed a theoretical framework (see Chapter 2) that summarized possible linguistic realizations of the future and relied on psycholinguistic hypotheses on language and thought, such as the Thinking-for-Speaking (TfS) hypothesis by Slobin (2003), and we identified several cognitive mechanisms that could be affected by the grammaticalization of the future. These mechanisms pertain mainly to *perceived temporal distance* and *memory*. Further, we chose to add an applied health-psychological perspective as the effects of the grammaticalization of the future on the hypothesized cognitive mechanisms could lead to more effective health messages.

However, the results of the first two studies conducted as part of this thesis (Chapters 3.1 and 3.2) did not confirm the hypothesized effect of the grammaticalization of the future. We found no effect on temporal distance or memory. Hence, in the last study (Chapter 3.3) we adjusted the theoretical framework to redefine the constituents of future time reference (i.e., how we linguistically refer to the future). With this shift in theory also a new cognitive mechanism emerged that could be studied: *probabilistic reasoning*. Again, we tested whether the

grammaticalization of the future affects probabilistic reasoning. This time we found a small effect on the grammaticalization of the future, but not in the way we hypothesized.

Lastly, we discussed methodological and conceptual issues that arose during this thesis and establish concrete measures for future research (Chapter 4). Generally, we concluded that the data from our initial experiments (Chapters 3.1 and 3.2) indicate no effect of the grammaticalization of the future on mental representations of future events. However, by expanding our theoretical framework and adjusting methodological considerations, our last study (Chapter 3.3) showed that the way the future is grammaticalized may affect mental representations of the future in certain contexts and under certain conditions.

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I want to thank everyone who accompanied me along this journey and supported this endeavor. First and foremost, I want to thank Pascal G. for the excellent, competent, and pleasant supervision. I really appreciated the warm and considerate work environment you provided, while still challenging me in becoming a better researcher.

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Of course, I want to thank my support network in Zurich – my friends, family, and partner – who were at times as confused with the topic of my thesis as I was, but who never doubted that I would make it to this point. My special thanks go to my parents, who gave me all the opportunities and support to not only start a thesis but also finish it. And to my partner, who always believed in me, even if sometimes I did not. Thank you for your love and support.

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DECLARATION

I declare that this thesis has been composed solely by myself and that it has not been submitted, in whole or in part, in any previous application for a degree. Except where it states otherwise by reference or acknowledgment, the work presented is entirely my own.

Tiziana Aline Jäggi, 19. September 2022, Fribourg

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LIST OF ABBREVIATIONS

d': D prime

df: Degrees of Freedom

FTR: Future Time Reference

LSH: Linguistic-Saving-Hypothesis

M: Mean

Mdn: Median

OSF: Open Science Framework

p: P Value

SD: Standard Deviation

Std. : Standard

SWH: Sapir-Whorf-Hypothesis

TfS: Thinking-for-Speaking

Var: Variance

INTRODUCTION

1. INTRODUCTION

In 2013, an article from the economist M. K. Chen sparked upheaval among the scientific community, as he allegedly found that differences in grammatical marking related to the future tense across (European) languages were correlated with economic outcomes such as saving behaviors in the corresponding countries. He explained his findings under the *linguistic savings hypothesis* (LSH), which states that languages that do not obligatory mark the future using a future tense (e.g., which may also use the present tense) foster more future-oriented behaviors because the future is considered closer to the present. For example, he found that in Switzerland the German-speaking population on average saved more retirement assets compared to the French-speaking population, attributing this finding to how these languages grammaticalize the future.

This article did not only create traction among other economists who started to publish a series of similar research (S. Chen et al., 2017; Liang et al., 2018), but also surfaced to a broader public via a TED talk (K. Chen, 2013). The linguistic community was not convinced about how the linguistic typology was used and criticized the article harshly in a series of blog posts, for example, for not considering the geographical relatedness of the studied languages (e.g., Dahl, 2013; M. Liberman, 2012). Other researchers then began to question the found correlation and even called it spurious, when considering other important factors, such as the cultural relatedness of these languages (Gotti et al., 2020; Roberts et al., 2015). The demand for experimental evidence grew.

The initial experimental research that materialized from this call for (experimental) action, mainly analyzed behavioral economic outcomes related to intertemporal choice preferences (J. I. Chen et al., 2019; Sutter et al., 2018; Thoma & Tytus, 2018). Intertemporal choice preference thereby refers to preferential differences in decision-making behavior for whether people prefer later and larger rewards or sooner and smaller rewards. Concretely, these experiments examined whether different grammatical future markers would change these preferential decision patterns often associated with financial decisions. However, the researchers were not able to settle this debate, as some researchers found evidence for the LSH (Sutter et al., 2018), and others found results contradicting it (J. I. Chen et al., 2019; Thoma & Tytus, 2018). Thus, the LSH remained contested.

Regardless, the idea that language can influence thought is not new and still seems compelling. Already in the nineteenth century, Wilhelm von Humboldt remarked on the active role of language in shaping different so-called world-views (Stam, 1980). This sentiment remerged in the early twentieth century among the psycholinguistic literature to be known as Sapir-Whorf Hypothesis (SWH; Lucy, 1992a; Stam, 1980; Whorf, 1954). The general idea of the SWH stated that the grammatical differences observed across languages guide language users to make different observations and evaluations of their environment specific to the grammatical structures their language provides. Whorf concluded that through these differences language users "are not equivalent as observers but must arrive at somewhat different views of the world." (1954, p. 221). Although this idea was harshly criticized across the twentieth century, in recent years the idea was popularized again by new methodological approaches and a more refined definition of the SWH (for a historic overview see Lucy, 1992a). For example, Slobin (2003) coined the *thinking-for-speaking* (TfS) hypothesis, which described how grammatical differences can lead to attentional differences that act like a filter depending on what is emphasized or omitted by a language. Recent research supported the TfS hypothesis and showed these specific effects of language in a variety of domains such as spatial relations (Bowerman & Choi, 2001), grammatical gender (Konishi, 1993; Sato et al., 2013) and grammatical aspect (Flecken et al., 2014). Interestingly, *future time reference* (i.e., how the future is marked linguistically; FTR) as a grammatical marker has not yet been investigated within the framework of TfS. However, what has been investigated, is how the abstract nature of time is translated linguistically.

Time is an abstract domain that can only be defined using metonymy, that is in relation to something else, such as the ticking of the clock, which indicates that time is passing (Lakoff & Johnson, 1999). In language, time is usually expressed metaphorically and translated to a concrete domain, particularly space (e.g., TIME IS SPACE; Lakoff & Johnson, 1980). Studies show that temporal notions of time are culture- and language-specific and influence how we think about time (e.g., Boroditsky, 2000). For example, whether the future is in front of you or behind you and whether time passes from left to right or the other way around, relates to how your language encodes these spatio-temporal notions (Fuhrman et al., 2011). This line of research could help us understand the impact of FTR on mental representations of the future. Mental representations are constructed as we process language and are updated as new information is presented (Johnson-Laird, 1983; Kintsch & van Dijk, 1978). Nevertheless, how the future is conceptually

represented in mental representations of future events in relation to FTR, has not yet been investigated.

Hence, the goal of the current thesis was to move the discussion initiated by M. K. Chen's (2013) research in economics to psycholinguistic grounds, which may be better equipped to study these claims using the framework of TfS to evaluate the effect of FTR on mental representations of the future. We tried to achieve this goal by using a theory-driven approach, which adapts to the data gathered from our empirical work. Specifically, a theoretical framework was designed to study the effects of the grammaticalization of the future on mental representations of future events. Here, we were generally interested in identifying cognitive mechanisms that could be associated with the effect of the grammaticalization of the future and thus affect mental representations of future events. Further, we were also interested in possible applications of the proposed effect of the grammaticalization of the future for health-psychological purposes such as producing more effective health messages for prevention behavior.

So, the chapter THEORETICAL FRAMEWORK (Chapter 2) lies the foundation for our proposition by focusing on linguistic realizations of the future, within and between languages. We discuss possible cognitive mechanisms, such as spatio-temporal perception and memory, that are linked to the domain of time. From there we propose research avenues to study the cognitive effects of the grammaticalization of the future. Importantly, we take a look beyond the constraints of psycholinguistic work and find that there is other relevant research to consider. For example, how we think about the future (i.e., the valence of thoughts and their frequency) can be relevant for affective disorders (A. MacLeod, 2017) and how we tweet about the future can be a predictor of how much we engage in health behaviors (Thorstad & Wolff, 2018). These findings emphasize that it may be interesting to explore not only cross-linguistic effects but also within-language effects for applied purposes. We argue that the within-language effect of the grammaticalization of the future could help make health messages more effective.

In the chapter EMPIRICAL WORK (Chapter 3) we present three different studies, some of which are composed of a series of experiments. In the first study, we wanted to establish a proof-of-concept, especially for the within-language effect. In four consecutive experiments we examined the hypothesized effect of the grammaticalization of the future on perceived temporal distance, within French and German as well as comparing the two languages. However, the series of experiments did not support our hypotheses. We discuss that maybe the grammaticalization

of the future does not affect perceived temporal distance as a cognitive mechanism. Therefore, in the second study, we changed our focus and explore whether a different cognitive mechanism – recognition memory – could be affected by the grammaticalization of the future. This second study did already include health-psychological applications as the experiment was based on health-related messages. Here, we studied only German speakers to investigate within-language effects. As in the first series of experiments, we did not find any effect of the grammaticalization of the future.

These two study avenues led us to reevaluate our theoretical framework as to why we did not find any effect of the grammaticalization of the future. Among the various explanations that we provide for the null results that are of methodological nature, we further tested the idea that the effect of the grammaticalization of the future could still be apparent, yet only if *epistemic modality* (i.e., a subtype of modality that pertains to probability) is considered. In fact, this idea is based on Robertson and Roberts (2020) who suggested that FTR is more complex than only considering the grammaticalization of the future tense, since modal constructions are often an important part of FTR. Modality and specifically epistemic modality are often used to mark the future semantically. For example, by using modal verbs (*It* might *rain tomorrow*) or modal adverbs (*It will* definitely *rain tomorrow*) that indicate epistemic modality. However, rather than encoding temporal distance, they encode probability, which we argue could affect cognitive mechanisms related to probabilistic reasoning. We wanted to test this semantic difference in our last study, where we expanded our theoretical framework to account for the entanglement between tense and epistemic modality. We used again a paradigm that would evaluate within-language differences. Our applied angle was to examine the perceived likelihood/probability to develop skin cancer at a certain point in life. The results of this final study were not completely in line with our hypotheses, as we found an effect for epistemic modality and tense, yet no interaction effect.

In the last chapter GENERAL DISCUSSION (Chapter 4) we critically evaluate the research undertaken within our proposed theoretical framework as well as within its extension in the last study. We conclude that although our data suggest to dismiss the idea that the grammaticalization of the future affects mental representation – as our first two experiments indicate – we still suspect that the way the future is grammaticalized could have an effect on mental representations of the future under certain conditions. With these conditions in mind, we

point to future research avenues within the domain of the future time reference and its potential psycholinguistic effects.

THEORETICAL FRAMEWORK

2. THEORETICAL FRAMEWORK: An Interdisciplinary Approach to Understanding the Psychological Impact of Different Grammaticalizations of the Future

Part of the literature review presented in this chapter was published as:

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2.1 Summary

Considering how fundamental and ubiquitous temporal information is in discourse (Zwaan & Radvansky, 1998), it seems rather surprising that the impact of the grammaticalization of the future on the way we perceive the future has only been scarcely studied. We argue that this may be due to its rather abstract nature and how it has been previously operationalized. In this theoretical framework, we lay the foundation for studying the impact of the grammaticalization of the future on mental representations of the future by taking an interdisciplinary perspective, connecting cognitive sciences, linguistics, psycholinguistics, economics, and health psychology. More specifically, we argue that experimental psycholinguistics, combined with more applied domains, constitute a promising research avenue.

2.2 Introduction

A growing body of research has demonstrated that grammatical features differing across languages, such as grammatical gender (e.g., Sato et al., 2013; Sera et al., 1994) or motion event construal (e.g., Athanasopoulos & Bylund, 2013; Flecken et al., 2014), can influence the way in which we mentally represent and perceive the world. However, the role of the future tense in forming mental representations of the world has only scarcely been studied. With this theoretical framework, we review the idea that as grammatical features are spontaneously processed, verb tense – the future tense in our case – is a very salient feature to language users, which, in turn, biases their mental representations (e.g., Slobin, 2003). As such, speakers of different languages

can experience unconscious shifts of focus and mental representations depending on the emphasized grammatical features used to express the future, even though the information conveyed is held constant (Slobin, 2003).

We argue that the grammaticalization of the future, that is, whether languages use a future tense or not to transmit information about future events (Dahl, 2000), has not received the deserved empirical attention. This neglect seems unusual in light of the importance that thinking about the future has in our daily lives: on average, thoughts about the future occur every 16 minutes (D'Argembeau et al., 2011), and their valence and structure can have important psychological consequences (A. MacLeod, 2017).

Although research in economics has addressed some level of psychological effect of the grammaticalization of the future, mainly focusing on behavioral economic outcomes (e.g., M. K. Chen, 2013), experimental evidence is still scarce, although some authors have started to investigate the effect of the grammaticalization of the future in *temporal discounting* (J. I. Chen et al., 2019) and *delayed gratification* (Sutter et al., 2018), both of which will be discussed later. Hereafter, we argue that some experimental paradigms, such as those typical in psycholinguistic research, may constitute a particularly well-suited avenue to address the psychological effects of the grammaticalization of the future.

This theoretical framework first reviews the theoretical and linguistic grounds used to distinguish languages in terms of the way the future is grammaticalized. We then present the mechanisms underlying the construction of mental representations of the future. Finally, we synthesize research on thinking about and referring to the future from different fields to adopt an interdisciplinary framework for future psycholinguistic research on this topic. In highlighting the importance that thinking about the future has in other domains, we offer an overview of the possible impacts grammaticalization could have on the way in which we think about the future. We ground our argument in health-psychological research, which has explored different conceptualizations of thinking about the future. In all, we take an interdisciplinary perspective to motivate future research on how we perceive the future, especially in light of its grammaticalization.

2.3 Linguistic Realizations of the Future

Language provides a set of linguistic features to refer to the future. Within this set, grammatical categories such as verb tense (i.e., location of time of a referred event, e.g., past, present or future tense; Comrie, 1985), aspect (i.e., temporal structure of a referred event, e.g., ongoing or completed event; Comrie, 1976), and modality (i.e., underlying meaning of modal verbs e.g., ability: I *can* go; probability: I *will* go) can be used to mark the future, which is generally referred to as *future time reference* (FTR; Dahl, 2000).

Within a language, FTR varies in that it can be marked in different ways, which range from simple lexical marking, using modal verbs (e.g., in French: *je peux aller à Paris* [I can go to Paris]) or temporal adverbs (e.g., in French: *demain, je vais aller à Paris* [tomorrow, I am going to go to Paris]), to grammatically marked FTR, such as using the future tense incorporated in the verb stem (e.g., in French: *j'irai à Paris* [I will go to Paris]; Bybee et al., 1991; Dahl, 2000).

These different ways of marking the future are connected to an immanent feature of talking about the future, which differs from talking about the past or the present: a degree of uncertainty underlying its content. That is, we know the events took place or are taking place in the present and the past, yet we cannot be sure about the future. This degree of uncertainty can translate into expressing intentions (i.e., transmitted with a notion of control over a situation) or predictions (i.e., estimated probability regarding future situations) and is reflected in the choice of FTR (Dahl, 2000). Intentions usually only require lexical marking of FTR and no obligatory grammatical marking (or no future tense; e.g., in French: *la semaine prochaine, je vais à Paris* [next week, I *go* to Paris]), at least within European languages (Dahl, 2000). However, predictions vary much more across languages in their FTR marking (Bybee et al., 1991).

Besides distinguishing between intentions and predictions, temporal context also serves as an indicator of how to mark FTR, especially if a language has several possibilities of grammatically marking FTR. For example, in French one can add a suffix to indicate an inflectional future construction (e.g., *j'ir**ai** à Paris* [I will go to Paris]; composed by a word stem and the suffix *-ai* indicating future tense). Although, depending on the context, one can also use the de-andative periphrastic construction; in other words, *aller* [to go] + infinitive (e.g., *je vais aller à Paris* [I am going to go to Paris]; Dahl, 2000). The temporal context of future events determines which future construction is used. Accordingly, the choice between periphrastic and inflectional constructions depends on how proximal or distant a future event is. Proximal future events are commonly expressed using periphrastic future constructions and are likely to represent intentions (e.g.,

French: *demain, je vais travailler à la bibliothèque* [tomorrow, I am going to work at the library]). Distant future events are expressed using inflectional future constructions and are likely to represent predictions (e.g., French: *la saison prochaine, la grippe frappera durement* [next season, the flu will hit hard]).

Interestingly, variations in lexical and grammatical marking of FTR can be explained by two different patterns, which evolve diachronically within languages and is referred to as grammaticalization of FTR (Bybee et al., 1991). The first pattern pertains to semantic changes of usual lexical FTR markers through different stages of grammaticalization. Across these stages, the modality of a verb changes as grammaticalization progresses. For example, the original meaning of *shall* was *'to owe'*, thus derived from an obligational modality; nowadays, *shall* can be used to signal intentional modality (e.g., *I shall get to Paris as soon as I can*). Through grammaticalization of FTR, the meaning of such modal verbs switches from indicating desire, obligation, or ability to signal intention to eventually indicating probability. The second pattern is characterized by the process of formal reduction of the FTR markers over time; in other words, constructions using modal verbs will shorten to morphemes incorporated into the verb stem over time. In French, for example, two such constructions exist at the same time, marking different degrees of grammaticalization (e.g., *je vais aller à Paris* [I am going to go to Paris]; *j'irai à Paris* [I will go to Paris]).

For cross-linguistic comparisons, it is important to consider these stages of grammaticalization (Bybee et al., 1991). Some languages are considered to be in an early stage of grammaticalization, as they only use lexical marking to refer to the future. We consider these languages to have a low degree of FTR (i.e., no future tense) as opposed to languages with grammatical marking of FTR (i.e., some form of inflectional future construction), following M. K. Chen (2013). According to the World Atlas of Language Structures (WALS), about 50% of languages have developed inflectional future constructions, meaning a high degree of grammaticalization of FTR (Dahl & Velupillai, 2013). In other languages, FTR expressions often show lower degrees of grammaticalization, such as periphrastic future constructions (e.g., English) or no future tense construction at all (e.g., Indonesian).

Although a formal classification of grammaticalization of FTR constitutes an initial reference point when designing cross-linguistic experiments, different classifications do exist, from dichotomizing FTR (e.g., high vs. low FTR; see M. K. Chen, 2013) to defining FTR as a

continuous variable (e.g., differentiating between high and low FTR based on topographical features of languages; see Thoma & Tytus, 2018). Importantly, we would argue that these boundaries are not precise, as the classification of some languages have been controversial (see, for example, Radford (1997) for further discussion on English).

2.4 Considering Cognitive Implications of the Grammaticalization of the Future

2.4.1 'Thinking-for-speaking' hypothesis

To address possible effects of FTR grammaticalization on cognition, we argue that Slobin's (e.g., 2003) Thinking-for-Speaking (TfS) hypothesis is particularly well adapted. This hypothesis states that as we prepare ourselves to verbally formulate our ideas, we tend to focus on information that is highlighted by the linguistic features specific to a language (e.g., future tense vs. no future tense). Through constant exposure to a given language, speakers' attention is inevitably directed towards these linguistic features (e.g., present and future are different vs. no linguistic distinction), making them particularly salient. Some have argued that these processes are especially strong with conceptual distinctions that are grammaticalized rather than lexicalized (e.g., Lucy, 1992a).

Consequently, FTR grammaticalization may lead to different mental representations of the same future events across speakers of different languages (i.e., languages with different degrees of FTR). Different mental representations of the same future events may even be found within a language (i.e., lexical vs. grammatical marking). This, however, does not necessarily mean that different linguistic features lead to changes in real-world cognition or in general perceptual processes, but that it has an effect on the way we construct, and the content of, mental representations of different events during the processing of linguistic information (Slobin, 2003). Evidence for the 'thinking-for-speaking' hypothesis can be found in other domains such as spatial relations (e.g., Bowerman & Choi, 2001), grammatical gender (e.g., Konishi, 1993; Sato et al., 2013) as well as motion event construal (e.g., (Athanasopoulos & Bylund, 2013; Flecken et al., 2014). To our knowledge, no research on linguistic features indicating FTR and their effect on mental representations has been conducted so far.

2.4.2 Temporal cognition

Thinking-for-speaking can help us to distinguish cognitive domains that are important to study in order to understand the impact that the grammaticalization of the future has on mental representations of future events. However, we need to draw ideas from existing research on temporal cognition to arrive at possible cognitive conceptualizations of time and of the future to ground our work. A fundamental notion is that time is *spatialized* in language as time metaphors (e.g., Evans, 2003; Núñez & Cooperrider, 2013), meaning that the vocabulary used to talk about time is often borrowed from spatial concepts (e.g., *time passes, time flows* or *the time has arrived*). These time metaphors distinguish between two different ways in which time is considered to move; either with the person themselves (e.g., *the past lies behind me*) or independent of a person's position (e.g., *June comes after May*). The directionality of these movements varies across cultures (Fuhrman et al., 2011). Research on time found evidence that the temporal information, considered as being abstract, is cognitively organized within concrete spatial concepts (Boroditsky, 2000). Within this spatial conceptualization of time, the future is conceptualized as *lying in front/being ahead of us* (at least in English and French; see, for example, Bylund et al., 2019). This conceptualization not only influences our general conceptualization of time, but can be activated without using language, suggesting a perceptual basis in the representation of time (Casasanto & Boroditsky, 2008).

Although we may assume that the grammaticalization of the future can impact or touch on the perceptual nature of time, the same way time metaphors do, this idea is only speculative at the moment. However, some research on how other temporal information is processed when comprehending text does exist and will be presented next. Although not directly targeting the grammaticalization of the future, we argue that such research offers an interesting platform to study its impact on the representations of time. In the same vein, the following section focuses on future conceptualizations and the role of memory for imagining the future. With these two sections, we aim to introduce a new perspective on the possible cognitive conceptualizations of the future, with a particular focus on its grammaticalization.

2.4.3 Mental representations of time

Although the term mental representation embodies a multitude of concepts, we refer to it as the cognitive construct of life-like representations of the world, such as those initially

presented by the seminal works of Johnson-Laird (1983), or Kintsch and van Dijk (1978). While the presentation of the theories and controversies pertaining to mental representations goes beyond the scope of the present chapter, it is crucial to understand that mental representations are built through an interaction between the environment (e.g., text, discourse) and the receiver (e.g., reader, listener). To illustrate this, let us consider the sentence *Olivia and George are planning their summer holiday*. In a nutshell, at a surface level of representation, the words and meaning that constitute the sentence are encoded. This level is of special interest for us, as grammatical realizations of the future may be first encoded at this level. We then use this information to build a coherent representation of what the text entails. In this representation, we further add implicit elements that are derived from our general knowledge and that directly interact with the elements already incorporated in our mental representation. For example, since the sentence uses *planning* and mentions *summer*, we can infer in a spontaneous manner that (a) Olivia and George have not yet been on holiday, and (b) It is not *summer* yet. As such, the temporal information *spring* may be encoded, to the extent that readers may even think it was explicit in the sentence.

In fact, temporal information has often been suggested as being part of the dimensions necessary for (text) comprehension (e.g., Zwaan & Radvansky, 1998). Zwaan and Radvansky (1998) stress the ubiquitous nature of temporal information, as even when no temporal cues are mentioned, readers follow the *iconicity assumption*, meaning that they always assume a temporal order (e.g., the narrated order of events is expected to match their chronological order). Others have also discussed the rather central nature of temporal information. In fact, earlier, Zwaan (1996) studied the effect of concretely mentioned temporal cues (e.g., *in an hour*), and showed that reading times increased when processing long time shifts (e.g., *an hour later*) compared with short time shifts (e.g., *a minute later*). Anderson et al. (1983) also showed that readers accessed concepts that were read earlier more efficiently when the shift was congruent with the situation described in the text (e.g., *one hour later at the restaurant*) compared to temporal shifts incongruent with the situation described in the text (e.g., *seven hours later at the restaurant*). Zwaan (1996) confirmed these findings by showing that readers have facilitated access to concepts if they are described within the same time frame as the central situation being depicted.

Other temporal cues, namely grammatical tense and aspect markers, have also attracted some attention in the realm of mental representations (e.g., Becker et al., 2013; Carreiras et al.,

1997; Ferretti et al., 2009; Madden & Zwaan, 2003; Magliano & Schleich, 2000). Magliano and Schleich (2000), for example, showed participants narratives that described protagonists in actions that were described either with a perfective or imperfective aspect (i.e., completed vs. incomplete action). When asked about these actions, participants perceived the actions in the imperfective aspect as ongoing and the actions described with the perfective aspect as completed. These results indicated that aspect markers provided processing instructions for the construction of mental representations. Carreiras et al. (1997) investigated the effect of past and present tense markers on mental representations. Participants read paragraph-long narratives with one critical sentence presented in either the past or present tense. After the critical sentence, a test word was presented either directly, after one filler sentence or after two filler sentences. Participants were asked whether the test word was or was not presented in the preceding text. Results showed that they responded (correctly) more quickly when the test word had been presented in the sentence in the present tense compared to the past tense, suggesting that the information in the present tense was better integrated into participants' mental representations of the narratives. These results document how temporal information is integrated into mental representations and that different temporal cues can impact mental representations differently, emphasizing the importance of studying the impact of the grammaticalization of FTR in mental representations.

2.4.4 Perceptual representation of time

Mental representations, such as those discussed so far, are not simply constructed via verbal encoding, but their contents may well include perceptual information too. Many have studied such properties, showing that when readers comprehend a text (or discourse more generally), they access perceptual and action-related representations of the described situation (e.g., Barsalou, 1999; Zwaan, 2004; Zwaan & Rapp, 2006). This is true for concrete concepts such as performed actions (e.g., Glenberg & Kaschak, 2002; Zwaan & Taylor, 2006) or an object's form (e.g., Stanfield & Zwaan, 2001; Zwaan et al., 2002) but also for abstract concepts such as emotions (e.g., Havas et al., 2007), speed (e.g., Fecica & O'Neill, 2010; Speed & Vigliocco, 2014), space (e.g., Dudschig et al., 2012), and most importantly here, time (e.g., Boroditsky, 2000; Casasanto & Boroditsky, 2008). This is not surprising, as those studying metaphors have suggested that seemingly abstract concepts such as time are often translated into concrete ones that have a

perceptual basis, such as in “time is a moving object” and “we move through time” (e.g., Casasanto & Boroditsky, 2008; Lakoff & Johnson, 1980).

While research on temporal information in mental representations can help us understand what impact the grammaticalization of the future could have, we still lack information on how the construction of the mental representation is manifested and would thus be conceptualized in an experimental setup. We argue here that research on memory and the future helps further untangle this question and offers some interesting avenues.

2.4.5 Research on memory and future events

Although memory is usually associated with past events, it plays an important role when mentally representing the future. In fact, although the term future is not always presented as such in this domain, concepts such as *prospection*, broadly defined as mentally representing possible future outcomes (e.g., Gilbert & Wilson, 2007), offer us some insight into the possible mechanisms underlying the construction of mental representations of future events. Szpunar et al. (2016), for example, developed a taxonomy of prospection, documenting the many ways one can think of the future. The authors mainly identified four modes of thinking about the future: *simulation* (constructing a comprehensive mental representation of the future), *prediction* (estimating the likelihood of an event in the future), *intention* (determining a goal), and *planning* (organization needed in order to reach a goal). Each mode of thinking about the future is divided into episodic and/or semantic processes. Episodic memory is considered necessary when thinking about a specific autobiographical event in the future (e.g., *I will take some holidays*), semantic memory is relevant for general or abstract future events (e.g., *because of global warming, heat waves will hit us every year*).

Szpunar et al. (2016) highlighted the occurrence of hybrid forms between episodic and semantic memory, which manifest as mental representations based on autobiographical information without a concrete nature (e.g., *I will play an important role in science*). More relevant for our present argument, Szpunar et al. (2016) highlighted the importance of episodic memory, and others have suggested episodic memory to be temporally organized (e.g., Cohn-Sheehy & Ranganath, 2017). Consequently, episodic memory represents events occurring in close succession, at least compared to more distant ones (e.g., Howard & Kahana, 2002; Jenkins &

Ranganath, 2010) and people recall items with closer temporal proximity better (e.g., Polyn & Kahana, 2008).

In all, we suggest that different grammaticalizations of the future should lead to different memory structures and that this is grounded in the way future events are represented. For example, it is possible that the grammaticalization of the future can influence whether temporal information is processed as semantic or episodic memory. For example, some abstract information (i.e., semantic memory), such as *Because of global warming, heat waves will hit us every year*, could well be encoded as more concrete (i.e., episodic memory) if only weak FTR marking is used. We could further hypothesize that cross-linguistic differences in FTR might impact the way in which such information is (a) processed, (2) retained in terms of memory structure, and (c) subsequently acted upon. We now turn to some indirect empirical evidence to support our perspective.

2.5 From Economy to Health-Psychology: The Explored and the Unexplored

2.5.1 Linguistic-savings hypothesis (LSH)

Previous parts of this chapter laid the theoretical foundation to understand relevant processes when thinking about the future as well as the pivotal role grammaticalization of the future may play within these processes. In this section, although we focus on direct applications of this grammaticalization, mainly documented in economic research, we also aim to extend the ideas presented so far to health-psychological domains. Of course, we hope that our considerations will inspire researchers to investigate these concepts more broadly, but we believe that they are particularly relevant for the domains we present next.

In his original paper on the link between FTR strength and the representation of the future, M. K. Chen (2013) compared different behavioral indexes, such as saving money, having retirement assets, or adopting healthy behaviors, between countries with different degrees of FTR in their corresponding language. Through his *linguistic-savings hypothesis* (LSH), he argued that people speaking languages with a higher degree of FTR were less likely to engage in future-oriented behavior. More explicitly, he suggested two possible underlying mechanisms: first, the distance to future events is perceived differently between language groups (i.e., in terms of high vs. low degree of FTR) and second, the concreteness of how future events are perceived between language groups differs. Through greater distance and less concreteness for speakers with a

higher degree of FTR, thinking about the future is detached from thinking about the present. To distinguish whether a language was considered to have a high or low degree of FTR, he used a dichotomous criterium (adapted from Dahl, 2000): a low degree of FTR was attributed to languages that do not require the verb tense to mark the future (i.e., weak FTR) in a prediction-based context, whereas a high degree of FTR was attributed to languages that require the verb tense to mark the future (i.e., strong FTR) in a prediction-based context. He found a significant effect of the degree of FTR on behavioral indexes and showed that these effects were independent of other economic or demographic factors (e.g., socio-economic status or origin of the legal system in the corresponding country).

Other studies have shown evidence for the LSH, examining *corporate savings behavior* (S. Chen et al., 2017), *corporate responsibility* (Liang et al., 2018), and *research and development investment* (Liang et al., 2018; Su et al., 2016). All three domains operationalized the degree of FTR according to M.K. Chen's (2013) dichotomized weak/strong FTR, although Liang et al. (2018) additionally used alternative operationalizations (i.e., inflectional FTR vs. any FTR to code a high degree of FTR). As dependent variables they used variables of different panel data following M. K. Chen's (2013) approach, finding significant negative correlations between FTR and their respective dependent variable.

Further, the LSH was confirmed by research concerning *pro-environmental attitudes* (S. Kim & Filimonau, 2017), *environmental behavior and policies* (Mavisakalyan et al., 2018) as well as *future-oriented policies in general* (Pérez & Tavits, 2017). Mavisakalyan et al. (2018), for example, followed M. K. Chen's (2003) setup, using panel data from the *World Values Survey*, finding speakers of weak FTR languages to be more willing to engage in costly pro-environmental actions, which was also evident across all countries (e.g., more climate change policies). Kim and Filimonau (2017) assessed pro-environmental attitudes between Mandarin (weak FTR) and Korean (strong FTR) speakers using an online questionnaire. They found significantly higher pro-environmental attitudes in Mandarin speakers suggesting a higher perceived urgency in pro-environmental topics when speaking a weak FTR language (i.e., the future was perceived as being closer). Pérez and Tavits (2017) randomly assigned Russian-Estonian bilinguals to either submit a survey about a "green tax" in Russian or Estonian (strong vs. weak FTR respectively) and found that answering the Estonian questionnaire led to more support for the "green tax", even after controlling for political conviction.

Although many authors found M. K. Chen's (2013) idea quite promising, others have raised some concerns as to the validity of the LSH. For example, Roberts et al. (2015) argue that M. K. Chen's (2013) results could likely be a statistical artifact from big data analyses, as cultural traits were not factored into the analyses. Hence, they re-analyzed M. K. Chen's (2013) data adding the geographical and historical relatedness of languages as factors and found that the correlations no longer yielded significant results when applying the strictest test of relatedness of languages, suggesting that M. K. Chen's (2013) correlations may have been spurious. Additionally, the operationalization of the dichotomous weak vs. strong FTR can be criticized, given that information from the continuous variable is lost and the threshold between weak vs. strong FTR seems arbitrary from a linguistic point of view (e.g., what would be considered as future tense, periphrastic vs. inflectional forms). Note that this criticism can be generally applied to all studies dichotomizing continuous concepts. Although presenting a detailed account of this issue goes beyond the scope of this chapter, we urge researchers to keep such issues in mind.

Roberts et al. (2015) also suggested that experimental paradigms are better suited to investigate the effect of grammaticalization on mental representations of the future, which others have done. Sutter et al. (2018), for example, conducted a study in a bilingual city with primary school children assessing their intertemporal choice preference and compared it between the two language groups (German – weak FTR and Italian – strong FTR). They found that German-speaking children preferred later-larger outcomes significantly more often than their Italian-speaking peers, supporting M. K. Chen's LHS. J. I. Chen et al. (2019) conducted an experimental study with Chinese-speaking participants from Singapore and Taiwan. As in Chinese there is no obligatory marked FTR, speakers tend to use two FTR forms, the present tense and a future construction. They set up an intra-linguistic study, presenting participants with the two FTR conditions (using the present tense vs. using the future construction, which can be built according to the English "will + infinitive"-structure) and randomized the conditions in a time preference task. The results did not yield statistical significance but showed a trend in the direction opposite to the LHS. Namely, participants seem to prefer smaller rewards when presented in the future tense and bigger ones when presented in the present tense. It remains unclear whether the trend found constitute a true signal of a possible effect or whether it was only spurious. More experimental research is necessary to clarify these findings.

Interestingly, research investigating the co-evolution of economic and cultural factors found that long-term orientation may have developed as a consequence of pre-industrial crop return (Galor et al., 2016). Long-term orientation hereby refers to a cultural orientation that values future rewards (Hofstede, 1991). Concretely, higher crop return in pre-1500 AD in different geographical regions was linked to higher long-term orientation in those regions, suggesting that a surplus in resources elicited a process of planning for the future. In a subsequent study, Galor et al. (2018) directly linked higher crop return in pre-1500 AD to the existence of periphrastic future tense in languages, finding that periphrastic future tense was more likely to be derived in regions associated with higher crop return in pre-1500 AD and higher long-term orientation. Long-term orientation, however, is not conceptualized as a construct that may easily apply to individuals, as it refers to a value found within cultures (Hofstede, 1991). This means that it cannot be adopted in experimental studies examining the effect of the grammaticalization of the future in mental representations. Hence, similar measures, such as temporal discounting, which will be discussed in the next section, have been proposed.

2.5.2 Temporal discounting

Temporal discounting and *future time perspective* are concepts that, although primarily used in economic research, have also been applied to health psychology. Both measures address, at an individual level, the way we think about future outcomes (e.g., Teuscher & Mitchell, 2011). Temporal discounting defines a tendency to devalue rewards in the future compared to rewards in the present, even if the rewards are the same, or even larger in the future (e.g., Chapman & Elstein, 1995), whereas future time perspective broadly refers to the sum of a person's thoughts towards the future within a specific time frame (Lewin, 1951). Both concepts have been widely studied indicating correlations with various health related outcomes such as well-being, substance use and physical exercise (e.g., future time perspective: Kooij et al., 2018; temporal discounting: Story et al., 2014). Namely, those preferring later rewards can be characterized as driven by long-term outcomes. In fact, temporal discounting has even been proposed as a potential behavioral marker for addiction (Bickel et al., 2014), as those suffering from diverse addictions have been shown to prefer short-term over long-term rewards than those without any addiction (Bickel et al., 2007), except for coffee addiction (Jarmolowicz et al., 2015). Thoma and Tytus (2018) adapted the temporal discounting paradigm to investigate the effect of the

grammaticalization of the future on perceiving future outcomes. Unlike previous studies, they operationalized FTR strength as a continuous variable and examined five languages ranging from a low degree of FTR to a high degree of FTR (in increasing FTR order: Chinese, German, Danish, Spanish, English). Participants read ten decision scenarios and had to choose either sooner-smaller or later-larger economic and health-related outcomes (e.g., *Your doctor recommends to eat more healthily in order to lower your BMI*: *ignore advice, enjoy good food and live now* or *take advice, change diet and lower your BMI for the next visit*). Across all languages, they found a bias towards the later-larger condition; against their expectations, speakers of a high degree of FTR languages showed a bigger bias for later-larger choices. The authors argue that this result is due to the hypothetical nature of the decision scenarios leading participants to answer in a more biased manner. In all, although these studies represent promising avenues of research, their results are not yet conclusive as to the impact of future grammaticalization on the way we perceive the future.

2.5.3 Mental time travel

Another line of research in the health-psychological context has focused on mental time travel, which refers to imagining one's own future as vividly as possible (e.g., (A. MacLeod, 2017), yet it has never addressed the possibility of focusing on different grammaticalizations of the future. The concept of mental time travel has been studied regarding well-being, depression, and anxiety, especially focusing on patterns of positive and negative thoughts related to the future (e.g., A. K. MacLeod & O'Conner, 2018). For example, in healthy controls, positive thoughts about the future are related to positive affect, but not negative affect. Vice versa, negative thoughts about the future are associated with negative affect, but not positive affect. Compared with healthy controls, in clinically depressed patients, positive thoughts about the future are reduced, whereas the amount of negative thoughts about the future remains unchanged (MacLeod & O'Conner, 2018). Research combining mental time travel and the grammaticalization of the future may be eventually applied when developing interventions to reduce depressive symptoms. More specifically, given that the mental processes discussed so far may prove to be relevant, verb tense (or other markers for that matter) may well trigger different processes depending on the temporal distance they imply. This could be of relevance either for multilingual or for monolingual patients within their own language. For the latter patients, this will depend on the very existence

of different FTRs within the language, and possible effects may well be explained in terms of *framing effects* (as discussed by Gross (1998) in relation to emotion regulation). For the former group, the issues at stake are reminiscent of those discussed by Monaco et al. (2019) on the clinical effects linked to embodied cognition in L2 (i.e., non-native language). Namely, many clinical professionals deal with migrant populations compelled to interact in L2. Research on the impact of these interactions, in terms of embodiment (e.g., Monaco et al., 2019), or in terms of different grammaticalization, on clinical outcomes are still scarce.

2.5.4 Big data approach

Evidence that thinking about the future has an influence in health-psychological contexts derives from big data using Twitter. For example, Thorstad & Wolff (2018) analyzed the content of over 90 million tweets and found that future-sightedness (i.e., how far into the future people think) was related to decision-making. Far future-sighted people connected the future more closely to the present compared to close future-sighted people, indicating more blurred distinctions between present and future representations. This is highly reminiscent of differences between strong and weak FTR. Note that in terms of operationalizing future-sightedness in tweets, the authors used a SUTime tagger measure, which tags regular expression patterns with a combination of keywords and rules to recognize temporal expressions. Hence, the measure did not directly assess grammatically or lexically marked FTR. A similar paper studied tweets regarding their future orientation (i.e., frequency of referencing the future) in different counties of the USA and their association of HIV prevalence within the county (Ireland et al., 2015). Interestingly, the authors found that future-oriented language in tweets buffered health risk, in other words, referencing the future was associated with lower HIV prevalence. Future orientation in tweets was assessed using the text analysis tool LIWC2007, including a category 'future tense' (using mainly modal verbs such as *will* or *should* to detect FTR; Tausczik & Pennebaker, 2010). Importantly, and maybe unfortunately for the questions at stake in this thesis, this category was removed in the later version of the LIWC due to poor psychometric criteria and replaced by the category 'future focus' (Pennebaker et al., 2015).

In all, these different results speak to a link between certain language constructions and one's orientation towards the future. So far, big data analyses could be used as a hypothesis-generating tool regarding the grammaticalization of FTR and its presumed effect on health-

psychological cognition. As such, future research in that direction might benefit from big text data analyses yet incorporating different degrees of grammaticalization and further testing their effects in experimental paradigms.

2.6 Conclusions and Directions to Follow in the Upcoming Empirical Chapters

Studying the grammaticalization of the future with a TfS approach seems a viable research avenue, as linguistic literature suggests that different degrees of FTR exist within languages but also across languages. Usually, languages with higher degrees of FTR additionally use particular constructions with lower degrees of FTR, as seen in the French inflectional and periphrastic constructions, to express a range of probability regarding future events (Bybee et al., 1991). There are no clear criteria to identify languages with a high degree of FTR: some studies categorize periphrastic future constructions as a high degree of FTR (e.g., Dahl & Velupillai, 2013; Galor et al., 2018), whereas other studies use the general marking of the verb tense to characterize a high degree of FTR (e.g., M. K. Chen, 2013; Kim & Filimonau, 2017; Mavisakalyan et al., 2018). Future research may consider grammaticalization of the future as a continuum (e.g., Thoma & Tytus, 2018) and adapt the categorization of the degree of FTR to suit a specific research question.

Psycholinguistic research has clearly identified the importance of time as a necessary dimension to construct coherent mental representations of text and discourse. Following Slobin's (e.g., 2003) TfS hypothesis, we suggest that the grammaticalization of the future may impact mental representations of future events, as it alters the way it implicitly conveys information about uncertainty and distance of future events. Research on these issues have been scarce, which may be due to the difficulty to (a) operationalize grammaticalization of the future and (b) operationalize the representation of the future. We hope that we have provided solutions to these issues, mainly to motivate research along these avenues. We believe that these definitional issues constitute fascinating challenges for research. Possible operationalizations of the representation of the future could be based on M. K. Chen's (2013) LSH, where he proposes differences in perceived *concreteness* or *certainty* and *distance* between language groups. Distance as an alternative operationalization would follow the linear space-time relation found in research of time metaphors (Boroditsky, 2001), where time is conceptualized as a timeline suggesting that the future is simply spatially further away compared to the present.

Research in economics has already applied the grammaticalization of the future to research questions comparing differences in *saving behaviors*, *retirement assets*, and *smoking behaviors* across countries speaking different languages (M. K. Chen, 2013; Liang et al., 2018), yet their observations have also been questioned. Although their results indicated some level of correlation between degrees of FTR and various behavioral economic outcomes, their methodological approaches may have been prone to the overestimation of these correlations (Roberts et al., 2015). Consequently, we would join Roberts et al.'s (2015) observation that experimental work may be better suited to address these issues.

Finally, if the link between grammaticalization of the future and the way we perceive the future may prove to be a viable scientific avenue, it may be applied to health psychology (see Chapters 3.2 and 3.3). Indeed, literature seems to indicate that thinking about the future is a central concern in this domain (Teuscher & Mitchell, 2011). For example, research suggests that thinking about the future influences our well-being and mental health (MacLeod & O'Conner, 2018). The relevance of thinking about the future in health psychology combined with the theoretical implications we have discussed regarding the grammaticalization of the future compose a synthesis that could lead to exciting new research avenues. In general, the challenge for applied research using psycholinguistic approaches will be to find suitable behavioral outcomes. Future interdisciplinary research should be aware of the considerations offered in this chapter.

To build on these conclusions, in the next chapter (3.1 PROOF-OF-CONCEPT) we want to test the proposed theoretical framework by not only comparing languages with different degrees of FTR (i.e., French and German), but also find experimental evidence for an effect of the grammaticalization of the future within a language. For this study, we assume that the cognitive mechanism affected by using differing degrees of FTR relates to the metaphoric structuring of time into space and we call this cognitive mechanism *temporal distance*. We regard this study as proof-of-concept that if different degrees of FTR affect mental representations of future events – especially within a language – we could apply this effect to create more effective health messages or any applied domain where thinking about the future is of importance (e.g., ecological considerations concerning the global climate).

EMPIRICAL WORK

3. EMPIRICAL WORK

3.1 PROOF-OF-CONCEPT: Is the Future Near or Far Depending on the Verb Tense Markers Used? An Experimental Investigation Into the Effects of the Grammaticalization of the Future

Part of the study presented in this chapter was published as:

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3.1.1 Summary

Psycholinguistic approaches that study the effects of language on mental representations have ignored a potential role of the grammaticalization of the future (i.e., how the future manifests linguistically). We argue that the grammaticalization of the future may be an important aspect, as thinking about the future is omnipresent in our everyday life. The aim of this study was to experimentally manipulate the degree of future time reference (i.e., present and future verb tense and temporal adverbials) to address their impact on the perceived location of future events (i.e., temporal distance). We were specifically interested in the within-language effect as this would constitute a proof-of-concept for our theoretical framework and further pave the way for research with concrete applications in health or environmental psychology.

Across four experiments, two in French and two in German, no effect was found, irrespective of our verb and adverbial manipulations, and contrary to our hypotheses. Bayes factors confirmed that our null effects were not due to a lack of power. We present one of the first empirical accounts investigating the role of the grammaticalization of the future on effects of mental representations. We discuss possible reasons for these null results and illustrate further research avenues derived from our theoretical framework.

3.1.2 Introduction

Languages are built with grammatical structures, such as grammatical gender (Corbett, 1991) or grammatical aspect (Talmy, 1975, 2000). These structures vary across languages (N. Evans & Levinson, 2009) and have been shown to affect how we mentally represent these different aspects of our environment (Athanasopoulos & Bylund, 2013; Flecken et al., 2014; Lucy, 1992b; Sato et al., 2013). Prior research on the effect of FTR on temporal discounting (M. K. Chen, 2013; S. Chen et al., 2017; Liang et al., 2018) has established that languages that obligatorily mark the future grammatically show stronger future discounting effects, although the design of these studies remains disputed (Gotti et al., 2020; Roberts et al., 2015). In the present study, we examine the impact of the grammaticalization of the future, that is, the grammatical manifestations of how to refer to the future, and how these grammaticalizations may impact our representations of future events. This approach differs from other experimental studies within the field of future time reference and temporal discounting (J. I. Chen et al., 2019; Thoma & Tytus, 2018), in that we try to unravel the possible underlying cognitive processes involved from a psycholinguistic perspective, as delineated in our theoretical framework in the previous chapter.

In a nutshell, we argued that thinking about the future is an activity we engage in, on average, every 16 minutes (D'Argembeau et al., 2011) and that it can affect different mental health outcomes (A. K. MacLeod & O'Conner, 2018). We therefore regard it as important to examine the link between grammatical manifestations of the future and mental representations of future events. Not only is the future a vital part of our everyday life, but time in general has been shown to be an important dimension for generating and processing mental representations of text and discourse (Zwaan & Radvansky, 1998). As mental representations have a perceptual basis (Barsalou, 2010; Zwaan, 2004; Zwaan & Rapp, 2006) and grammatical structures can make some aspects of our visual perception more salient (Slobin, 2003), we hypothesize that the grammaticalization of the future should influence how we construct grounded representations of future events.

3.1.2.1 How is the future linguistically realized?

Talking about the future is inherently different than talking about the past or present, in that there is uncertainty about whether an event will take place or not (Dahl, 1985, 2000). In

European languages there are different nuances of certainty about future events, these nuances are defined by how likely it is that an event will happen. For example, a scheduled meeting or an intended visit are more likely to happen than a predicted outcome of a horse race (Dahl, 2000). This difference in likelihood is reflected in which linguistic devices are used to mark the future: most European languages use the present tense when referring to a very likely event, but when met with uncertainty in a prediction-like context, languages vary with regards to the linguistic devices used (Dahl, 1985, 2000). The general notion of referring to a future event is called *future time reference* (FTR) and can use a variety of linguistic devices (Dahl, 1985, 2000). In this study we mainly focus on temporal adverbials (e.g., words that describe the time frame of an action in a clause such as tomorrow; Harkness, 1987) combined with a present or a future tense (e.g., a grammatical construction indicating a temporal context in the future such as 'I will go.').

In European languages, FTR varies, to some extent, in the use of linguistic devices in prediction-like contexts, that is, whether a language uses lexical or grammatical structures (Dahl, 2000). In German, for example, the future tense is indicated using a modal verb construction, as in (1).

(1) German

Morgen wird es regnen.

Tomorrow will it rain:INFINITIVE.

'Tomorrow, it will rain.'

In French, the future tense is constructed using an inflectional structure, which means that the future tense is marked within the verb form, as in (2).

(2) French

Demain, il pleuvra.

Tomorrow it rain:FUTURE.

'Tomorrow, it will rain.'

An important difference between the German and French future tense is its obligatory use to signal FTR. German future tense use is not obligatory; this means that German speakers can also use the present tense to talk about the future, and they even do this quite often (Dahl, 1996). In contrast, for French speakers it is more common to use a more obligatory form – at least when

written (Comeau & Villeneuve, 2016). For this study, we use the terms high and low degrees of FTR to refer to two different situations, as described in our theoretical framework. When comparing French and German, it refers to whether a language requires an obligatory marking (i.e., high degree of FTR) or not (i.e., low degree of FTR). More importantly for this chapter, within each language, it also refers to whether we use the future tense (i.e., high degree of FTR) or the present tense to talk about the future (i.e., low degree of FTR).

3.1.2.2 The effects of different FTR

The difference in degrees of FTR between languages was first used by M. K. Chen (2013) in his paper on the link between FTR strength and intertemporal choices (i.e., saving money, having retirement assets, or adopting healthy behaviors), where he proposed the Linguistic Savings Hypothesis (LSH). This hypothesis states that speakers of languages with a high degree of FTR (such as French) are less likely to engage in future-oriented behaviors compared to speakers of languages with a low degree of FTR (such as German). The mechanisms suggested for this hypothesis were that speakers of languages with a high degree of FTR perceive the distance to future events as greater and generally less concrete compared to speakers of languages of a low degree of FTR. This is because referring to the future in the present tense leads speakers to perceive the future as if it were occurring in the present (or at least closer to the present). M. K. Chen (2013) chose to establish a dichotomous criterium between high vs. low degree of FTR languages adapting (Dahl, 2000) observations on obligatory FTR use in prediction-like contexts, so that a low degree of FTR was attributed to languages that do not require the verb tense to mark the future (e.g., German) and a high degree of FTR attributed to languages that require the verb tense to mark the future (e.g., English). M. K. Chen (2013) found a significant effect of the degree of FTR on behavioral outcomes (correlations), even when other economic and demographic parameters were accounted for (e.g., socio-economic status or origin of the legal system in the corresponding country).

Other studies followed M. K. Chen's (2013) approach and showed evidence for the LSH with diverse behavioral outcomes, such as corporate savings behavior (S. Chen et al., 2017), corporate responsibility (Liang et al., 2018), research and development investment (Liang et al., 2018), environmental behavior and policies (Mavisakalyan et al., 2018), pro-environmental attitudes (S. Kim & Filimonau, 2017), future-oriented policies in general (Pérez & Tavits, 2017), as

well as religiosity (Mavisakalyan et al., 2022). Nonetheless, some researchers have raised concerns about the methodological approach of these correlational studies (Gotti et al., 2020; Roberts et al., 2015). In particular, by reanalyzing M. K. Chen's (2013) data but accounting for cultural traits (such as geographical and historical relatedness of languages), the correlations no longer yielded statistical significance (Roberts et al., 2015).

Roberts et al. (2015) suggested that experimental designs were better suited to investigate the effect of FTR strength. In fact, researchers that followed an experimental approach did find a difference between German-speaking (low degree of FTR) and Italian-speaking (high degree of FTR) school children in their intertemporal choice preference, in support of the LSH (Sutter et al., 2018). J.I. Chen et al. (2019) also compared different degrees of FTR within a language using a time preference task with Mandarin speakers. In their study, however, the findings obtained were not in favor of the LSH. Interestingly, the results showed a trend in the opposite direction, suggesting that participants were more patient about receiving a certain reward when it was presented in the future tense.

The impact of the LSH is still unsettled given the different results reported by various experimental studies (J. I. Chen et al., 2019; Sutter et al., 2018; Thoma & Tytus, 2018). Thus, our goal in the present study is to reassess the LSH and its assumed effects on temporal discounting and delayed gratification from an experimental psycholinguistic approach, as extensively discussed in our theoretical framework. In using such an approach, not only can we address the issue of causality – and overcome issues related to correlational studies (M. K. Chen, 2013; S. Chen et al., 2017; Liang et al., 2018) –, but we can also examine the underlying cognitive mechanism at the heart of the assumed effect. We predict that the mechanism in question is driven by the fact that the grammatical structures that refer to the future draw attention to temporal information, particularly that of the future.

The thinking-for-speaking hypothesis coined by Slobin (2003) provides a potential foundation of the mechanism by which FTR can exert an effect on the mental representations of the future. The thinking-for-speaking hypothesis states that when we prepare our thoughts to be expressed in language, we need to tailor these thoughts into the grammatical structures that our language provides. In turn, this motivates speakers (and listeners) to attend to particular information, which makes certain concepts conveyed through grammar more or less salient. For example, if someone is thinking about a specific event that will happen three weeks from today

and expresses it, they would most likely use some sort of FTR to express their thoughts. Depending on whether, in their language, the future tense is or is not marked within the verb form, the attention of speakers (or listeners) might be differently drawn towards the future. The thinking-for-speaking hypothesis has been tested on other domains such as spatial relations (Bowerman & Choi, 2001), grammatical gender (Konishi, 1993; Sato et al., 2013) and grammatical aspect (Athanasopoulos & Bylund, 2013; Flecken et al., 2014). We argue that the highlighted differences between the present and the future as suggested by the thinking-for-speaking hypothesis can influence mental representations of the future.

3.1.2.3 Mental representations of the future

We define mental representations of temporal events as grounded in space. This definition is derived from research on grounded cognition (Barsalou, 2008, 2020; Lakoff & Johnson, 1999), which states that cognitive processes (such as mental simulations of events) are not computed amodally, but are rather influenced or grounded in the body, in our perceptual system, or in the physical and/or social environment (Barsalou, 2020). Mental representations play an important role when we process language, or more specifically discourse (Johnson-Laird, 1983; Kintsch & van Dijk, 1978). Mental representations of discourse events are constructed during language processing, and are constantly updated when confronted with new information (Zwaan & Radvansky, 1998). Apart from incorporating semantic information, mental representations carry perceptual information, which can be accessed when processing language (Barsalou, 2010; Zwaan, 2004; Zwaan & Rapp, 2006). This pertains to concrete concepts such as performed actions (Glenberg & Kaschak, 2002; Zwaan & Taylor, 2006) or forms of objects (Stanfield & Zwaan, 2001; Zwaan et al., 2002), but can also be observed when processing abstract concepts, such as emotions (Havas et al., 2007), speed (Fecica & O'Neill, 2010; Speed & Vigliocco, 2014), space (Dudschig et al., 2012), and importantly, time (Boroditsky, 2000; Casasanto & Boroditsky, 2008).

As time is considered an abstract concept that cannot be defined by itself (Lakoff & Johnson, 1999), its definition is based on metonymy (e.g., the iterative event of a clock ticking defines time) and more importantly here, on temporal metaphorization (Lakoff & Johnson, 1999). This latter aspect is crucial in the context of our study, in that the use of temporal metaphors essentially transforms time into a concrete concept. In temporal metaphors, time is grounded in

space and/or motion (Lakoff & Johnson, 1980). For example, time is “a moving object” or “we move through time” spatially. Although the spatial translation of time into metaphors is quite universal, these metaphors do vary across languages: while both English- and Mandarin-speakers use horizontal front/back spatial metaphors, Mandarin-speakers also commonly use vertical up/down temporal metaphors (Boroditsky et al., 2011). These differing space-time orientations are linked to writing conventions (Majid et al., 2013). As the writing convention for French and German is from left to right, we can safely assume that time is perceptually mapped horizontally from left to right. Consequently, and as we do in the present study, using a horizontal timeline to track the spatial differences of grounding time related to using differing degrees of FTR seems appropriate.

3.1.2.4 The present study

The aim of the present study is to explore whether spatio-temporal representations of time vary as a function of different degrees of FTR, mainly within languages. We look at two languages that have different degrees of FTR between and within them: French, with a higher degree of FTR compared to German, yet with a possibility to use a lower degree of FTR within the language and German, with a lower degree of FTR compared to French yet with the possibility to use a higher degree of FTR within the language. To manipulate FTR experimentally, we use a combination of temporal adverbials and tenses (present/future), as we detail in the Method sections. Experiments 1 and 2 explore possible FTR effects in French, whereas Experiments 3 and 4 explore possible FTR effects in German. To look for between language effects, a post-hoc comparison between Experiment 2 (French) and Experiment 3 (German) is also conducted.

This study serves as proof-of-concept of the theoretical framework that we propose in the last chapter. Proof-of-concept is mainly used in other fields (e.g., drug research, business development) to establish the feasibility of a certain idea or method (Sedkaoui, 2019). Here, we use proof-of-concept to demonstrate that the grammaticalization of the future affects mental representations of future events, and therefore, should be considered in applied psychological research with a high relevance to thinking about future events such as health and environmental psychology.

We hypothesize that within each language, readers perceptually represent sentences with a lower degree of FTR (i.e., present tense and temporal adverbials to indicate the future) as

spatially closer to the left – representing the present (T0) – than sentences with a higher degree of FTR (i.e., future tense and temporal adverbials to indicate the future). This hypothesis is drawn from the assumption that a higher degree of FTR habitually emphasizes the difference between the present and the future [23] and thus creates perceptually increased distance as time is grounded in space [36]. As a lower degree of FTR is much more common in German than in French, we expect the effect between a low and high degree of FTR in German to be stronger than in French. In other terms, a feeling of novelty when using the future verb tense in German (quite uncommon) might create an even bigger perceptual distance than in French.

3.1.3 Experiment 1

3.1.3.1 Method

3.1.3.1.1 Participants

Sixty-nine participants were recruited for this study. We recruited 20 French-speaking students via convenience sampling at the University of Fribourg. An additional 49 French-speaking participants were recruited using Prolific (www.prolific.co) [11.12.2018], a webservice specialized in online research. The inclusion criterion was that participants' first language needed to be French. Participants recruited at the University of Fribourg received experimental credits; the Prolific participants received £6.39 per hour for their participation.

We assessed participants' gender, age, student status and language information such as their first language. Further, we asked participants the first three questions from the Language Experience and Proficiency Questionnaire (LEAP-Q, French version; Marian et al., 2007) to check their level of multilingualism ("Please list all the languages you know in order of dominance."/"Please list all the languages you know in order of acquisition (your native language first)") and the amount of time they are immersed in a French surrounding ("Please list what percentage of the time you are currently and on average exposed to each language. (Your percentage should add up to 100%)"). We used the individual language differences to exclude participants that did not meet the inclusion criterion.

The final sample consisted of 30 female and 39 male participants with a mean age of 30.93 years (SD = 10.54). All participants spoke at least one other language – which is very common in Switzerland (Federal Statistical Office, 2021) – and one third of participants reported speaking languages other than French more than 50% of their time.

3.1.3.1.2 Materials and Procedure

3.1.3.1.2.1 Item Construction

We designed 48 sentences that followed a similar pattern: a person starts an event at a given time (e.g., In six months, Julie will join an international organization). The names of the persons were taken from the name registry of the Federal Statistical Office and the 24 most common female and male names from the year 1998 (estimated participant age based on student population) were chosen for our sentences. The events described in the sentences were common events that people experience in their lives, such as starting a new job, moving to a new apartment or finishing a degree.

As the sentences described events at a given time, six adverbials were defined for events taking place in the present (e.g., en ce moment [at this moment], aujourd'hui [today]) and 16 adverbials for events in the future (e.g., dans six mois [in six months], en juin [in June]). Adverbials referring to the future covered a time range between six months up to one year in the future. As temporal adverbials can be placed in different positions within a sentence (Hancock, 2012), we decided to construct half of the items with adverbials placed at the beginning of the sentence and the other half with adverbials placed at the end/in the middle of the sentence. This was done to control for a possible position effect.

In addition to the 48 critical sentences, another 48 filler sentences were created with the same structure as the critical sentences. The filler sentences served the purpose of varying the time range and including different adverbials that indicated a time range from tomorrow up to six months.

3.1.3.1.2.2 Scale Construction

To measure the perceptual effects of our experimental sentences, we chose to create a visual analogue scale based on the findings of the spatial representation of time (Fuhrman & Boroditsky, 2010). The scale represented a timeline from left to right with the poles tout de suite [right now] to beaucoup plus tard [much later] and was translated as a numerical scale from 0 to 100 when analyzed (i.e., the numerical scale was not visible for participants). The scale was presented at the same time as the sentences and for each sentence, participants were instructed to place the event described in the sentence on the continuous timeline.

3.1.3.1.2.3 Design and Procedure

Critical sentences were presented in three different FTR strength conditions: a) present tense – present adverbial (PP), b) present tense – future adverbial (PF), c) future tense – future adverbial (FF) (see Table 1).

Table 1.

Example of Critical Sentences in Three Different Conditions.

Condition	Sentence in French [English translation]
PP	*Aujourd'hui*, Julie **rejoint** une organisation internationale. [Today, Julie joins an international organisation.]
PF	*Dans six mois*, Julie **rejoint** une organisation internationale. [In six months, Julie joins an international organisation.]
FF	*Dans six mois*, Julie **rejoindra** une organisation internationale. [In six months, Julie will join an international organisation.]

Note. Adverbials are marked using *italics*; tense is highlighted in **bold**.

Participants were presented with all three conditions, as a repeated-measure design (i.e., 16 sentences in each condition). To ensure that all sentences were also presented in the three conditions across the experiment, three balanced lists were created. The full list of items used in all experiments can be downloaded on the Open Science Framework (OSF) the link is available in Appendix A.

The experiment was programmed with Qualtrics, an online survey program [59], so participants could participate on their own computers at home. The study link was distributed among the French-speaking university students via social media, flyers and word of mouth advertising. As few students enrolled in the experiment, we decided to further recruit Prolific participants (*Prolific*, 2014).

When starting the experiment, participants first read the study information and were then asked for consent to participate in the study. After consenting, we asked participants for their demographic information (age, gender and student status) and language related information (first language and LEAP-Q). Then participants received additional information on how to place events on the timeline by clicking with their cursor on the estimated position. We emphasized that there were no correct or wrong solutions, but rather, we were interested in their

spontaneous opinions. Next, participants were randomly presented with one of the three lists containing 96 sentences to be placed on the timeline – each presented after another in a random order. After placing all 96 events on the timeline, participants were informed that the experiment had ended. On average, participants took 16.5 minutes to complete the study.

3.1.3.1.3 Pre-Registration

Experiment 1 was pre-registered on the OSF by the Centre for Open Science (accessible under the link in Appendix A). Experiments 2 to 4 are modified versions of Experiment 1. As planned in the pre-registration, mixed effects models were calculated with Value as the dependent variable and Time condition as well as Adverbial position as fixed effects with a maximal random effects structure justified by the design that will converge. Further, we pre-registered to use Bayes factor to determine whether the data were sensitive enough to either detect a null hypothesis or the alternative one. Not included in the pre-registration were the additional analyses of the temporal adverbials in Experiment 1 and the between language comparison in Experiment 3.

3.1.3.1.4 Ethical consent

Our request for ethical consent with the number 2018-429 to conduct these experiments was granted by the ethics committee from the University of Fribourg.

3.1.3.2 Results and Discussion

Before the analyses, we removed participants that did not finish the study or that mentioned that their first language was not French. We ended up with a sample of 69 participants.

To check our hypotheses, a series of linear mixed models were computed and compared using the package afex (Singmann et al., 2020) in R (R Core Team, 2020). All linear mixed models used the Value (value of the analogue visual scale) as the dependent variable. The final model contained Time condition (PP vs. PF vs. FF) and Adverb position (Beginning of the sentence vs. End of the sentence) as fixed effects (Adverb position was incorporated to control for a potential effect). Time condition was added as a random slope per Participants and a random slope per Items, and both Participants and Items were set as random intercepts. Both predictors employed treatment contrasts. The reference level for the predictor Time condition was set to the PF

condition, so for the effect of Time condition, the intercept is that of the PF condition. For the predictor Adverb position, the reference level was set to the Adverb at the beginning of the sentence condition. The Kenward-Roger method was used to calculate the p-values for the terms in the mixed model. Due to lack of convergence, and as justified by the design, the random structure for the model was only composed of Participants and Items as a random intercept effect. The results of the final model are summarized in Table 2.

Table 2.

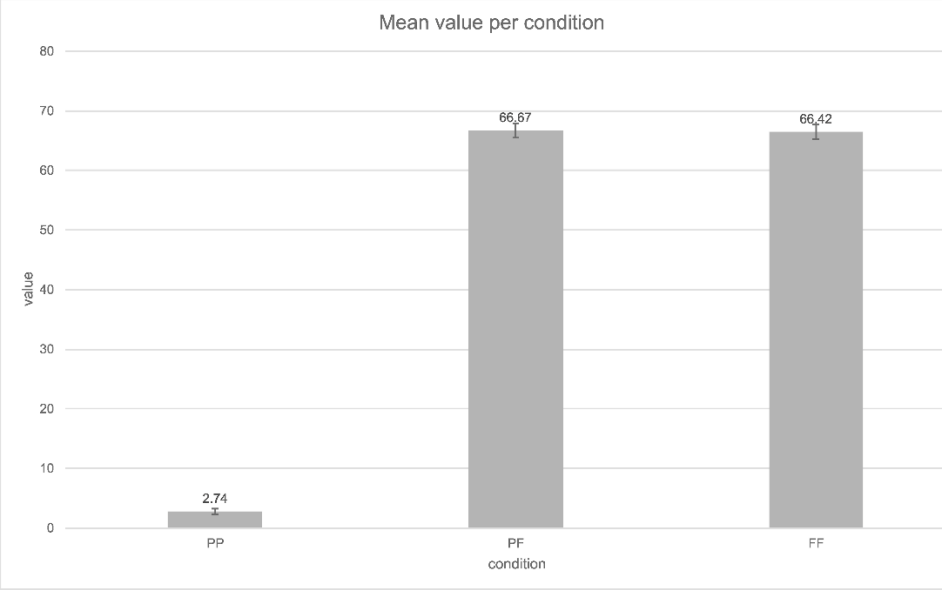
Results of the Mixed Effects Model of the French-Speaking Participants for Experiment 1.

Model / Fixed effects	Estimate (β)	df	t-value	p(>|t|)
value ~ Time condition + Adverb position + (1|item number) + (1|participants)				
Intercept (PF)	66.40	123.00	47.43	< 0.001
Time condition (PP)	-63.90	3194.37	-111.42	< 0.001
Time condition (FF)	-0.27	3194.37	-0.46	0.64
Adverb position (end of sentence)	0.54	899.40	0.75	0.45

The mean and confidence interval of the different conditions are presented in Figure 1. The mean value for the PP condition was M = 2.74, this value was significantly different from the PF (M = 66.67) and FF conditions (M = 66.42). The comparison between the PF and FF condition did not yield significant differences. Random effects showed that the greatest variability derived from residual variability (Var = 181.24, SD = 13.46), which cannot be attributed to either Participants (Var = 89.47, SD = 9.46) nor Items (Var = 17.67, SD = 4.20).

Figure 1.

Mean Value per Time Condition with Confidence Intervals (95%).

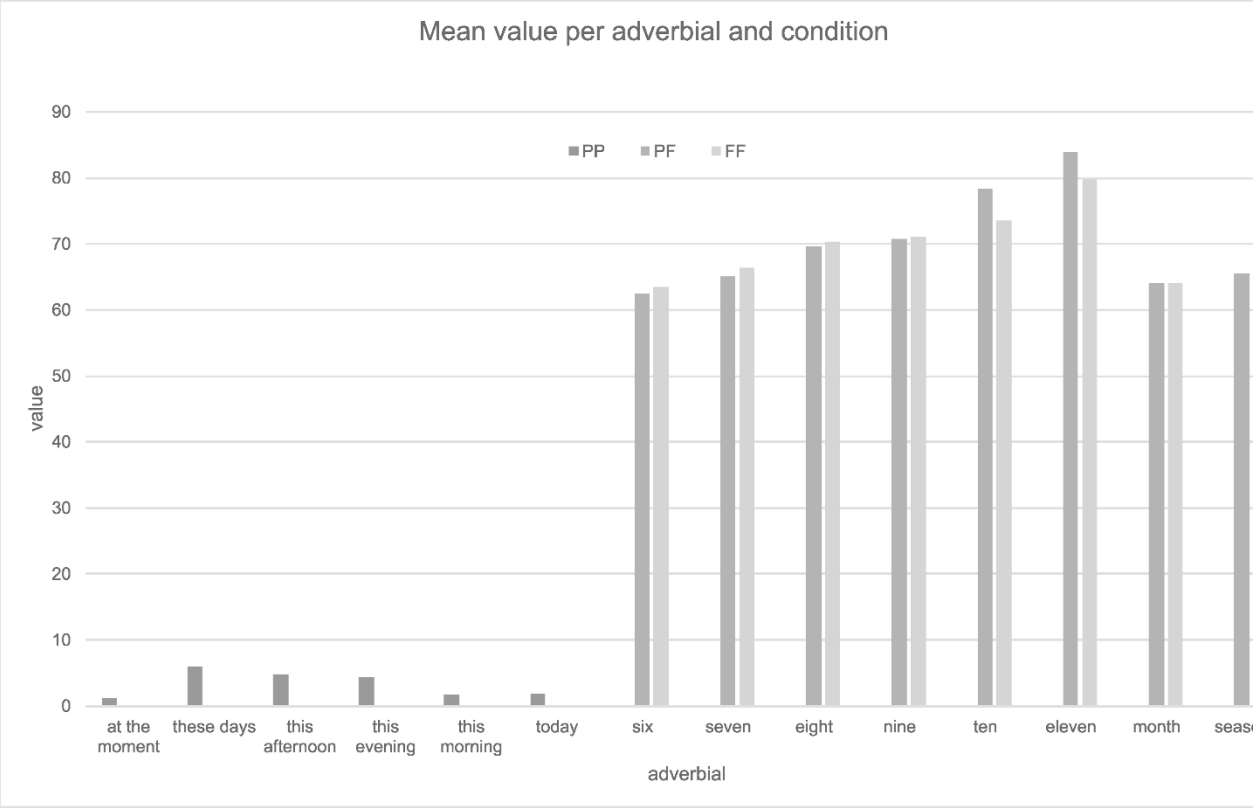


As the expected difference between the PF and FF did not seem to emerge, we calculated Bayes factor on the lack of effect to assess the relative strength of our evidence. In other terms, we attempted to verify that our data were sufficiently sensitive to detect and strongly support H0 (no effect) over H1 (effect of verb tense) (Dienes, 2014; Dienes et al., 2018). In order to determine the evidence for H0 over H1 and calculate a Bayes factor, a plausible range of effect is needed. We decided to set it to 32, as it means that PF (expected 34.42) would fall somehow in between PP (2.74) and FF (66.42). We used a half-normal distribution to calculate our Bayes factor, to avoid favoring the probability of supporting H0 over H1 (i.e., half-Cauchy distribution; Dienes, 2019). In other terms, we statistically tested whether our lack of difference between PF and FF constituted evidence for H0. To do this, we used the difference of -.25 as our sample mean (PF: 66.67; FF: 66.42, and SE = -.46, i.e., the raw difference divided by the t-value given by our model encompassing Time condition). Using the conventional cut-off of .30 suggested by Jeffreys (1961) the resulting Bayesian analysis showed strong evidence for the null hypothesis over the existence of an effect of Time condition B = .012. This Bayes factor can be taken as substantial evidence for the null hypothesis over the alternative hypothesis (i.e., the alternative hypothesis is .012 times more likely than the null hypothesis). In other terms, our data were sensitive enough to evaluate that the null hypothesis is extremely likely.

To ensure that the adverbials did not influence the placement of events on the timeline an additional analysis was conducted. The analysis of the adverbials revealed an interesting pattern (see Figure 2). Concrete adverbs that mentioned a specific number (e.g., in six months, in eleven months), followed a discrete distribution (i.e., the bigger the number, the bigger the distance on the scale) suggesting that participants used the numbers in the adverbials to create a mental numerical scale and probably mainly focused on the adverbials rather than the tense. This finding is reminiscent of the SNARC effect (i.e., Spatial Numerical Association of Response Codes), which emerges when participants have to classify random Arabic numbers presented on a screen by clicking either the left or right button on a keyboard. They respond more quickly to small numbers with the left hand and more quickly to large numbers on the right hand, suggesting a spatial mental representation of numerical series (Dehaene et al., 1993).

Figure 2.

Mean Value per Adverbial and Time Condition.



Note. The numerical adverbials (indicated by the numbers six to eleven) show a distinct pattern reminiscent of the SNARC effect (Dehaene et al., 1993). The pattern for other adverbials is less distinct.

In all, the results from Experiment 1 did not support our within-language hypothesis. We found that although participants constructed different temporal representations when reading the present tense to refer to the present (PP) and the future tense (FF), there were no differences in their representations when reading the future tense (FF) and present tense to refer to the future (PF). Interestingly, however, the results of our additional analysis on the adverbials indicated a preference for using concrete, numerical adverbials for participants to decide the position of an event on the timeline. To examine whether this effect was masking a possible effect of tense, in Experiment 2 we modified the temporal adverbials to avoid using concrete ones in order to direct participants' attention to the verb tense.

3.1.4 Experiment 2

3.1.4.1 Method

3.1.4.1.1 Participants

Sixty-five French-speaking participants were recruited using convenience sampling. Participants were recruited from the student population at the University of Fribourg. Participants' mean age was 24.86 years (SD = 6.42) and the sample consisted of 40 females, 24 males and 1 other gender. All participants reported knowing at least two other languages. Participants from the University of Fribourg received experimental credits for their participation.

3.1.4.1.2 Materials and Procedure

3.1.4.1.2.1 Item Construction

The same 48 items as in Experiment 1 were used in Experiment 2, with the difference that we modified the adverbials to avoid using numerical, concrete adverbials. The new set of adverbials consisted of four adverbials to refer to the present (e.g., en ce moment [in this moment], maintenant [now]) and eight adverbials to refer to the future (e.g., d'ici quelque mois [within a few months], le semestre prochain [next semester]).

3.1.4.1.2.2 Scale Construction

We adjusted the poles of the analogue visual scale from tout de suite [right now] and beaucoup plus tard [much later] to proche dans le temps [close in time] and éloigné dans le temps [distant in time]. These changes were considered due to the large dispersion of the data points in the PP condition indicating a semantic ambiguity of the original poles. The new poles emphasized the spatial dimension of time.

3.1.4.1.2.3 Design and Procedure

No other changes were made, neither to the procedure nor to the experimental design.

3.1.4.2 Results and Discussion

We explored the within-language hypothesis for the French-speaking participants. We used the same parameters for the mixed effects model as in Experiment 1. Again, a model with Participants and Items as random slopes and intercepts, and Time condition and Adverb position as fixed effects did not converge. However, the final model did, with Value as a dependent

variable, Time condition and Adverb position as fixed effects and Participant and Item as random intercepts. The results of the final model are summarized in Table 3.

Table 3.

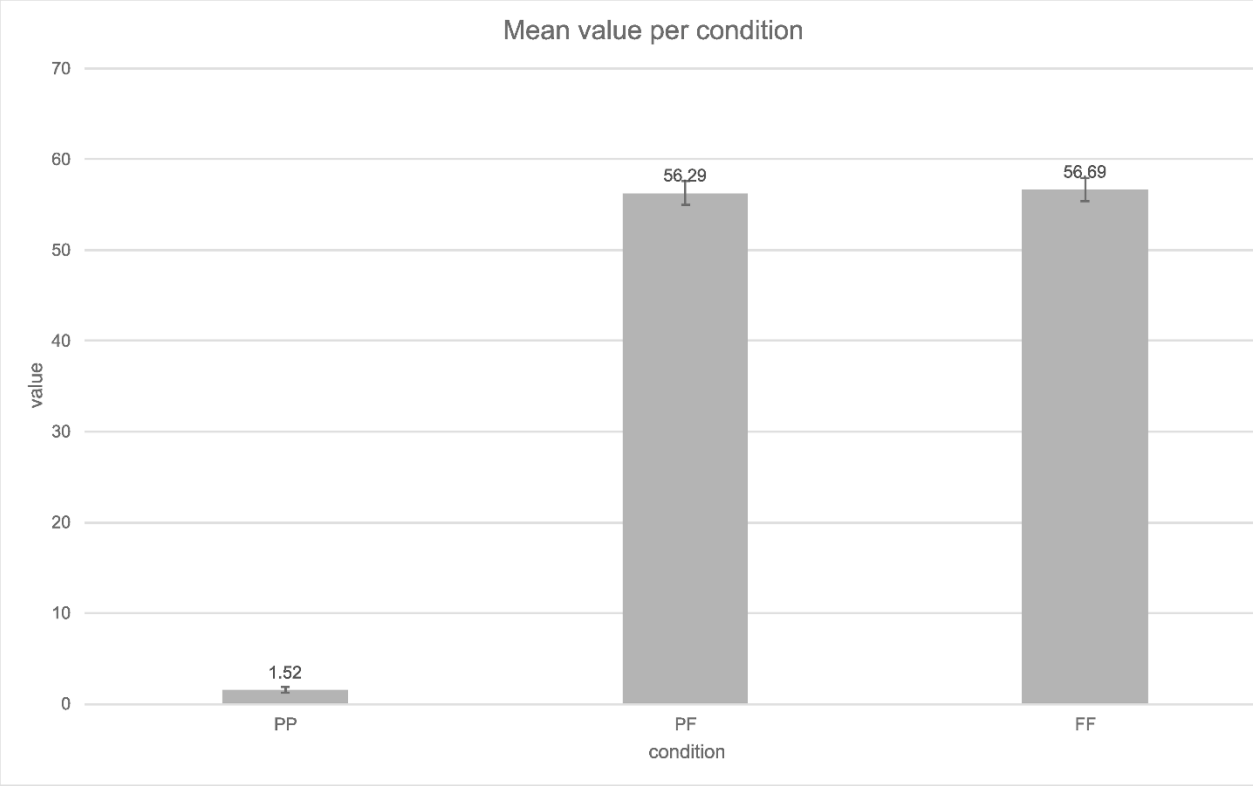
Results of the Mixed Effects Model of the French-Speaking Participants for Experiment 2.

Model / Fixed effects	Estimate (β)	df	t-value	p(>|t|)
value ~ Time condition + Adverb position + (1|item number) + (1|participants)				
Intercept (PF)	56.16	86.40	28.14	< 0.001
Time condition (PP)	-54.84	3007.51	-92.72	< 0.001
Time condition (FF)	0.29	3007.51	0.50	0.62
Adverb position (end of sentence)	0.37	46.00	0.16	0.87

Mean and confidence interval (95%) are presented in Figure 3. The mean for the PP condition (M = 1.52) was significantly different from the PF (M = 56.29) and FF (M = 56.69) conditions. The two future conditions PF and FF did not significantly differ from each other. Again, for the random effect the greatest variability was derived from residual variability (Var = 180.88, SD = 13.45), which cannot be attributed to either Participants (Var = 74.43, SD = 8.63) or Items (Var = 62.53, SD = 7.91).

Figure 3.

Mean Value per Time Condition and Confidence Intervals (95%).



Again, we chose to conduct a Bayesian analysis to check if our data were sensitive enough to support the H0. For this analysis, we calculated the SE = 0.8, the difference between PF and FF diff = 0.4. For this experiment we set the expected value to 28, as the range was smaller compared to Experiment 1. The obtained Bayes factor B = 0.036 indicated that our data were sensitive enough.

The results revealed, again, no significant difference between the PF and the FF condition for our participants. One interpretation was that French may actually not be the ideal language to test our hypothesis, as PF may only be partly present in French and mostly in spoken language. As such, French-speakers may not be as familiar with reading about the future in the present tense, at least not as familiar as German-speakers (see the theoretical framework in the last chapter). A potential novelty effect could have masked a potential FTR effect. In the following experiment, we opted to examine German, as German-speakers are more familiar with speaking and reading about the future in the present tense, as well as reading in the future tense.

3.1.5 Experiment 3

3.1.5.1 Method

3.1.5.1.1 Participants

Sixty-four German-speaking participants were recruited using a convenience sampling method at the University of Fribourg campus. Further, a mailing list from a Swiss German-speaking university was used to advertise the study among German-speaking psychology students. Participants from the University of Fribourg received experimental credits for their participation. We recruited 51 female and 13 male participants with a mean age of 25.25 years (SD = 7.18). All participants reported speaking at least one second language.

3.1.5.1.2 Materials and Procedure

3.1.5.1.2.1 Item Construction

The French items from Experiment 2 were translated by a professional translator into German. The first author translated the items back to French to check for consistency and semantic accuracy. The German equivalent of adverbials to refer to the present were, for example, im Moment [in this moment] and jetzt [now]) and examples of adverbials to refer to the future were in einigen Monaten [within a few months] and nächstes Semester [next semester]).

3.1.5.1.2.2 Scale Construction

The scale used in Experiment 2 was translated to German. The German translation of the poles were zeitlich nahe [close in time] and zeitlich entfernt [distant in time].

3.1.5.1.2.3 Design and Procedure

No other changes in the design or procedure were made compared to Experiment 2.

3.1.5.2 Results and Discussion

The same analyses as in Experiment 2 were conducted for the German-speaking participants. Also, the same parameters were chosen for the linear mixed model analysis. Again, the model with the random effect structure with Participants and Items as random slopes and intercepts did not converge, so the final model used Participants and Items as random intercepts. The results of the mixed effects model are presented in Table 4; the mean and confidence interval are presented in Figure 4.

The PP condition (M = 2.4) was significantly different from the PF and FF conditions. The PF (M = 59.83) and FF (M = 59.08) conditions did not differ significantly. For random effects, the greatest variability was derived from residual variability (Var = 209.71, SD = 14.48), which cannot be attributed to either Participants (Var = 137.53, SD = 11.73) or Items (Var = 27.58, SD = 5.25).

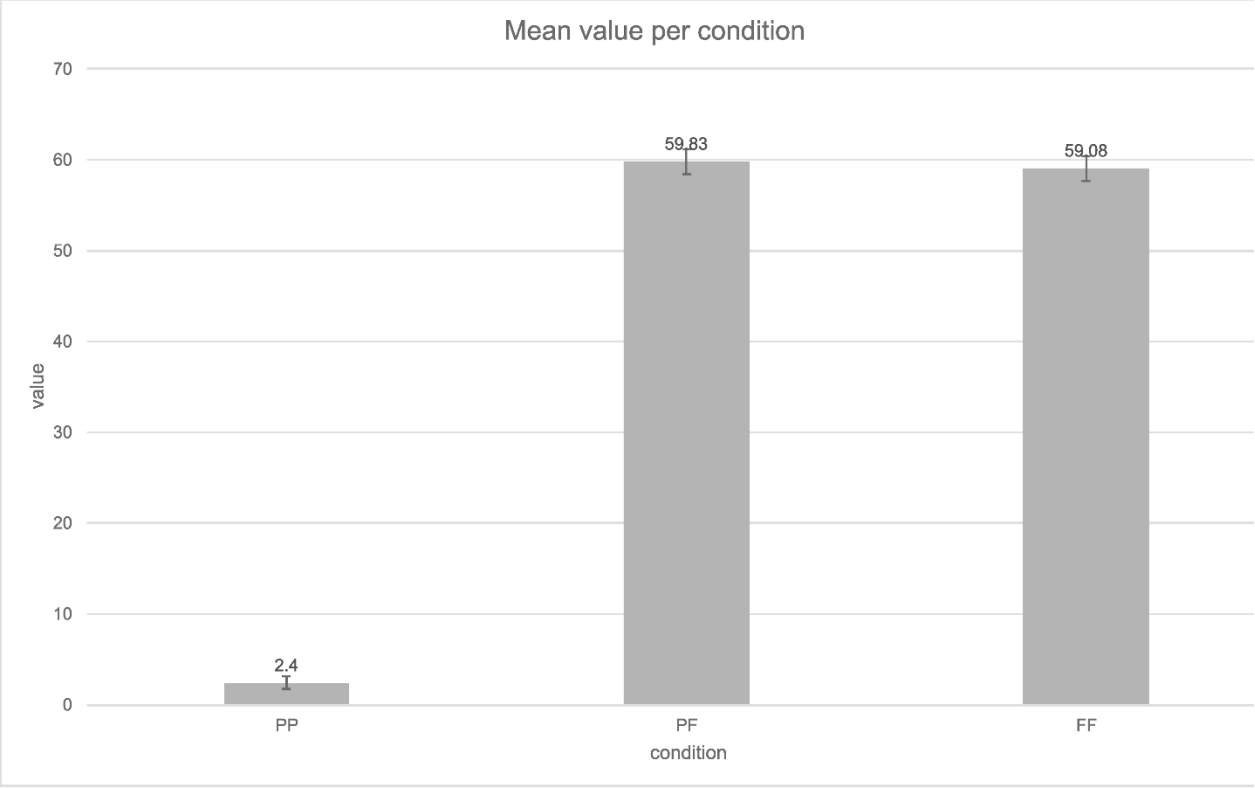
Table 4.

Results of the Mixed Effects Model of the German-Speaking Participants for Experiment 3.

Model / Fixed effects	Estimate (β)	df	t-value	p(>|t|)
value ~ Time condition + Adverb position + (1|item number) + (1|participants)				
Intercept (PF)	59.74	111.93	31.61	< 0.001
Time condition (PP)	-57.41	2961.88	-89.52	< 0.001
Time condition (FF)	-0.86	2961.88	-1.34	0.179
Adverb position (end of sentence)	0.24	46.00	0.15	0.88

Figure 4.

Mean Value per Time Condition and Confidence Intervals (95%).



A Bayesian analysis was conducted with the difference -0.75, SE = 0.56 and the expected effect = 28. The Bayes factor B = 0.006 confirmed our data to be sensitive enough to detect H0.

Additionally, a post-hoc between-language comparison (Experiment 2 and 3) was conducted. Following the grounded theory approach, languages that mark the future obligatorily would make a larger spatial distinction between lower and higher degrees of FTR. For our experimental setup, that would mean that French-speaking participants would generally perceive the future conditions (PF and FF) as spatially more distant than German-speaking ones.

We assessed this hypothesis using a linear mixed model. Again, Value was taken as a dependent variable. With regards to the Time condition, only the two future conditions (PF and FF) were compared as we did not suspect a difference in the present condition between the two languages. We also took Language as a fixed factor, which simply indicated whether the participants were French- or German-speaking. We used the R package afex (Singmann et al., 2020) and set treatment contrasts with French as the reference level. We used a random slopes and intercepts structure of Participants and Items, which converged. Language did not seem to significantly explain variance in the data, the analysis can be found on the OSF using the link on Appendix A.

As for Experiments 1 and 2, in French, although there was a large difference between PP and FF, as expected, there was no difference between PF and FF. As such, the effect that we expected was not just blurred by a lack of familiarity of PF in French. Now, it could be the case that due to the large difference between the PP condition and the other two conditions, an existing effect between PF and FF could be hidden by creating a temporal zoom-out effect. To examine this final possibility, in the final experiment, we removed the PP condition to zoom in on the expected effect between PF and FF. For this final experiment, we maintained German as our focus language, as we assumed the effect to be bigger in German (see also our rationale for moving from French to German at the end of the discussion section of Experiment 2).

3.1.6 Experiment 4

3.1.6.1 Method

3.1.6.1.1 Participants

Fifty-four German-speaking participants were recruited for Experiment 4. Participants were recruited using convenience sampling on campus and via social media. As in Experiment 3, the inclusion criterion for participants was defined as German as a first language. Participants

consisted of 40 females and 14 males who were, on average, 31.30 years old (SD = 13.92). In total, 52 out of 54 participants spoke at least one second language.

3.1.6.1.2 Materials and Procedure

3.1.6.1.2.1 Item Construction

We kept the same 48 critical PF and FF items as in Experiment 3, removed the PP items, and also eliminated four future adverbials that were tied to a specific month or season. To get a better zoom in effect, we also removed the adverbials in filler items that were too close to the present condition (e.g., morgen [tomorrow]).

3.1.6.1.2.2 Scale Construction

The scale was not changed with regards to Experiment 3.

3.1.6.1.2.3 Design and Procedure

Again, for this experiment, we dropped the PP condition. So, each participant saw 24 sentences in the PF and FF conditions. Participants were randomly appointed to one of the two lists. No other changes to the design and procedure were made.

3.1.6.2 Results and Discussion

To check the within-language hypothesis, we conducted a mixed effects model. We used the same parameters as in the experiments before. Initially, the model contained Value as the dependent variable, Time condition and Adverb position as fixed effects and Participants as well as Items as random slopes and intercepts. As this model did not converge, the final model used Participants and Items as random intercepts. The results of the mixed effects model can be found in Table 5.

Table 5.

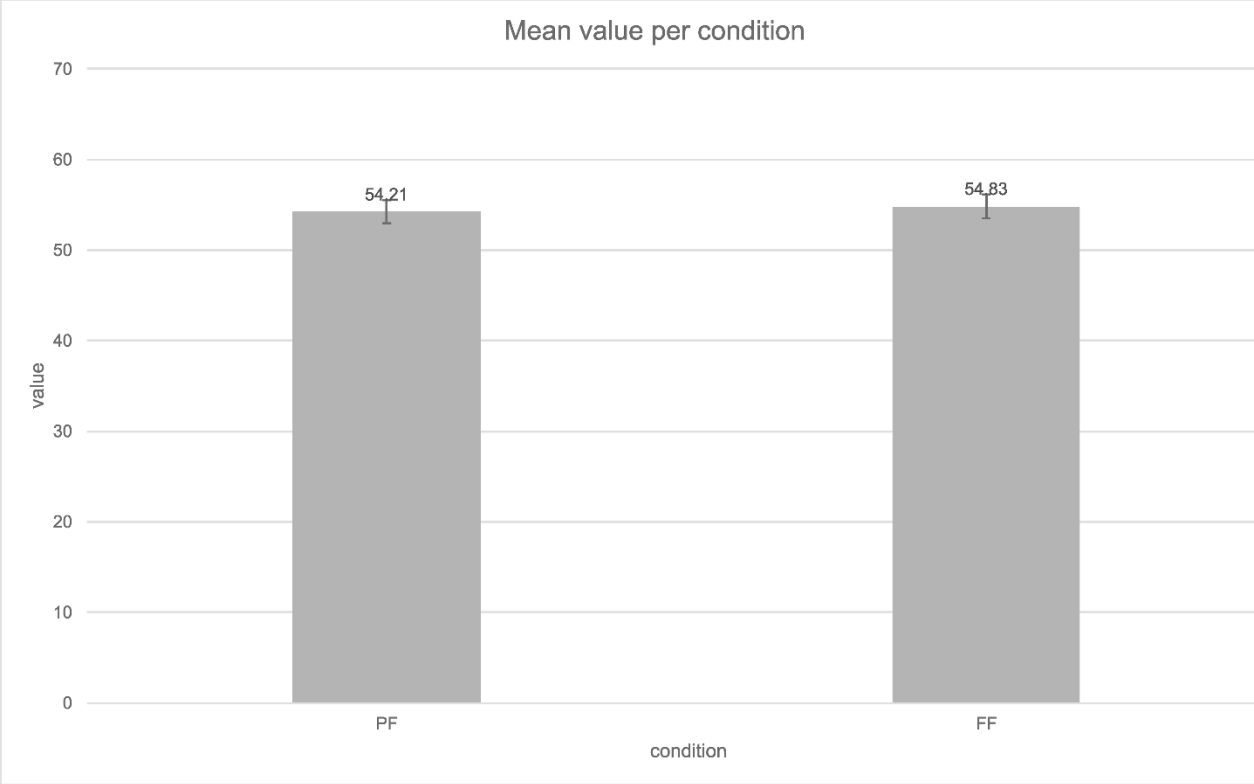
Results of the Mixed Effects Model of the German-Speaking Participants for Experiment 4.

Model / Fixed effects	Estimate (β)	df	t-value	p(>|t|)
value ~ Time condition + Adverb position + (1|item number) + (1|participants)				
Intercept (PF)	53.55	96.40	16.81	< 0.001
Time condition (FF)	0.53	2491.42	0.99	0.32
Adverb position (end of sentence)	1.40	46.00	0.42	0.68

The mean and confidence interval (95%) are depicted in Figure 5. The two future conditions PF (M = 54.21) and FF (M = 54.83) did not significantly differ from each other. The greatest variability from the random effects was derived from Participants (Var = 245.6, SD = 15.67), following the residual variability (Var = 185.7, SD = 13.63) and Items (Var = 129.5, SD = 11.38).

Figure 5.

Mean Value per Time Condition and Confidence Intervals (95%).



We conducted a Bayes analysis to evaluate our null result. We used diff = 0.62, SE = 0.62 and the expected value of 28, which resulted in a Bayes factor B = 0.05. So, our data were sensitive enough to confirm H0.

The results from the mixed effects model show that our conditions were not suitable to explain the variance in the data, which was supported by the lack of significant difference between the two conditions. As such, removing the PP condition to zoom in any effect between the PF and FF conditions did not result in any difference compared to Experiment 1, 2 or 3.

3.1.7 General Discussion

The series of experiments presented in this paper examined the effect of differing degrees of FTR within languages on the grounded representations of future events. We presented four experiments, to test the hypothesis of whether readers ground sentences with lower degrees of FTR as spatially closer to the left – representing the present (T0) – compared to sentences with higher degrees of FTR within a language. The results of the experiments refuted the proposed hypothesis. To confirm that our results were not due to data insensitivity (associated to some lack of power), we also calculated Bayes factors, as advocated by Dienes (2014). These analyses suggested that the null results are more likely true negatives than false ones, especially since all experiments show consistent results. This opens the discussion to analyzing the underlying reasons for these null results.

Could methodological issues account for our findings? As already mentioned, we made consecutive adjustments to the experiments to rule out methodological issues within our proposed methodological setup. Nevertheless, we chose the experimental setup based on assumed spatial differences in mental representations based on grounded cognition induced by varying degrees of FTR. More precisely, as the thinking-for-speaking framework focuses on visual attention as a cognitive mechanism (Slobin, 2003), we expected to measure visual-perceptual traces (i.e., perceived spatial location on a timeline). It could, however, be that the shift of attention induced by differing degrees of FTR may have no incidence on mental representations of the future (although it may have an effect on other cognitive mechanisms).

Another methodological issue could have been that the influence of temporal adverbials overpowered the assumed differences in mental representations affected by FTR variations. As mentioned earlier (see the discussion section of Experiment 1), the additional finding on concrete/numbered adverbials is reminiscent of the SNARC effect found in tasks where participants have to classify Arabic numbers presented on a screen by clicking either a left or right button [68]. The SNARC effect is usually found in paradigms measuring response time, although the response pattern suggests that mental representations of numerical or other ordinal sequences, such as days of the week or months of the year, are spatially encoded (Gevers et al., 2003). This spatially encoded sequence is mainly manifested in working memory (Abrahamse et al., 2014, 2016). Although, in our task we did not ask participants to memorize ordinal sequences, information may have been encoded in the working memory as new adverbials appeared in subsequent sentences and participants may have implicitly wanted to put new adverbials

according to their already answered items. This account could explain why despite reducing the concreteness of the adverbials in the subsequent experiments, participants were still building a mental timeline based on the remaining adverbials. Further research may need to critically evaluate the use of temporal adverbials in similar paradigms to avoid such possible interference.

Should we have focused on cross-linguistic research? In our investigation we examined two languages based on different properties of FTR, but also based on availability as French- and German-speakers are both present in Switzerland, and participants were readily available. Although we included two different languages in our investigation and we conducted a post-hoc between-language analysis, we did not follow the usual cross-linguistic paradigm, where speakers of languages differing more drastically are compared directly. For example, comparing two languages at the end points of grammatical future marking (e.g., French with obligatory grammatical future marking vs. Finnish with no grammatical future marking) may better document these effects, as those differences may create a more categorically distinct mental representation of the future. Similar research, pertaining to language-and-thought, has examined grammatical and lexical differences that allow clean categorical distinctions (Lupyan et al., 2020). In our experiments we focused on within-language differences, which we hypothesized to have perceptual consequences based on fluid grammatical features rather than categorical ones. Perceptual traces of different mental representations may surface with more clean-cut categories. To the best of our knowledge, there has been very little research on such comparisons as detailed in our theoretical framework. Although this may be a legitimate possibility, we would still advocate investigating possible effects with a different paradigm than that tested in the present paper, especially in regards with the lack of a signal of possible perceptual effects.

A recent account, which contends the notion of FTR strength as the responsible driver for temporal discounting, argues that rather modality and, therefore, the amount of certainty transmitted in a FTR may be responsible for probability discounting (rather than temporal discounting) (Robertson & Roberts, 2020). In order to dismiss the notion that temporal distance is encoded in future tense, Robertson and Roberts 2020 conducted a similar experimental paradigm as part of their Study 2. They also experimentally manipulated the present and future tense in English- (high degree of FTR) and Dutch-speakers (low degree of FTR) and used temporal adverbials to invoke different temporal locations on a timeline. Their result matches with the results found in this paper: they could not find a within-language effect, where the future tense

invoked more temporal distance (Robertson & Roberts, 2020). The authors argued that their results indicated that FTR strength should not only be determined by future tense, but also by modal variations, which often encode FTR. This is especially true given that their results indicated that the English- and Dutch-speakers in their study were most likely probability discounting, and not temporal discounting. The distinction between future tense and modal variations as attentional cues is important, however, in terms of the thinking-for-speaking hypothesis it also raises two important issues. The first one is related to defining the actual linguistic elements that are most prevalent in FTR, and the second is related to defining what exactly can be considered as future verbal tense. Future research may need to address these intertwined issues to get a more exhaustive picture of the mechanisms at stake.

It may be the case that our hypothesis proved to be wrong, in that different FTR may not have any effect on the way we represent the future. Although our data would suggest this to be true, more data would definitely need to be collected, using different signal traces, maybe linked to other cognitive mechanisms, such as memory encoding (as discussed in the theoretical framework see Chapter 2).

So, in the next chapter we present a study that did exactly this, namely, to investigate the effect of the grammaticalization of the future on recognition memory.

3.2 EXPLORING ALTERNATIVE COGNITIVE MECHANISMS AND HEALTH-PSYCHOLOGICAL APPLICATIONS: The Grammaticalization of the Future Does Not Influence Recognition of Relevant Health Information

Part of the study presented in this chapter was published as preprint:

Jäggi, T., Sato, S., & Gygax, P. M. (2024). The grammaticalization of the future does not influence recognition of relevant health information. https://doi.org/10.31234/osf.io/4h8gs

3.2.1 Summary

In the last chapter, we have started to experimentally investigate the claim that the grammaticalization of the future may impact our mental representations of future events. So far, this study has mainly focused on the perceived distance of future events as cognitive mechanism to impact mental representations of the future, although with inconclusive results. The aim of this study was to explore the effects of the grammaticalization of the future on recognition memory as cognitive mechanism to affect mental representations of future events. We used gain-framed health messages to further explore potential applications of the hypothesized effect of the grammaticalization of the future. Concretely, we conducted an experiment, where participants were presented with sentences containing medical information about the effects of certain natural remedies. After the presentation of all sentences, participants were asked to identify the natural remedies that had been presented to them. Using different temporal conditions (i.e., health messages presented in the present or future tense), we assessed the number of correct answers. No effect of temporal condition was found, suggesting that the proposed theoretical framework may be inaccurate. We discuss several possibilities to further discern our results.

3.2.2 Introduction

In 2013, M. K. Chen (2013) published an article suggesting that grammatical differences across languages in the tenses used to refer to future events, may impact future-related savings and health behavior. Other researchers followed to show similar relationships (e.g., S. Kim & Filimonau, 2017; Liang et al., 2018; Mavisakalyan et al., 2022). However, some researchers have emphasized potential methodological problems related to the correlational nature of these studies (e.g., Roberts et al., 2015). Recently, some have experimentally addressed these concepts, interested in uncovering the possible underlying cognitive mechanisms, yet data so far is highly inconclusive (for a review see our theoretical framework).

In the proposed framework we reviewed studies within the field of possible effects of the grammaticalization of the future and proposed a psycholinguistic framework to experimentally study possible cognitive effects thereof. Based on our framework, in the present paper, we suggest that memory is important when generating mental representations of future events, and that it may be impacted by differing degrees of grammaticalization. To supplement past experimental studies on fundamental cognitive mechanisms, we also add an applied health psychological context by focusing on gain-framed messages in the first-person perspective.

3.2.2.1 Grammaticalization of the future

Talking about the future differs from talking about the past or the present (Dahl, 2000). When we talk about the past or the present, we know that an event happened because we lived through it during the past, or we are experiencing an event in this moment. Talking about the future involves anticipating what may, or may not, happen. There are therefore different degrees of certainty that an event will take place or not. For scheduled or planned events in the close future, there is usually a higher probability that they will happen as anticipated (e.g., “Tomorrow at noon, I am going to take the train to Paris.”). However, other events may have a higher level of uncertainty (e.g., “We do not know yet, which team will win the tournament next weekend.”). These differing degrees of uncertainty are usually reflected in differing grammatical realizations to refer to the future (Dahl, 1985, 2000).

These realizations, such as different grammatical and lexical forms, can be described under the umbrella term *future time reference* (FTR; (Dahl, 2000). Grammatical and lexical forms,

for example, range from temporal adverbs that mark the future in a clause (e.g., "*Tomorrow*, we are going to the theater."), to modal verbs that mark a future tense construction like in German (e.g., "In einigen Wochen *werden* wir uns wiedersehen." [In a few weeks, we will meet again.]; Dahl, 1996) and grammaticalized verb forms like future tense constructions in French (e.g., "Dans quelques semaines, nous *reverrons*." [In a few weeks, we will meet again.]; Comeau & Villeneuve, 2016). These differences can be categorized from low degree of FTR, meaning that a future construction is not or only moderately grammaticalized (e.g., using the present tense in German to indicate a future event: "*Morgen* regnet es." [Tomorrow, it rains.]) to high degree of FTR, meaning that a future construction is highly grammaticalized (e.g., in French, the direct inflection of the verb pleuvoir [to rain] changes when using the future tense: "Demain, il pleuv*ra*." [Tomorrow, it will rain.]; see our theoretical framework).

The degree of FTR can vary between languages – such as between German and French, where the French future tense is more grammaticalized –, but more importantly for this paper, even within a language (Bybee et al., 1991, 1994; Dahl, 2000). For example, German officially applies a construction associated with a higher degree of FTR that uses the modal verb *werden* (to become; e.g., "In einigen Wochen *werden* wir uns wiedersehen." [In a few weeks, we will meet again.]) paired with the infinitive verb form to indicate FTR (Dahl, 2000). However, German also allows speakers to a construction associated with a lower degree of FTR. This construction uses the present tense paired with a temporal adverbial (e.g., "*Morgen* regnet es." [Tomorrow, it rains.]) and is frequently employed in spoken – and to a certain extent in written – language to refer to the future (Dahl, 1996).

3.2.2.2 Practical implications of the grammaticalization of the future

The first to draw attention to possible practical implications of the grammaticalizations of the future was M. K. Chen (2013) in his seminal paper. They explored the link between degree of FTR and behavioral outcomes such as retirement assets or health behaviors on a global scale across different countries and languages. In a nutshell, they found that people who spoke languages with a low degree of FTR were more likely to save additional retirement assets and comply with more healthy behaviors, compared to people who spoke languages with a high degree of FTR. They proposed two mechanisms to their so-called *language-savings-hypothesis* (LSH): (1) speakers of languages with a lower degree of FTR perceive the future closer to the

present and (2) the future is more *concrete* for them compared to speakers of languages with a higher degree of FTR.

Numerous researchers adopted M. K. Chen's (2013) LSH to show a link between differing degrees of FTR and corporate savings behavior (S. Chen et al., 2017), corporate responsibility (Liang et al., 2018), research and development investment (Liang et al., 2018), environmental behavior and policies (Mavisakalyan et al., 2018), pro-environmental attitudes (S. Kim & Filimonau, 2017), future-oriented policies in general (Pérez & Tavits, 2017), as well as religiosity (Mavisakalyan et al., 2022). Other researchers engaged critically with M. K. Chen's (2013) research arguing that the proposed correlations did not correctly account for cultural traits, such as geographical and historical relatedness of languages. When the data were reanalyzed with adequately accounting for the proposed predictors, the correlation did not yield significance anymore (Roberts et al., 2015).

Some studies engaged with the criticism posed by Roberts et al. (2015) and implemented an experimental approach to study the LSH (e.g., Sutter et al., 2018; J. I. Chen et al., 2019). However, those studies were quite inconclusive. Sutter et al. (2018), for example, conducted a study in a bilingual city testing German- and Italian-speaking school children in their *intertemporal choice preference*. Intertemporal choice preference refers to a preference in the decision pattern, where people decide whether they prefer later and larger rewards or sooner and smaller rewards. In line with the LSH, the researchers found that the German-speaking children showed a more future-oriented intertemporal choice preference (i.e., later-larger reward), compared to the Italian-speaking children. However, another study comparing five different languages with increasing degrees of FTR found results opposite to the LSH (Thoma & Tytus, 2018). Again, they used an intertemporal choice task with scenarios about financial and health decisions and found that participants generally always preferred later-larger options, yet this effect was attenuated with *increasing* degrees of FTR (i.e., contrary to what LSH would predict). J. I. Chen et al. (2019) compared two different degrees of FTR within Mandarin. Mandarin allows using either a higher degree of FTR similar to the future tense or a lower degree of FTR similar to the present tense to refer to future events. The researchers examined whether in an intertemporal choice task, participants would take different decisions based on the FTR condition they were assigned to (i.e., low vs. high degree of FTR). Again, they found the opposite effect to what was predicted by the LSH, showing that participants were more patient to receive a reward in the future when the

future tense was presented, compared to the present tense. So, the discussion of whether differences in FTR affect how we perceive the future is, to the best of our knowledge, still open.

3.2.2.3 Theoretical framework to study cognitive effects of FTR

In the previous chapter (2. THEORETICAL FRAMEWORK) we proposed a specific framework that could account for effects congruent with the LSH. More specifically, we provided experimental considerations grounded in psycholinguistics concepts such as the thinking-for-speaking hypothesis by Slobin (2003). The thinking-for-speaking hypothesis states that as we prepare ourselves to utter a thought, we need to enclose this thought with the linguistic corset provided by the language we speak. As we think and speak, we focus our attention to the habitually disclosed structures encoded within our language and direct our attention effortlessly towards them. For example, German as a language that mainly uses a low degree of FTR (i.e., generally expressing future-related clauses with the present tense) directs German-speakers attention to connect future events with using the present tense. This could transmit the impression that the future is closer or more concrete with regards to the present. Contrarily, French or English, as languages that mainly use a high degree of FTR (i.e., expressing future-related clauses with an inflected future tense), distinguish more clearly between the present and the future, directing their speakers attention away from the present.

These linguistic differences most likely have consequences on our mental representations of future events. Mental representations have a specific role when we process language, or more specifically discourse (Johnson-Laird, 1983; Kintsch & van Dijk, 1978). Mental representations of discourse events are constructed during language processing, and are constantly updated when confronted with new information, which requires memory functions such as short term and long term working memory (Ericsson & Kintsch, 1995; Zwaan & Radvansky, 1998). Temporal information is considered one of five essential dimensions required to construct coherent mental representations (Zwaan & Radvansky, 1998). Accordingly, temporal cues, such as grammatical tense and aspect markers, have been shown to impact the construction of mental representations of events (Becker et al., 2013; Carreiras et al., 1997; Ferretti et al., 2009; Madden & Zwaan, 2003; Magliano & Schleich, 2000).

In the study presented in Chapter 3.1, we studied the hypothesis that the degree of FTR within and between languages (French and German) may also impact mental representations of

future events. More specifically, we proposed that the degree of FTR would impact the perceived distant of a future event on a timeline. However, in four consecutive experiments, this hypothesis was not supported, neither within nor between languages. Similarly, Robertson and Roberts (2020), in a subjective temporal distance task, did not find any FTR effects within language.

However, although these studies seem to indicate that FTR does not affect at least the *perceived distance of the future*, other underlying cognitive mechanisms may still be affected by FTR. In our theoretical framework, we proposed other cognitive mechanisms that could be influenced by FTR, based on the thinking-for-speaking hypothesis and on properties of mental representations. For example, and relevant for the current study is the idea that different degrees of FTR may impact *memory traces* differently. The rationale behind this derives from the importance of memory when constructing mental representations (e.g., (Zwaan & Radvansky, 1998), or more specifically, the importance of *prospection*. Prospection refers to the memory process through which mental representations of future outcomes are built. To understand the impact of FTR on prospection, we can consult the taxonomy of prospection proposed by Szpunar et al. (2016). Generally, the authors identified four modes of prospection: *simulation* (constructing a comprehensive mental representation of the future), *prediction* (estimating the likelihood of an event in the future), *intention* (determining a goal), and *planning* (organization needed to reach a goal). These modes can be divided into episodic and/or semantic processes. Episodic memory involves autobiographic information (e.g., *in spring, I will suffer from allergies*) and semantic memory involves general or abstract information (e.g., *Aspirin will help in case of a headache*).

Importantly, episodic memory has been shown to be temporally structured (Cohn-Sheehy & Ranganath, 2017). This structure is evident in that events happening in close succession are better recalled compared to more discontinued events (Howard & Kahana, 2002; Jenkins & Ranganath, 2010). Also, recent items are better recalled in comparison to earlier items (Polyn & Kahana, 2008). We suggested that differing degrees of FTR could impact this temporally organized memory structure by interfering with the simulation mode of prospection, which in turn would lead to different mental representations. Concretely, we theorize that lowering the degree of FTR of a sentence such as *Aspirin will help me in case of a headache* to *Aspirin helps me in case of a headache*, transforms this more abstract information to a more concrete information and thus, causing a differing mental representation of the information.

3.2.2.4 The current study

In this study, we test memory processes as one of the proposed mechanisms affected by FTR by using an experimental setup that evaluates how much information people can retain depending on the degrees of FTR used. Further, we are interested in whether there is an application of FTR in terms of health-related messages in a health-psychological context. We believe this to be quite important, as health messages and the suspected benefit for people complying with these proposed health behaviors rely on how well medical information is actually retained (e.g., Kessels, 2003; Ley, 1989). To maximize a health-psychological perspective, we test the effects of different degrees of FTR on *gain-framed health messages*.

Messages that are regarded as gain- or loss-framed are designed to invoke a behavioral change in a recipient by either focusing on the positive (gain-frame) or the negative effects (loss-frame) of a behavior change (e.g., O'Keefe & Jensen, 2006). For example, a sentence such as *if you keep smoking your risk for cardio-vascular disease will increase* is considered loss-framed compared to a sentence such as *if you stop smoking your general fitness will improve*, which is considered gain-framed. In terms of which type of message is more persuasive, meta-analyses seem to indicate that, for messages in the context of health behaviors, there is a slight advantage when using gain-framed messages (O'Keefe & Jensen, 2006, 2007, 2009). The lack of effectiveness for loss-framed messages is most likely due to reactance that can be elicited towards freedom-threatening language. Loss-framed messages are more likely to elicit reactance and therefore, lose their effect of being more persuasive (Reynolds-Tylus, 2019). Further, O'Keefe & Jensen's (2008) meta-analysis showed that gain-framed messages induce more engagement with the information compared to loss-framed messages. In the present experiment, to reduce potential reactance and keep participants engaged, we decided to only use gain-framed messages for the experimental items.

This is the first study – to our knowledge – to assess the effect of differing degrees of FTR on memory-processes, specifically on recognition. Based on our considerations regarding the role of memory in the construction of mental representations of the future, we hypothesize that German-speaking participants will recognize more items that are presented with a lower degree of FTR compared to those presented with a higher degree of FTR. With regards to health communication, this would signify a simple way to make health messages more effective – at least in terms of remembering them.

3.2.3 Method

3.2.3.1 Participants

Sixty participants were recruited using Prolific (www.prolific.co) [12.02.2021], a webservice specialized in online research. The only inclusion criterion for the study was to speak German as a first language. Although participants' first language was German, all participants spoke at least one other language. The sample consisted of 49 female and 9 male participants (two did not answer this question) with a mean age *M* = 22.6 (*SD* = 6.5). Before starting the online survey, participants consented to the terms of the study, which was approved by the ethics committee of the University of Fribourg.

3.2.3.2 Materials and Design

3.2.3.2.1 Stimuli and item construction

A total of 48 items were constructed for this study, where 32 were experimental items and 16 were filler items. Item construction followed a series of steps: first, a list of 32 alternative remedies along with their common physical and psychological health applications was created (e.g., taking ginger against nausea). We mostly chose remedies that have shown some degree of evidence-based efficacy. The rationale for choosing these alternative remedies was that people were less familiar with these remedies than with conventional ones, preventing any ceiling effects (i.e., all remedies would be too easy to memorize).

Second, we created sentences with the following structure: a) a health issue was presented ("if you feel nauseous"), b) an alternative remedy was presented ("and you take holy basil"), c) and an effect was implied ("you [to feel] better"). The 32 critical items were all gain-framed (e.g., feel better, get better, symptoms get better, recover), whereas filler items included eight loss-framed and eight neutrally-framed sentences (e.g., feel worse, nothing happens, don't know what happens, symptoms increase). This was to ensure that participants did not habituate to the outcome of a remedy/substance and read every item carefully. Further, to make the FTR explicit, we included "in the future" as part of the sentences.

In the lexical recognition task (see below) that followed the presentation of all sentences, 32 filler words were created and presented along with the 32 target words (i.e., remedies) from the experimental items. These additional words were semantically similar to the experimental words (e.g., remedy: *iron*; additional recognition word: *zinc*) and word length was kept as similar

as possible (72% of the additional recognition words varied up to three characters from the remedies). They were intended to elicit "no" responses from our participants contrary to the critical target words that were elicited "yes" responses. Further, we kept the word length of the presented items up to 11 characters. This measure was necessary, as a pretest found an interaction effect between the number of correct answers and word length. Concretely, the interaction indicated that words longer than 11 characters were especially poorly recognized in the future tense compared to the present tense condition. The supplementary materials of this chapter, such as further information on the pretest as well as the materials described here, are deposited on the OSF (see Appendix B).

3.2.3.2.2 Design and procedure

The experimental items were presented in two different conditions: a) using a low degree of FTR (present tense, Low FTR), b) using a high degree of FTR (future tense, High FTR) (see Table 6). Two rotated lists were created, where half of the items were presented with lower degree of FTR (present tense) and the other half was presented with a higher degree of FTR (future tense). Participants were randomly allocated to one of the two lists.

Table 6.

Examples of Critical Items in Two Different Conditions.

Condition	**Sentence in German [English translation]**
Low FTR	Wenn dir in der Zukunft übel ist, **fühlst** du dich mit Ingwer besser. [If you feel nauseous in the future, ginger *makes* you feel better.]
High FTR	Wenn dir in der Zukunft übel ist, **wirst** du dich mit Ingwer besser fühlen. [If you feel nauseous in the future, ginger *will make* you feel better.]

The experiment was programmed on the online survey tool Qualtrics (*Qualtrics*, 2021), as due to COVID 19 regulations it was not possible to test participants in the lab. Participants were recruited on the webservice Prolific (*Prolific*, 2014), which is a platform to find participants for online studies. Right at the beginning of the online study, participants signed for consent. The study information indicated that participants would read medical information that would be tested in a quiz in the second part of the experiment (recognition task). The true purpose of the

study was concealed and participants were told that the goal of the study was to investigate how medical information is processed.

Before the start of the experiment, participants shared additional information such as handedness, gender and age. The experiment started with participants reading the experimental sentences of one of two lists. After each item, they had to press *Next* to indicate that they finished reading the item and continue with the next sentence. After reading all sentences, participants were directly presented with the recognition task. For the recognition task, the remedies of the critical items were randomly presented intermixed with the filler words. The words were presented individually and participants were instructed to indicate whether or not they had seen the presented word among the sentences they had read earlier in the experiment by pressing either *Y* or *N* key on their keyboard. All sentences and stimuli in the recognition task were presented randomly. After the recognition task participants were debriefed. Participants took on average 10 minutes to finish the experiment.

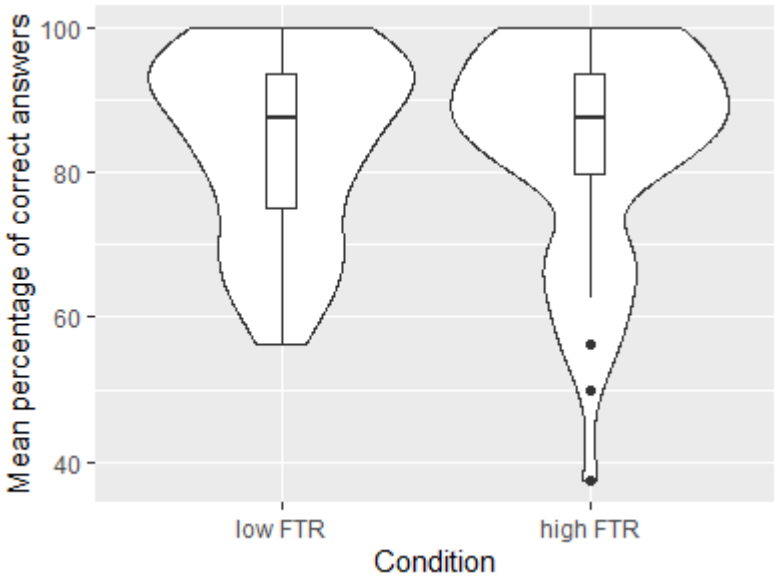
3.2.4 Results

Before we conducted the main hypothesis, we ensured participants did not answer the lexical recognition task by chance by calculating participants' d prime (*d'*). *D'* is a measure derived from signal detection theory that includes hit rates and false alarm rates (i.e. d' < 0 indicating an accuracy level below chance; Macmillan & Creelman, 2005). D' was calculated with the R package *psycho* and the corresponding function *dprime* (Makowski, 2018). All participants had *d'* scores higher than 0, indicating a better performance compared to answering by chance.

The distribution of the percentage of correct answers for both conditions is depicted in Figure 6. For condition Low FTR, participants answered 84.06% correct; for condition High FTR, participants answered 83.44% correct.

Figure 6.

Mean Percentage of Correct Answers per Conditions Low FTR and High FTR.



Note. The violin plot further depicts the distribution of the mean percentage of correct answers and the median thereof.

For the main analysis, we calculated a mixed effects logistic regression in R with the package *lme4* (Bates, 2015). The dependent variable *Correct answers* (TRUE/FALSE) was modeled as a function of *Time* (Low FTR/High FTR), *Distance* (number of items) and *Age* (in years) as fixed factors and *Participant* and *Item* as random intercept and *Time* as random slope by Participant and by Item. The fixed effects *Distance* and *Age* were introduced to the model as control variables. *Distance* was determined by the number of items between a certain $item_i$ presented in the reading task and $item_i$ presented in the recognition task. As the items in the reading (48 items) and recognition (64 items) task were presented randomly, *Distance* could theoretically range from 1 to 112 (actual range: 9 – 110).

The described model did not converge. We then reduced the random structure to only include *Participant* and *Item* as random intercept. The final model converged and included the main effects for *Time* and *Distance* as fixed factors. The final model is summarized in Table 7.

Table 7.

Results of Mixed Effects Logistic Regression Fitted for Correct Answers*, with* Time*,* Distance *and* Age *as Fixed Effects.*

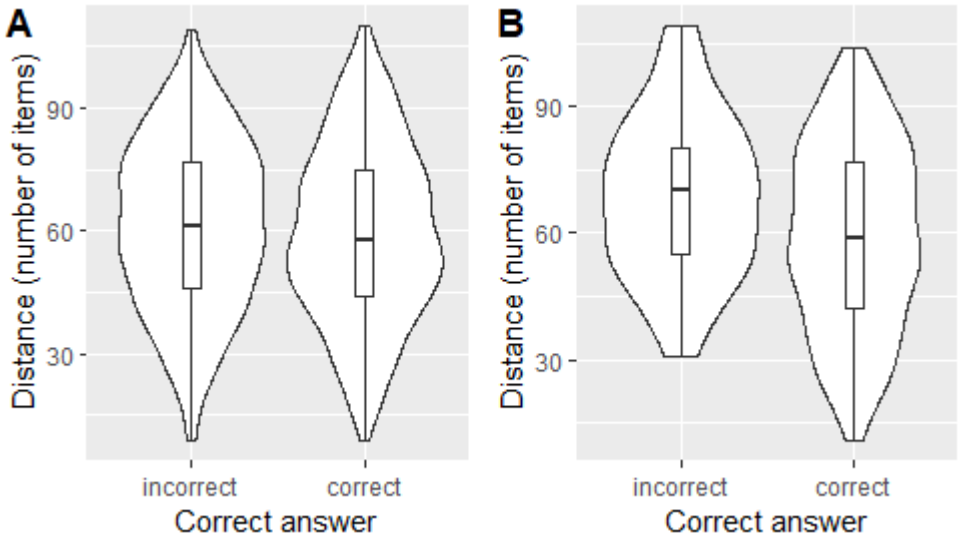
Model / Fixed effects	Estimate (β)	Std. Error	z-value	p(>|z|)
Correct answers ~ Time + Distance + (1|Item) + (1|Participants)				
Intercept	1.11	.55	2.03	< .05
Time (High FTR)	-.06	.13	-.45	.65
Distance	-.01	.00	-2.35	< .05
Age	.06	.02	2.70	< .01

The results of the final model for the fixed effects showed that *Time* did not significantly explain variance. However, *Age* and *Distance* yielded significance in our final model, suggesting for *Age* a change of 0.06 considering the log odds of answering correctly and a change of -0.01 for *Distance*. For *Age*, that means that as participants are older, the log odds of answering correctly increases. For *Distance*, that means that as the distance (in terms of number of items between the presented $item_i$ and the recognition $item_{i)}$ increases, the log odds of answering correctly decreases. Random effects showed greater variability derived from *Participants* (Var = 0.66, SD = 0.81) compared to *Items* (Var = 0.27, SD = 0.52).

As *Age* and *Distance* yielded significance, further analyses were conducted to ensure that the effects of *Age* and *Distance* were not masking the effect of *Time*. First, we inspected the descriptive data on *Age* and noticed an interesting pattern: participants above the median (*Mdn* = 21), had a different distribution of *Correct answers* compared to participants below or equal the median. This distribution can be observed in Figure 7.

Figure 7.

Distribution of Distance in Incorrect and Correct Answers. A) Participants Aged up to 21 Years; B) Participants Aged 22 years and Older.



From the distribution in Figure 7 it can be noticed, that there is a difference between the two age groups: participants aged 22 and older showed no false answers when the distance between item presentation and item recognition was distanced below 30 items. So, we further modelled two mixed effect logistic models for each age group. The properties of these models followed the same properties as our final model above. In the model for the younger aged group, none of the fixed effects (*Age*, *Distance* and *Time*) did yield significance. In the model for the older aged group, *Distance* did still yield significance, but *Age* and *Time* did not.

For the older aged group, we further excluded cases where the *Distance* of the number of items was smaller than 30 items and again, modelled a mixed effects logistic model with the same properties as illustrated before. In this model, *Distance* did not yield significance, and neither did *Time*. See supplementary materials on OSF for all the additional model summaries (Appendix B).

Finally, to ensure that the lack of effect of *Time* truly reflects the relative strength of our evidence, and it is not due to missing statistical power, we conducted a Bayes factor analysis (Dienes, 2014; Dienes et al., 2018). In other terms, we attempted to verify that our data were sufficiently sensitive to detect and strongly support H0 (no effect) over H1 (effect of FTR). To determine the evidence for H0 over H1 and calculate a Bayes factor, a plausible range of effect is needed. We followed Silvey's et al. (2021) approach to calculate Bayes factors for mixed effects

logistic regression models, and set the estimated effect using the value of the intercept from our model (i.e., 1.11). Further we used the estimate for the effect of FTR (-0.06) and the standard error of this estimate (0.13) of the final model (see Table 2). To calculate the Bayes factor, the Bf function by Dienes & Mclatchie (2017) and updated by Bence Palfi was set as half-normal distribution (Dienes, 2019). Using the conventional cut-off of .30 suggested by Jeffreys (1961) the resulting Bayesian analysis showed strong evidence for the null hypothesis over the existence of an effect of *Time* (B = .15). This Bayes factor can be taken as moderate evidence for the null hypothesis over the alternative hypothesis (i.e., the alternative hypothesis is .15 times more likely than the null hypothesis). In other terms, our data were sensitive enough to evaluate that the null hypothesis was very likely.

3.2.5 Discussion

We examined the effect of FTR on recognition when presenting health messages geared at taking specific remedies for different health issues. According to our proposed framework, we expected the FTR manipulation to affect the processing of health messages, which in turn would manifest in a lexical memory task (of the remedies). More precisely, we hypothesized that using a lower degree of FTR would increase recognition rate of remedies, and a higher degree of FTR would decrease recognition rate. The results of our experiment refuted this hypothesis and supported the idea that FTR had no effect on recognition and memory.

These results provide insight into the proposed Language-Saving Hypothesis (M. K. Chen, 2013) from an experimental point of view. Even though our study is the first to assess the effect of FTR on recognition and memory, our results are in line with the series of experiments presented in the last study (Chapter 3.1) as well as other studies that evaluated temporal distance (Robertson & Roberts, 2020) or intertemporal choice (J. I. Chen et al., 2019; Thoma & Tytus, 2018). The former studies did not find any effect of the degree of FTR, and the latter even found opposite effects from those predicted by LSH. So, this study adds experimental evidence to further question the validity of the LSH.

Still, even if FTR showed to have no effect in the final model, interestingly, age and the distance between the item presentation and the item recognition did. Our data suggest that older adults recognized items better than younger adults. This finding contradicts the general notion

that the discrimination of correct items declines with age (Fraundorf et al., 2019). However, the age difference for discriminating between new and old text stimuli is less attenuated (Fraundorf et al., 2019). Further, our results are in line with research on age differences in recognition memory suggesting that motivational factors, such as how interesting the content of the presented stimuli is, are important for older adults (Castel, 2007; Castel et al., 2002). Thus, older adults in our sample could have been more interested in the health messages, which motivated them to perform better than younger adults. In light of this increased motivation, the second finding – namely that recognition items under a certain distance (i.e., less than 30 items away) were all correctly identified in the older age group – could be attributed to recency effects found in short term memory processes for recognition memory (McElree & Dosher, 1989; Monsell, 1978). Nevertheless, our post-hoc analyses as well as the additional Bayesian analysis still confirmed our null result.

What do these results mean in terms of applied health communication? If our hypothesis were to be confirmed, this would mean that health messages in languages with a low degree of FTR would benefit from using the present tense instead of the future tense when mentioning future health issues. However, from our proposed methodological approach, it becomes clear that if the degree of FTR has an effect on cognitive structures, it may not be on recognition memory. Future studies that investigate the effect of FTR on memory-related processes may consider to invoke stronger involvement with prospection and episodic memory. As prospection is the process of mentally representing possible future outcomes (Gilbert & Wilson, 2007) and relies on episodic memory processes (Szpunar et al., 2016), a paradigm that explicitly invokes simulating future events may be more suitable and may reveal FTR effects. Such a paradigm could involve using a narrative story. Narrative stories consist of either personal stories, testimonials, or anecdotes – generally illustrative examples of others' experiences relevant to the decision. These stories help people learn by providing a model from which attitudes and skills can be emulated (Bekker et al., 2013). Narrative stories in particular can make information more memorable by interrupting people's processing and recall of factual information (Betsch et al., 2011). In all, as a narrative story provides ample details to simulate a more complex mental representation of a future event, using narrative stories may invoke an effect on FTR on memory processes.

Along these lines, another approach to follow in future experiments could involve emerging a participant fully to one FTR condition by using a between-participant design. In the current study, participants were subjected to both, low and high degree of FTR. Maybe the effect of FTR was too small to be found in such an experimental setting, and could be provoked by longer exposure. This strategy could be regarded as *temporal framing*. Temporal framing is part of the Temporal Construal Theory by Liberman and Trope (1998, 2003) and is involved in how temporal distance is perceived as more concrete or more distant depending on the temporal frame of a message or text.

On a more individual-differences level, research on the impact of the Temporal Construal Theory has also found a relationship between the perceived temporal distance and the effect of participants' future orientation (Kees, 2010; J. Kim & Nan, 2016; Zhao et al., 2015). Future orientation is a trait that identifies how people process, evaluate and act upon information related to the future (Joireman et al., 2012). As future orientation describes a difference in personality, it could be that our participants simply reacted differently to the experimental manipulation depending on their future orientation trait. The larger distribution in the condition with a higher degree of FTR found in our data could indicate a possible involvement of another factor such as future orientation. Most likely, future orientation should moderate the effect of FTR, in that, more future-oriented participants may be more susceptible to an FTR manipulation compared to less future-oriented participants. It could also be that participants in the lower and higher poles of future-orientation may be impermeable to FTR manipulations, and that only those in the middle may be impacted. As there is no way in discerning this assumption with our data, future research may look into this possible relationship.

3.2.6 Conclusions for the Upcoming Study

Although our data do not support M. K. Chen's (2013) LSH and the assumptions formulated in our theoretical framework (Chapter 2), dismissing FTR as an important factor when thinking about the future may be too hasty. Indeed, as raised in this discussion and also in the theoretical framework, other factors may be determinant in the propensity of different FTR to affect the way we perceive the future. For example, future orientation might have to be

accounted for, and other methodological considerations (such as using narratives to immerse participants in different FTR conditions) might bring FTR effects to light.

We want to address these issues in the upcoming study (Chapter 3.3) and test the above discussed methodological considerations such as the use of narratives or exploration of individual factors. Nevertheless, we have to consider the possibility that our initial framework may contain some theoretical weaknesses. Such a weakness is exposed by the recent research of Robertson and Roberts (2020). Interestingly, they criticize how the typological differences in FTR in previous research were usually reduced to differences in future tense, without considering that a lot of FTR constructions contain modal identifiers. Especially, since these modal constructions bear specific meaning beyond futurity pertaining to probability. As such, they urge future research to consider accounting for modality – specifically for epistemic modality that carries the meaning of probability – and to move from the proposed mechanism of temporal distance to contemplate the role of probability discounting. Probability discounting refers to the tendency to appoint less probability to outcomes that lie further in the future. In the next study, we expand the theoretical framework and account for this criticism placed by Robertson and Roberts (2020) in that we consider the role of epistemic modality and the entanglement of FTR. We regard the next study in this thesis as final test – at least within this theoretical framework – to evaluate the whether the proposed effect of the grammaticalization of the future should further be studied.

3.3 EXPANDING THE FRAMEWORK: Skin Cancer Risk Assessment and the Grammaticalization of the Future: The Role of Epistemic Modality

Part of the study presented in this chapter was published as:
Jäggi, T., Sato, S., & Gygax, P. M. (2023). Skin cancer risk assessment and the grammaticalization of the future: The role of epistemic modality when temporally framing health information. *Language and Health, 1*(1), p. 58-66. https://doi.org/10.1016/j.laheal.2023.07.001

3.3.1 Summary

In the theoretical framework of this thesis, we proposed the idea that the grammaticalization of the future may impact mental representations of future events. However, as in the last chapters (3.1 & 3.2) presented, we did not find results supporting our proposed hypothesis. Recently, Robertson and Roberts (2020) suggested to change the experimental approach to not only look at grammaticalization of the future in terms of future tense, but to include epistemic modality, which instead of temporal distance rather marks *probability* or *likelihood*. The aim of this study was to conclusively assess the proposed framework with the extension of epistemic modality to evaluate whether we should consider the effect of the grammaticalization of the future in future research. Effectively, we looked at three aspects. First, we want to assess the role of epistemic modality within the framework of the grammaticalization of the future. Second, we wanted to apply a potential effect of epistemic modality within a language in the context of effective health messages for skin cancer. And third, we wanted to evaluate the effect of individual factors such as *future orientation*.

Concretely, we conducted two similar experiments where we presented participants with narratives that varied in their outcome variable (cognitive vs. affective skin cancer likelihood). We manipulated the narratives both in terms of verb tense and epistemic modality. In the first experiment (cognitive likelihood), we found a main effect of epistemic modality. In the second experiment (affective likelihood), we found a main effect of verb tense and a statistical trend of epistemic modality. Interestingly, we did not find any effect of the individual factor future orientation. We discuss the results in terms of the significance for the theoretical framework and for applied research in health psychology.

3.3.2 Introduction

Along the chapters of this thesis we explored the idea that the grammaticalization of the future has an impact on mental representations of future events. As research in behavioral economics suggested (M. K. Chen, 2013), there seemed to be a correlational relationship between differing degrees of grammaticalization of the future between countries and behavioral (economic and health) outcomes. Our theoretical framework was proposed to analyze this matter from an experimental point of view. The theoretical base of this framework used the thinking-for-speaking hypothesis (Slobin, 2003), which assumes that grammatical features of a language can direct language users' attention to information conveyed by these grammatical structures. Further, we argued that mental representations of future events should be impacted by the degree of FTR, as temporal information is an important parameter to form mental representations in general (Johnson-Laird, 1983; Zwaan, 2004). The framework hypothesized certain cognitive mechanisms to have a direct impact on the mental representations of future events. The most promising mechanisms that were hypothesized to be impacted by different degrees of grammaticalization were temporal distance in mental representations (Chapter 3.1) or memory effects due to attentional processes (Chapter 3.2).

So far, our empirical work did not yield the hypothesized results (see Chapters 3.1 and 3.2). Recently, Robertson and Roberts (2020) proposed that the grammaticalization of the future should not only be studied considering tense, but also modality. As modality, and specifically epistemic modality, are commonly used to refer to the future, they should not be disregarded when studying the grammaticalization of the future. Further, Robertson and Roberts (2020) provide evidence that the grammaticalization of the future marks probability rather than temporal distance. Thus, for this study we expanded the theoretical framework including these important changes on the linguistic determinants and cognitive mechanisms. And we further developed the initial idea of the theoretical framework to apply the hypothesized effect of grammaticalization of the future in a health psychological context (as discussed in Chapter 2), concretely to see whether skin cancer risk perception can be impacted by considering epistemic modality.

3.3.2.1 Linguistic realizations of the future and their cognitive impact

As outlined in previous chapters, when we talk about the future, we are talking about events and situations that may or may not occur. This is inherently different than talking about the past or present, given that we know what happened in the past and we witness what is happening in the present. Compared to the past and present, future events are characterized by differing degrees of uncertainty (Dahl, 1985, 2000). For example, a scheduled meeting with a reliable friend is more likely to occur compared to a prediction about who will be the winner at a sports tournament.

These differences in certainty are linguistically reflected by using differing lexical and grammatical structures to mark the future (Bybee et al., 1991; Dahl, 2000). European languages commonly apply the present tense, when events are very likely to happen (i.e., scheduled events; e.g., *the train departs tomorrow at noon*). However, when the outcome of an event is based on a prediction, these languages can vary greatly in the linguistic devices used (Dahl, 2000). For example, in German one can use the present tense to make a prediction about the weather next week (e.g., *nächste Woche regnet es* [next week, it rains]), whereas in English it is required to use the future tense (e.g., next week, it will rain). Generally, the term to describe that an event refers to the future regardless of the linguistic device used, is also known as Future Time Reference (FTR).

The framework we used in previous chapters, emphasized that there are differing degrees of FTR, which depend on the grammaticalization of the linguistic device used (Bybee et al., 1994). For example, a weather forecast predicting rain for tomorrow would use differing linguistic devices in German and French, which differ in their degree of FTR. In German, this future event can be expressed using a modal verb construction, as in (1).

(1) German

Morgen wird es regnen.

Tomorrow will it rain:INFINITIVE.

'Tomorrow, it will rain.'

In French, the same expression requires an inflectional structure (i.e., the future tense is marked within the verb form), as in (2).

(2) French

Demain, *il pleuvra*.

Tomorrow it rain:FUTURE.

'Tomorrow, it will rain.'

In this example, French employs a higher degree of FTR as the linguistic device used is more grammaticalized (i.e., the future tense is marked directly within the verb form) compared with German. However, it is not only possible to distinguish between higher and lower degrees of FTR between languages, but also within a language. This is relevant in the current study, as we will investigate the role of differing degrees of FTR within German. German-speakers can use the present tense as well as the future tense to refer to future events, since FTR is not obligatory marked in the verb form when referring to the future (Dahl, 1996).

The theoretical framework presented in Chapter 2 hypothesized that the differing degrees of FTR between and within languages were to inflict differing mental representations of future events. Mental representations are constructed while discourse is processed and updated accordingly as new information is attained (Zwaan & Radvansky, 1998). Hence, we assumed the impact of FTR on mental representations to be explained by attentional processes described by the thinking-for-speaking hypothesis (TfS; Slobin, 2003). The TfS hypothesis proposes that when we are about to formulate our thoughts using language, we are bound by the grammatical constraints our language provides (Slobin, 2003). These constraints lead us to focus on the information conveyed by the grammatical structure used and can therefore affect mental representations. The TfS hypothesis hitherto has been studied in domains such as spatial relations (Bowerman & Choi, 2001), grammatical gender (Konishi, 1993; Sato et al., 2013), and grammatical aspect (Athanasopoulos & Bylund, 2013; Flecken et al., 2014). Within the proposed framework, the TfS hypothesis provided a potential explanation of how FTR affects mental representations of the future. For example, if a person expects a particular event to happen in two weeks and wants to tell another person about this event, they may use some degree of FTR to share their thoughts. As a lower degree of FTR can be characterized by using the present tense to refer to the future, this would impact mental representations differently than using a higher degree of FTR, where the idea of the future is encoded directly in the verb tense.

As we presented in our theoretical framework in Chapter 2, the effect of FTR on mental representations of future events was first explored by M. K. Chen (2013). They studied countries that are part of the OECD and compared their different saving and health behaviors based on panel data. These differences were correlated with whether or not it was obligatory to grammatically mark the future in those languages. Their results supported the hypothesis that people who speak languages with no obligatory marking in the verb tense (comparable to a lower degree of FTR) showed more retirement savings and stronger health behaviors compared to people who speak languages that obligate speakers to mark the future grammatically (comparable to the higher degree of FTR) (M. K. Chen, 2013). The correlational nature of this study has been strongly criticized and a reevaluation of the results, that controlled for cultural evolution, revealed no longer a statistical significance of FTR (Roberts et al., 2015).

Again, some studies followed M. K. Chen's (2013) initial large-scale correlational approach and found similar relationships (without controlling for cultural evolution) for corporate savings behavior (S. Chen et al., 2017), corporate responsibility (Liang et al., 2018), pro-environmental attitudes (S. Kim & Filimonau, 2017) as well as religiosity (Mavisakalyan et al., 2022). However, these studies fall under the same criticism expressed about M. K. Chen's study. Other studies addressed the criticism and explored experimental paradigms (J. I. Chen et al., 2019; Sutter et al., 2018; Thoma & Tytus, 2018). For example, Thoma & Tytus (2018) explored the effect of differing degrees of FTR on intertemporal choice preferences in five languages with differing degrees of FTR. In an intertemporal choice paradigm, people are asked to choose between a sooner-smaller vs. later-larger outcome. For example, a person has to choose whether they want to receive 50 coins today or 150 coins in 4 weeks. Depending on how much this person discounts the future, they will either decide to take the 50 coins now or 150 coins in 4 weeks. The researchers tested the LSH between languages, but also added a within-language experiment. Although they found an effect of FTR between and within languages, the effect was the opposite as hypothesized by the LSH. In sum, studies investigating the LSH experimentally present inconclusive results (J. I. Chen et al., 2019; Sutter et al., 2018).

So, in our theoretical framework we not only considered the criticism raised by Roberts et al. (2015) but also presented established experimental, psycholinguistic methods, which are better equipped to find underlying cognitive mechanisms that could explain the hypothesized effect of FTR on mental representations. As in the previous chapters presented, we

experimentally tested two hypothesized cognitive mechanisms, namely temporal distance and memory processes. In the first chapter of our empirical work (Chapter 3.1), we investigated in a series of experiments whether using different degrees of FTR within and between two languages would impact mental representations of future events regarding temporal distance. Participants were presented sentences of future events with lower and higher degrees of FTR and the temporal distance was determined by their response on visual analogue scale that represented a timeline. We hypothesized that sentences presented with a lower degree of FTR would be perceived as closer to the present on the timeline compared to sentences presented with a higher degree of FTR. Although we adjusted the study in four consecutive experiments, we could not find any effect of FTR on mental representations of the future.

Because in this study we could not find any effects, in the next study (Chapter 3.2) we switched to investigate an alternative cognitive mechanism to study the effect of FTR on recognition memory. In the study presented in Chapter 3.2, participants read sentences containing information on natural remedies and their effect on certain symptoms and disorders. These sentences were presented either with a lower or higher degree of FTR within a language (i.e., German). After reading all sentences participants were presented with a recognition task that consisted of a list of natural remedies, some from the sentences and some new, and participants had to decide whether they had already read about this natural remedy. We hypothesized that sentences presented with a lower FTR (i.e., the present tense) would be better memorized and therefore the recognition of the presented words would be better compared to sentences presented with a higher FTR (i.e., the future tense). We found no significant difference in the number of correct answers and concluded that FTR may not influence mental presentations through memory processes. Among the explanations that we suggested for this lack of effects, some required us to move beyond the existing theoretical framework.

3.3.2.2 Expanding the framework

Recently, Robertson and Roberts (2020) argued that the hypothesized effect of FTR may not be due to differences in temporal distance caused by using differing degrees of FTR (i.e., whether the present or future tense is used), but rather by differing degrees of certainty transmitted by modal constructions. Modality is a grammatical category that encodes speakers' attitudes and opinions with notions such as ability, obligation or probability (Bybee et al., 1994).

In some cases, modality can also be used in sentences to refer to future events. For example, the German future tense construction *werden* [to become] *+* infinitive is technically a modal verb construction (T. Janssen, 1989). Robertson and Roberts (2020) studied English, German and Dutch future constructions of situations with ascending uncertainty (i.e., from schedule that entails low uncertainty, to intention that entails medium uncertainty, up to predictions that entail high uncertainty) using an adapted elicitation task originally developed by Dahl (2000). The elicitation task consisted in participants reading sentences that described situations referring to future events, where they had to decide which grammatical FTR construction they would use in the specific situation. The researchers found that English and German speakers were more likely to use uncertain language (i.e., modal adverbs such as *maybe* or modal verbs such as *might*) as temporal distance increased (i.e., in one week vs. in two months). An important observation that they made was, that temporal distance was not influenced when they compared sentences in the present or future tense (similar to our study in Chapter 3.1).

These results indicate that FTR may rather mark uncertainty encoded by modality instead of temporal distance. Although there are different types of modality that describe distinct attitudes and opinions of speakers, epistemic modality is often associated with FTR, because it encodes notions of knowledge and belief, which can help us forecast the future (Bybee et al., 1991; Robertson & Roberts, 2020). Therefore it is relevant to consider for this study. Concretely, epistemic modality pertains to utterances that imply some sort of possibility, probability or inferred certainty (Bybee et al., 1994).

Epistemic modality in German can be expressed using a wide array of word classes, such as modal verbs (e.g., *Morgen* könnte *es regnen* [Tomorrow, it *could* rain]), modal adverbs (e.g., *Morgen regnet es* wahrscheinlich [Tomorrow, it will *probably* rain]), predicative adjectives (e.g., *Morgen ist es* möglich*, dass es regnen wird* [Tomorrow it is *possible* that it will rain]), nouns (e.g., *Morgen besteht die* Möglichkeit*, dass es regnen wird* [Tomorrow there is a *possibility* that it will rain]), and mental state predicates (e.g., *Ich* glaube*, dass es morgen regnen wird* [I *believe*, that tomorrow it will rain]) (Nuyts, 2001).

To facilitate the understanding of their modal functions, these different word classes can be grouped into three more general categories (Nuyts, 2001; Robertson & Roberts, 2020) pertaining to *modal modifiers*, *mental state predicates* and *modal verbs*. Although only modal modifiers and modal verbs are relevant in this study. Modal modifiers consist of modal adverbs,

adjectives and nouns that convey notions of certainty. They are regarded as the most specific and precise linguistic devices to do so (Nuyts, 2001). For example, on a scale from high to low certainty the adverb *certainly* would indicate the highest probability, *probably* still indicating a higher probability, *possibly* indicating a neutral middle point, and *uncertainly* indicating a low probability. German uses a similar set of adverbs to describe differing levels of epistemic modality (i.e., low vs. high probability). Thus we use this category for our current study when we manipulate epistemic modality. Modal verbs refer to set of verbs that have a differing use compared to conventional verbs and share properties with grammatical markers. Some modal verbs convey notions of epistemic modality (i.e., may, might), while others carry additional temporal meaning and are related to future tense constructions (i.e., will). Often it depends on the contextual meaning of a clause whether epistemic modality is expressed or not (Nuyts, 2001). This category is relevant for our study as the German future tense construction is technically a modal verb construction. To distinguish between these two categories of epistemic modality, for our experimental setup we refer to the modal modifiers as epistemic modality and to the German modal verb construction as tense, as we are still comparing its impact with that of the present tense.

In light of the entanglement between future tenses and modality, the question arises as to what role epistemic modality plays when evaluating clauses that refer to future events and how this could affect mental representations of future events. In their investigation, Robertson and Roberts (2020) compared the three languages English, Dutch and German regarding their use of modal constructions to refer to future events – which included the future tenses of these language – depending on the degree of certainty. Although, these languages pertain to the same language family (i.e., West Germanic languages), they differ, for example, in the obligatoriness to use the future tense – which in these languages is built using a modal verb – to refer to future events.

As the entanglement between tense and epistemic modality is not clear yet, Robertson and Roberts (2020) formulated two contradictory hypotheses. On the one hand, they hypothesized that the differences in future tense obligatoriness may lead English speakers to focus more on uncertainty and therefore (probability) discount more than German and Dutch speakers (as in those languages the future tense is not obligatory). On the other hand, they argued that it may rather depend on the relative frequency of the use of the future tenses. For example,

English speakers are required to use a modal construction to refer to the future, this means that compared to German speakers, who use it less frequent, English speakers are more commonly using the future tense. This could lead to differences in how the future tense is viewed in terms of conveying probabilistic notions, in that German speakers attribute less probability to clauses formulated in the future tense compared to English speakers. Robertson and Roberts' (2020) investigation clearly showed evidence for the latter hypothesis, so they concluded that tense should not be investigated isolated from (epistemic) modality. Thus, rather than focusing on a single grammatical construction (such as the future tense) it may be more fruitful to engage with the conceptual construct of probabilistic reasoning rather than temporal representations. These findings bear main consequences for our final study of this thesis as – so far – we considered FTR to mainly affect temporal representations, but not probabilistic reasoning.

So, what does this mean for the theoretical framework proposed in the beginning of this thesis? As we have been mainly hypothesizing about the cognitive mechanism that could be responsible for generating differing mental representations of future events as a function of FTR, we focused on the temporal dimension of FTR. In line with Robertson and Roberts (2020) suggestions, we deem necessary to also include epistemic modality as well as its different related outcome variables. Hence, for the current study we will take epistemic modality into account. This could indicate why in past investigations we could not find an effect of FTR on mental representations of the future.

3.3.2.3 Focusing on health-psychological applications

With the expected interaction of epistemic modality and future tense, we need to reconsider the cognitive mechanism that could affect the health-psychological applications proposed in our initial framework (Chapter 2). Initially, we suggested that within-language effects could have applications in health-psychological interventions. So, if using different degrees of FTR within a language would cause differing mental representations of a future event (e.g., being more attentive to future-related outcomes when using a present tense), we could use this effect to tailor more effective health messages. For example, a health message containing certain prevention behavior conveyed with a lower degree of FTR may lead people to be more attentive towards a health risk than the same message conveyed with a higher degree of FTR.

In Chapter 3.2, we presented – to the best of our knowledge – the first study to experimentally investigate this claim. We showed German speaking participants a series of sentences containing health information relating to the future in the present and future tense (i.e., lower and higher degree of FTR). After reading all the sentences, participants completed a recognition memory task regarding the health information in the sentences. We hypothesized that participants would recognize health information conveyed through the present tense better compared to health information conveyed through the future tense. However, we did not find any effect of the degree of FTR. Taking into consideration the expansion of the framework now including epistemic modality, this result may reflect to the interaction between temporality and probability associated to FTR. As Di Meola (2013) identifies in their linguistic investigation comparing the use of the present and future tense as FTR in German: the use of either the present or future tense for future events depends on the context of the situation. The meaning of the present and future tense for future events can differ between only signifying temporal notions, only probabilistic notions and in some situations a mix of both. There are also some cases where there is no difference in meaning between the two tenses (i.e., whether the present or future tense is used does not change the meaning in some contexts). So, in the study of Chapter 3.2, the difference in meaning between the present and the future tense may have been too low to effectively affect participants' memory.

One potential avenue that can explore the interaction between temporality and probability is health messages designed to prevent certain health conditions. Health messages usually entail a population-based probability to be afflicted by a certain health condition, which can increase by individual risk factors. Further, they involve a temporal horizon that can also influence given probability. A research field that comprise both of these notions relates to health messages associated with skin cancer risk. Compared to other types of cancer, the incidence of skin cancer has been steadily increasing since the past few decades and skin cancer is considered the most common type of cancer in Europe and particularly in Switzerland (e.g., Bulliard et al., 2009; Greinert, 2009). Also, prevention measures are very effective in mitigating the skin cancer risk and easier to follow compared to other types of cancer (Krebsliga Schweiz, 2017). So, the general goal of health messages related to skin cancer is to motivate populations at risk to display prevention behaviors.

To effectively motivate populations at risk, the literature on health messages for skin cancer prevention has found narratives to be the most effective form of communicating information and eliciting prevention behaviors compared to didactive messages stating statistical or general factual information (e.g., Dillard et al., 2018; Hinyard & Kreuter, 2007). Narratives generally refer to personal stories, testimonials, or anecdotes and they usually contain information that are relevant to take a decision or make an evaluation (e.g., Bekker et al., 2013). They help learning information by providing a model from which people can draw attitudes and skills. Narratives also make information more memorable, as they interfere with the processing of factual information (e.g., Betsch et al., 2011). However, the components of a successful (i.e., more effective) narrative are not yet fully understood (Dillard et al., 2018). So, with this study we wanted to contribute to the existing literature regarding narratives and prevention behaviors to reduce skin cancer risks. Further, we wanted to deliver an updated proof-of-concept by showing that considering epistemic modality in FTR might render the hypothesized effect detectable. Concretely, we can use the narratives to transmit skin cancer related information concerning risk factors, UV radiation and preventive behaviors and adjust the degree of FTR and epistemic modality to see whether this affects the perceived likelihood to suffer from skin cancer.

3.3.2.4 Future orientation as personality trait

Finally, we also wanted to consider whether certain personality characteristics may influence the hypothesized effects of FTR and epistemic modality. As discussed in Chapter 2, there are some individual measures that assess the way someone thinks about the future (e.g., future time perspective or future orientation). Future orientation refers to a personality trait that distinguishes between people that consider current behavior to have an impact on potential outcomes in the future compared to people that consider current behavior to have a lower impact on potential future outcomes (Joireman et al., 2012; Strathman et al., 1994). Studies found that people who are more future-oriented tend to generally exhibit healthier behaviors, such as exercise more or maintain their diet (for a review see Joireman et al., 2012), but also behaviors that reduce the risk for skin cancer, such as accept free sun cream (Orbell & Kyriakaki, 2008) and limit UV exposure (Heckman, 2009).

So, future orientation seems conceptually close to temporal discounting, which is the tendency to regard a desired outcome in the future as less valuable compared to one in the

present. Although both concepts pertain to consequences in the future especially related to health outcomes, it seems that empirically the two concepts are not related to each other (Teuscher & Mitchell, 2011). For example, whereas temporal discounting was found to be influenced in experimental designs, this was not the case for future orientation. This makes considering future orientation of people more compelling for this study, because it measures a relevant individual trait dimension that influences a person's future behavior. Our hypothesis for future orientation is that people who are more future-oriented may be more susceptible to the linguistic cues of FTR and epistemic modality.

3.3.2.5 The current study

The purpose of this study was threefold. First, we wanted to examine the role of epistemic modality and its possible entanglement with FTR in a prediction-like context (i.e., the probability to develop skin cancer). We conducted the study in German because the investigation by Robertson and Roberts (2020) showed that modal notions of (un)certainty are especially relevant when assessing prediction-like contexts in German.

Second, we wanted to contribute to the existing literature on effective health messages by altering the degree of FTR and epistemic modality in prevention-based narratives. For that, we chose the context of the probability to develop skin cancer, because the risk factors associated are concrete and measurable compared to other types of cancer, and prevention behaviors are bound to self-efficacy. This allows participants to predict the skin cancer risk based on behavior (Betsch et al., 2011).

Third, we aimed to examine whether future orientation as a trait influences the relationship of FTR and epistemic modality, as studies have suggested that people vary in how they process, evaluate and act upon information related to the future (Joireman et al., 2012). Since this personality trait could influence participant's probability estimation or the processing of health prevention messages in general, we will consider it in our analyses.

Our hypotheses assume that the characters portrayed in the narratives transmitted with certain epistemic modality are perceived as having a greater likelihood of developing skin cancer compared to the characters in the narratives transmitted with uncertain epistemic modality. At the same time, we assume that this effect is either weakened by using a high degree of FTR (i.e., decreasing likelihood) or strengthened by using a low degree of FTR in the narratives (increasing

likelihood). Concretely, we expect characters depicted in narratives transmitted with a low degree of FTR (present tense) and certain epistemic modality (modal adverb *definitely*) to be perceived as having a greater likelihood of developing skin cancer, whereas characters depicted in narratives transmitted with a higher degree of FTR (future tense) and uncertain epistemic modality (modal adverb *possibly*) will be perceived as having less likelihood of developing skin cancer. For characters depicted in narratives with a mixed present tense/uncertain epistemic modality we predict a lower perceived likelihood of developing skin cancer than for characters depicted in narratives with future tense/certain epistemic modality. Concerning participants' future-orientation, we hypothesize that future-oriented participants will be more susceptible to the tense/epistemic modality manipulation and estimate the likelihood of developing skin cancer higher compared to participants that are not future-oriented.

This study presents two identical experiments that differ in their outcome variable. Experiment 1 assesses cognitively-framed skin cancer likelihood estimation and Experiment 2 assess affectively-framed skin cancer likelihood estimation. Concretely, we test whether there is a difference in using a question touching on one's cognitive state (i.e., how likely one thinks about the potential likelihood of developing cancer) or affect (i.e., how likely one feels about the potential likelihood of developing cancer). The difference of framing such a question cognitively or affectively is thought to impact our processing pathways and may lead to differing likelihood estimations (E. Janssen et al., 2012). As these differing impacts are not clearly resolved in the literature, we will use both outcome variables.

3.3.3 Experiment 1: Cognitively-framed skin cancer likelihood estimation

3.3.3.1 Method

3.3.3.1.1 Participants

One hundred forty-nine participants were recruited via Prolific, i.e. an online service that facilitates the connection between suitable participants and researchers (*Prolific*, 2014). Inclusion criteria for the experiment was that participants are German-speakers as first language users. Participants were on average 33 years old (SD = 11) and the sample consisted of 84 male, 64 female and one participant with another gender. Almost all participants (*N* = 147) spoke at least one other language. Participants spend on average 9.5 minutes to read through the narratives and complete the questionnaire. The study was approved by the ethics committee of the

psychology department at the University of Fribourg and all participants gave their consent to participate in the study.

3.3.3.1.2 Materials and procedure

3.3.3.1.2.1 General information about skin cancer

Participants first received general information on skin cancer to assure that they had a similar point of departure in terms of information about skin cancer. This was important to avoid mayor differences in knowledge about skin cancer that could have influenced the probability assessment beyond our language manipulations. The information was transmitted using a text with general information that first described why skin cancer is a serious topic in Switzerland; second, described risk factors that have to be considered for probability assessment; third, specified differing UV radiation under different circumstances (e.g., stronger radiation near a body of water); and lastly, informed participants about prevention behaviors to reduce sunlight exposure (see Appendix C for OSF link to the general information). The information used for this general text about skin cancer was extracted from two information leaflets of the Swiss League Against Cancer (Krebsliga Schweiz, 2017, 2019). After this general narrative, participants were presented with the experimental narratives.

3.3.3.1.2.2 Narrative construction and pretest

We created four narratives that all included a fictional character's exposure to UV radiation during their job, their skin cancer risk and prevention behaviors (see Appendix C). The content of the narrative was based on recommendations by Brewer et al. (2007) for designing risk perception measures and included the following elements: (1) mentioning specific risks rather than vague ones; (2) determining a specific person whose risk is being assessed; (3) the risks should be deducible by the persons behavior; and (4) the risk should be analyzed within a given timeframe. Accordingly, our narratives first introduced the fictional character with their name and a fact about their life related to their career. Second, readers learnt that the character is starting a new job or career. The start of the new career is used to set the following health and risk behaviors in a future setting. Third, a description of the new career was given with special focus on the expected UV light exposure on the job. Fourth, a risk factor was mentioned in the narrative that pertained to the character. And last, a prevention strategy was presented that the

character used to reduce UV light exposure. See Figure 8 for an example of one of the narratives used.

Table 8.

Example of Narrative.

German version	English translation
Anna ist begeisterte Kraftsportlerin und verbringt ihre Freizeit regelmässig im Fitnessstudio. Seit einem Jahr verfolgt sie den Plan professionelle Bodybuilderin zu werden. Annas Anstrengungen machen sich bezahlt, denn sie *unterschreibt/wird unterschreiben* einen Sponsoring Vertrag für die nächsten fünf Jahre. Dies *ermöglicht*/*wird ermöglichen* ihr ermöglichen professionelles Bodybuilding zu betreiben. In den nächsten fünf Jahren *nimmt teil/wird teilnehmen* Anna an vielen Wettkämpfen. Die Wettkämpfe *finden statt/werden stattfinden* **möglicherweise/bestimmt** am Wasser, beispielsweise am Ufer eines Sees oder am Strand. Anna *geht/wird gehen* ausserdem regelmässig ins Solarium, denn sie findet, dass durch die Bräunung ihre Muskeln mehr zur Geltung kommen. Um sich von der Sonne zu schützen *geht/wird gehen* Anna **wahrscheinlich/definitiv** während der Mittagszeit von 11-15 Uhr sich im Schatten ausruhen.	Anna is an enthusiastic weightlifter and spends her free time regularly in the gym. For the past year, she has been pursuing the plan to become a professional bodybuilder. Anna's efforts are paying off as she *signs/will sign* a sponsorship contract for the next five years. This *allows/will allow* her to pursue professional bodybuilding. Over the next five years Anna *participates/will participate* in many competitions. The competitions *take/will take* place **probably/certainly** on the water, for example on the shore of a lake or on the beach. Anna also *goes/will go* to the tanning salon regularly because she finds that the tan shows off her muscles more. To protect herself from the sun, Anna **probably/definitely** *goes/will go* to rest in the shade during lunchtime from 11-15.

Note. Italicized words indicate where tense is manipulated and bold word indicate where epistemic modality is manipulated.

To ensure that the different UV conditions, risk factors and prevention behaviors were regarded as having a similar impact on the likelihood of developing skin cancer, we conducted a pretest. We recruited 32 participants for this pretest. The pretest first evaluated the comprehensibility of the general text information on skin cancer by asking participants whether or not they found the text easy to understand. Participants also had the opportunity to comment on the information text. Further, participants saw three lists with 16 UV conditions (e.g., to work as a geologist in the mountains), 12 risk factors (e.g., no or only slow tanning of the skin by the sun) and 13 prevention behaviors (e.g., using sunscreen with SPF 50), which they were asked to

rate their impact on developing skin cancer from (1) *very weak* to (5) *very strong* on a five-point scale. The means and standard deviations were calculated for each item of the UV radiation, risk factors and prevention behaviors, to decide on the configuration of the final narratives.

The narratives were experimentally manipulated regarding two different factors. The first manipulation determined the tense used in the narratives, either present or future tense. Although, the present tense was used, the narrative was still set in a future setting. The second manipulation set the narratives to include either certain or uncertain epistemic modality. Concretely, we used modal modifiers, which mark lexical uncertainty. We consulted the work of Robertson and Roberts (2020) to identify whether particular modal modifiers were considered to mark certain or uncertain epistemic modality. Further, we checked those modal modifiers for frequency using the German SUBTLEX-DE database (Brysbaert et al., 2011). The certain and uncertain modal modifiers were matched using the frequency count. See Table 9 for the specific modal modifiers used for the manipulation of epistemic modality.

Table 9.

Modal Modifiers Used for the Different Conditions of Epistemic Modality for the Narratives in German (English translation italicized).

Epistemic modality	Uncertain	Certain
Modal modifiers (lexical uncertainty)	Wahrscheinlich (*possibly*) Möglicherweise (*probably*)	Sicher (*sure*) Bestimmt (*definitely*)

3.3.3.1.2.3 Scale construction

For the skin cancer likelihood rating, we followed E. Janssen's et al. (2011) classification of likelihood measures, which can be divided into differing categories. First, absolute vs. comparative risk refers to the difference in having a reference point (i.e., person or population). Accordingly, a comparative risk measure would emphasize a person's risk compared to a specific group, as opposed to an absolute risk measure that uses no reference point. Second, conditional vs. unconditional risk refers to whether there is a condition tied to the likelihood or not. For example, a conditional measure would emphasize a person's risk given that a certain condition (e.g., the use of sunscreen) is true or not, whereas an unconditional measure is not tied to any condition. Third, cognitive vs. affective risk refers to whether the risk measure propels a rational

decision or rather an intuitive assessment (i.e., thinking vs. feeling). Since we were not interested in the estimation of participants' skin cancer likelihood for themselves, but rather for a third person, we decided to use an absolute, unconditional and cognitive measure, which had neither comparative nor conditional elements and focused on rational decision making of participants.

The original absolute, unconditional, cognitive scale was phrased as follows: *What do you think your chances are of getting skin cancer at some point in your life?* (E. Janssen et al., 2011) and participants could answer on a five-point scale from *very small* to *very big*. We adjusted the scale to reflect the likelihood estimation of a third person (i.e., the characters of our narratives), resulting in: *What do you think are Annas' chances of getting skin cancer at some point in her life?* [Wie hoch schätzen Sie Annas Wahrscheinlichkeit ein, irgendwann in ihrem Leben an Hautkrebs zu erkranken?]. Again, we used the German translated five-point scale from *very small* [sehr klein] to *very big* [sehr gross] to assess the perceived skin cancer likelihood.

3.3.3.1.2.4 Future orientation measure

We employed the Considerations of Future Consequences Scale (CFC-14) by Joireman et al. (2012), which is a well-validated measure that assesses future orientation in 14 items. The CFC-14 was especially studied regarding behavioral decisions that relate to the future such as how likely someone engages in exercise and healthy eating vs. how likely some engage is hedonistic and fast-reward activities such as gambling. We used the validated German version with 10 items translated by Kübel & Wittmann (2020). Each item is a statement, which is answered using the general question: *For each of the statements shown, please indicate whether or not the statement is characteristic of you.* [Inwieweit sind die folgenden Aussagen für Sie charakteristisch bzw. zutreffend?]. The items are responded using a seven-point Likert scale from 1 (*not at all like you* [überhaupt nicht charakteristisch für mich]) to 7 (*very much like you* [sehr charakteristisch für mich]). The evaluation of the CFC-14 results in two subscales that named future (CFC-F; measures orientation towards the future) and immediate (CFC-I; measures orientation towards the present). As the two subscales are correlated we used only the one that measured orientation towards the future in our analyses. See Table 10 for the German and English items.

Table 10.

German Items Translated from the English Version of the CFC-14 by Kübel & Wittmann (2020).

Item Nr.	German Items	English Items
1	Ich überlege, wie die Zukunft aussehen könnte und versuche, sie mit meinem täglichen Verhalten zu beeinflussen.	I consider how things might be in the future, and try to influence those things with my day to day behavior.
2	Oft verhalte ich mich auf eine bestimmte Art, um Ergebnisse zu erzielen, die vielleicht erst nach Jahren eintreten werden.	Often, I engage in a particular behavior in order to achieve outcomes that may not result for many years.
3	Ich handle nur um unmittelbare Bedürfnisse zu befriedigen und glaube, dass die Zukunft sich von alleine regeln wird.	I only act to satisfy immediate concerns, figuring the future will take care of itself.
4	Mein Verhalten wird nur von unmittelbaren Folgen (d.h. wenige Tage oder Wochen) meiner Handlungen beeinflusst.	My behavior is only influenced by the immediate (i.e., a matter of days or weeks) outcomes of my actions.
5	Es ist wichtig, Warnungen vor negativen Folgen ernst zu nehmen, selbst wenn diese erst viele Jahre später eintreffen.	I think it is important to take warnings about negative outcomes seriously even if the negative outcome will not occur for many years.
6	Im Allgemeinen ignoriere ich Warnungen über mögliche zukünftige Probleme, weil ich glaube, dass sie gelöst werden, bevor sie kritisch werden.	I generally ignore warnings about possible future problems because I think the problems will be resolved before they reach crisis level.
7	Ich glaube, dass es meist unnötig ist, gegenwärtig auf etwas zu verzichten, da man sich auch später um zukünftige Konsequenzen kümmern kann.	I think that sacrificing now is usually unnecessary since future outcomes can be dealt with at a later time.
8	Ich handle nur, um unmittelbare Bedürfnisse zu befriedigen und glaube, dass ich mich um eventuell eintretende Probleme später kümmern werde.	I only act to satisfy immediate concerns, figuring that I will take care of future problems that may occur at a later date.
9	Wenn ich eine Entscheidung treffe, denke ich darüber nach, wie sie mich in der Zukunft beeinflussen könnte.	When I make a decision, I think about how it might affect me in the future.
10	Mein Verhalten wird im Allgemeinen von zukünftigen Konsequenzen beeinflusst.	My behavior is generally influenced by future consequences.

3.3.3.1.2.5 Design and procedure

The experiment was programmed on Qualtrics (*Qualtrics*, 2021), a webservice to create and host online surveys. Upon starting the experiment, participants read a welcome note that explained the purpose of the study. Subsequently, participants were instructed to read the

consent form and give their informed consent. Then participants supplied information concerning their demographics (i.e., age and gender). Further, we asked about their first language as well their proficiency and exposure to other languages to make sure, that our participants were really first language German-speakers. After that, participants were informed that the skin cancer likelihood assessment would start next. They were instructed to read the first information text on skin cancer. When they felt they understood the information, they could continue. The general information was not visible after participants proceeded to the individual narratives.

After reading the text information on skin cancer, participants were randomly allocated to one of four rotated lists. Experimentally, the design consisted of a between-participant for tense (present vs. future tense), a within-participant design for epistemic modality (certain vs. uncertain modality) and future orientation as personality trait. With the between-participant design for tense, we wanted to extend the exposure of tense to maximize signal detection. This is a change from the experiments in Chapters 3.1 and 3.2, where tense was used in a within-participant design. We discussed this change as potential measure in Chapter 3.2 to increase the possible effect of tense. So, a participant reading narratives in the present tense would get two narratives with certain epistemic modality and two with uncertain epistemic modality. The order of the narratives was randomly assigned. After reading each narrative, participants answered the question concerning the likelihood assessment of skin cancer.

After the skin cancer assessment, participants completed the future orientation questionnaire. When they finished answering all items of the questionnaire, participants were asked whether they suspected a deviating study purpose. They could write this as a comment. Finally, the participants were debriefed and the experiment was over for them.

3.3.3.1.3 Pre-registration

The experiment in this study were pre-registered on OSF using the template by AsPredicted.org (see Appendix C for the link). The study design as well as the scales and questionnaire described above were pre-registered. The hypotheses as well as the statistical analysis described in the pre-registration were followed according to the pre-registration.

3.3.3.2 Results

To check our hypothesis, a mixed effects model was calculated to modal cognitive likelihood of developing skin cancer. We used the package *afex* (Singmann et al., 2020) in R (R Core Team, 2020) for our analyses. The dependent variable *cognitive likelihood* was modelled using *tense*, *epistemic modality*, *future orientation* as predictors. As the measurement of future orientation consists of two subscales (immediate/future), only the subscale pertaining to future orientation was included to the model as fixed factor. For *tense* and *epistemic modality*, sum contrasts were used and *future orientation* was mean-centered (Dalal & Zickar, 2012). *Participants* and *item* were modelled as random intercepts and the random slope was modelled using the variable *participant* and the predictor *epistemic modality*. As we expected a three-way interaction of *tense*, *epistemic modality* and *future orientation*, the according term was added as fixed effects in the equation. The interaction term for the random effects consisted of *item* and the predictors *tense* and *epistemic modality* (Barr, 2013). We used the Kenward-Roger method to calculate p-values. The concrete R formula used is visible in Equation (1):

(1)

$$cognitive\ likelihood \sim tense + epistemic\ modality + future\ orientation + tense{:}\,epistemic\ modality{:}\,future\ orientation + (epistemic\ modality \mid participant) + (tense * epistemic\ modality \mid item)$$

This model did not converge. We reduced the complexity of the random effects structure by first removing the interaction term of the random slope of *item* and the predictors *tense* and *epistemic modality*. This model did still not converge, so we kept reducing the complexity of the random structure. The final model that converged included *tense*, *epistemic modality*, *future orientation* as fixed effects, including an interaction of *tense*, *epistemic modality* and *future orientation* as well as *participant* and *item* as random intercept parameters. The model is summarized in Table 11.

Table 11.

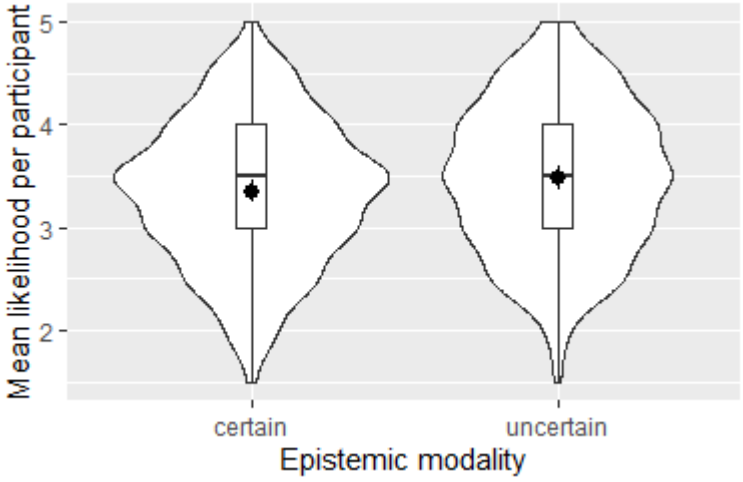
Results of the Mixed Effects Model for Cognitive Likelihood.

Model / Fixed effects	Estimate (β)	df	t-value	p(>|t|)
cognitive likelihood ~ tense + epistemic modality + future orientation + tense:epistemic modality:future orientation + (1| participant) + (1| item)				
intercept	3.41	3.34	20.49	< .001
tense (future)	-.01	145.00	-.29	.77
epistemic modality (certain)	-.07	441.01	-2.35	< .05
future orientation	.13	267.53	1.37	.17
tense (future) : epistemic modality (certain) : future orientation	-.14	266.96	-.98	.33
tense (present) : epistemic modality (certain) : future orientation	-.02	441.05	-.23	.82
tense (future) : epistemic modality (uncertain) : future orientation	-.13	267.88	-.91	.36

The three-way interaction did not reach significance. The predictor *epistemic modality* significantly explained variance in the model, although we hypothesized the inverse effect. The mean for certain epistemic modality was *M* = 3.35 (*SD* = .93) and for uncertain epistemic modality *M* = 3.49 (*SD* = .92). The distribution of the data can be gathered from Figure 8.

Figure 8.

Mean Cognitive Likelihood per Condition.



Random effects indicated that the greatest variability derived from residual variability (Var = .57). This type of variability cannot be attributed to either participant (Var = .23) nor item (Var = .10).

3.3.3.3 Discussion

We did not find the hypothesized three-way interaction in this experiment. However, we found a main effect for epistemic modality. Interestingly, the effect of epistemic modality seems to indicate the inverse hypothesized effect on the likelihood to develop skin cancer: using certain epistemic modality led to reduced perceived likelihood of skin cancer compared to using uncertain epistemic modality. This finding may be explained by how we constructed the narratives. We used two modal adverbs in the narratives to indicate epistemic modality. The first adverb was used in the sentence that described the UV exposure of the narrative character. Accordingly, the use of certain epistemic modality should have increased the perceived likelihood of skin cancer, because the character is more likely exposed to UV radiation. However, the second modal adverb was used in the sentence that described the preventive behavior of the narrative character. This could have inverted the proposed effect for certain epistemic modality, in that the likelihood of developing skin cancer is reduced when the character is more likely to apply preventive behavior. If participants considered the preventive behavior to be more important than the UV radiation for their evaluation, then our finding could be explained by this account.

For tense, we did not find an effect, despite tense being a between-participant variable in this experiment. As discussed already in Chapter 3.2, we considered that using tense as between-participant variable could create a framing-effect. However, we could not find such an effect in this experiment.

Further, we did not find any main nor interaction effects for future orientation. This is interesting in that future orientation is considered an important individual factor that can influence health-related behavior. In this experiment, however, we did not find that this applies to the perceived risk of skin cancer.

Our experiment accounted for cognitively-framed skin cancer likelihood as dependent variable, as is common in this line of research. Nevertheless, E. Janssen et al. (2012) found that assessing affectively-framed likelihood is important because affective measures are higher

correlated with actual behavioral change compared to cognitively-framed likelihood. This indicates that affective measures may use a different processing pathway than cognitive measures and therefore researchers should consider using both measures in their investigations. As such, in the next experiment we accounted for affectively-framed skin cancer likelihood. Although we found an inverse effect of epistemic modality in Experiment 1 compared to our hypothesis and that this may be due to the placement of the epistemic modality markers in our narrative, we will not adjust the narrative structure. We decided to proceed with Experiment 2 using the same materials, so that we could compare the two experiments based on their outcome variables (cognitive vs. affective).

3.3.4 Experiment 2: Affectively-framed skin cancer likelihood estimation

3.3.4.1 Method

3.3.4.1.1 Participants

One hundred fifty participants were recruited via Prolific (*Prolific*, 2014) for Experiment 2. However, two of these participants had to be removed as they had correctly disclosed the purpose of the study. The remaining 148 participants were on average M = 29.57 years old (SD = 9.94) and consisted of 76 female, 69 male and 2 other-gendered participants (1 person did prefer not to disclose their gender).

3.3.4.1.2 Materials and procedure

Experiment 2 used the exact same materials and procedure as Experiment 1, with the exception of the question to determine the affective likelihood estimation of participants. Again, we used the German translation of the absolute, unconditional, affective scale used by E. Janssen et al. (2011) and adapted it to the characters of the narratives: *Wie hoch glauben Sie (ihrem Gefühl nach) ist Annas Wahrscheinlichkeit, irgendwann in ihrem Leben an Hautkrebs zu erkranken?* [How strongly do you feel are Annas' chances of getting skin cancer at some point of her life?]. As the word *to feel* does not have the equivalent meaning in German, we used the verb *glauben* [to believe] and emphasized the affective component by explicitly stating *ihrem Gefühl nach* [according to you feeling] in the German translation.

3.3.4.1.3 Pre-registration

The experiment in this study were pre-registered on OSF using the template by AsPredicted.org (see Appendix C for the link). The study design as well as the scales and questionnaire described above were pre-registered. The hypotheses as well as the statistical analysis described in the pre-registration were followed according to the pre-registration.

3.3.4.2 Results

For Experiment 2, we used the same analyses as for Experiment 1. The linear mixed effects models were calculated using the R package *afex* (Singmann et al., 2020). The dependent variable for the selected model was *affective likelihood* modelled with *tense*, *epistemic modality*, *future orientation* and the three-way interaction between *tense*, *epistemic modality* and *future orientation* as fixed effects. The proposed random effects structure consisted of a random slope and intercept structure for *participant* per *epistemic modality* and a random slope and intercept structure for *item* and the interaction of *tense* and *epistemic modality*. See Equation (2) for the equation analyzed in R.

$$\begin{aligned} affective\ likelihood \sim\ & tense + epistemic\ modality + future\ orientation \\ & + tense{:}\ epistemic\ modality{:}\ future\ orientation \\ & + (epistemic\ modality \mid participant) \\ & + (tense * epistemic\ modality \mid item) \end{aligned} \tag{2}$$

As this model did not converge, we reduced the random structures to only include a random intercept for *participant* and *item*. This model included *tense*, *epistemic modality* and *future orientation* and the three-way interaction of *tense*, *epistemic modality* and *future orientation* as fixed effects. The results of the final model are visible in Table 12.

Table 12.

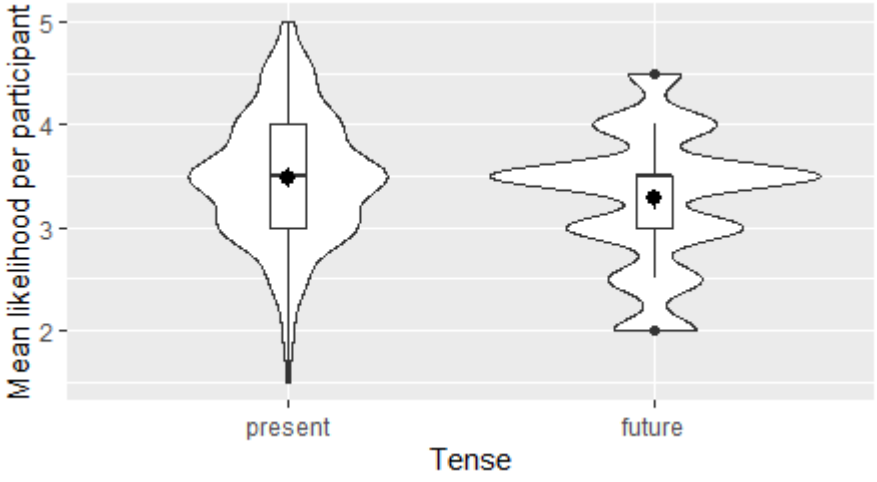
Results of the Mixed Effects Model for Affective Likelihood.

Model / Fixed effects	Estimate (β)	df	t-value	p(>|t|)
affective likelihood ~ tense + epistemic modality + future orientation + tense:epistemic modality:future orientation + (1| participant) + (1| item)				
intercept	3.38	3.32	22.53	< .001
tense (future)	-.10	144.00	-2.28	< .05
epistemic modality (certain)	-.06	438.00	-1.96	.05
future orientation	.07	275.97	.85	.39
tense (future) : epistemic modality (certain) : future orientation	.04	274.21	.32	.74
tense (present) : epistemic modality (certain) : future orientation	.04	438.45	.42	.68
tense (future) : epistemic modality (uncertain) : future orientation	.12	278.98	.96	.34

As for the fixed effects, the three-way interaction did not yield significance. However, there is a main effect for *tense* and a statistical trend for *epistemic modality*. The mean for present tense was M = 3.48 (SD = 0.83) and the mean for future tense was M = 3.28 (SD = 0.84), which is in line with our hypotheses. The distribution of the different conditions can be obtained from Figure 9.

Figure 9.

Mean Affective Likelihood per Condition.



For certain epistemic modality the mean was M = 3.33 (SD = 0.79) and for uncertain epistemic modality the mean was M = 3.44 (SD = 0.89), same direction as in Experiment 1. Random effects showed highest variance (Var = 0.47) for residual variability; participant showed higher variance (Var = 0.16) than item (Var = 0.08).

3.3.4.3 Discussion

Again, in Experiment 2 we did not find the hypothesized three-way interaction. Interestingly, in this experiment we found a main effect of tense in line with our hypothesis. This means that participants that read the narratives in the present tense rated the perceived skin cancer likelihood as higher than participants that read the narratives in the future tense. This is the first time that we found this framing-effect according to our hypotheses compared to the studies presented in the previous chapters (Chapters 3.1 and 3.2) as well as the first experiment presented in the current chapter (Chapter 3.3). We discuss possible explanations for this finding in the next section (Chapter 3.3.5), where we also compare the results of Experiments 1 and 2.

Although in this experiment epistemic modality did not reach significance, we could nevertheless observe a numerical difference that was congruent with Experiment 1. Again, this difference goes in the same direction as before, suggesting that narratives with certain epistemic modality elicited lower skin cancer likelihoods compared to narrative with uncertain epistemic modality. This could again be due to the narrative structure as explained in Experiment 1.

As for future orientation, we did again not find a main effect, which is consistent with Experiment 1.

3.3.5 General discussion

The two experiments presented in this study provided an extension to the proposed initial theoretical framework of the effects of the grammaticalization of the future by including epistemic modality as linguistic marker of probability, which may interact with tense as proposed by Robertson and Roberts (2020). Further, the experiments showed that the grammaticalization of the future can be applied to a health-psychological context, where it seems to influence the perceived likelihood of developing skin cancer. Both experiments were based on third-person

narratives describing four fictitious persons and their UV exposure, skin cancer risk and prevention behaviors, in which we manipulated tense and epistemic modality to analyze perceived skin cancer likelihood. Perceived skin cancer was further tested using a cognitively- (Experiment 1) and affectively-framed (Experiment 2) outcome measure, which was suggested by E. Janssen et al. (2012). We tested the hypothesis that tense and epistemic modality as well as the personality trait future orientation influence the perceived skin cancer likelihood in a three-way interaction.

We did not find the hypothesized three-way interaction in neither experiment. In Experiment 1, where we measured the outcome of cognitive likelihood, we found a main effect of epistemic modality. Neither tense nor the individual trait future orientation did significantly explain variance for cognitive likelihood. In Experiment 2, where we measured affective likelihood, we found a main effect of tense and a statistical trend of epistemic modality. Again, future orientation did not significantly explain variance for affective likelihood. The effect of tense found in Experiment 2 did confirm the hypothesized effect. However, the effect of epistemic modality in both experiments did go against our hypothesized effect. This is most likely due to the construction of the narratives and the placement of the epistemic modality markers within the narratives, as these markers were also placed in sentences referring to prevention behavior. When constructing the narratives, we decided to use two epistemic modality markers, which were placed in sentences relevant to information concerning a character's skin cancer risk. However, we could only place them in sentences related to UV exposure and prevention behavior, since these factors were malleable by epistemic modality (i.e., a person is more or less likely to execute a preventive behavior or to expose themselves to more or less UV exposure), whereas risk factor was not (i.e., a person has a certain risk factor or not). While constructing the narratives this way, we were not aware that using the epistemic modality markers could lead to an effect inverse to our hypothesis, i.e. marking a specific prevention behavior as more likely would reduce the perceived risk of developing skin cancer.

This study was primarily concerned with advancing and expanding our initially proposed theoretical framework. As recommended by Robertson and Roberts (2020) we included epistemic modality to study its proposed interaction with FTR and possible cognitive mechanism related to probabilistic reasoning. Our study showed, especially in the first experiment, that epistemic modality is an important factor to consider when studying the grammaticalization of the future,

as it did influence participants' likelihood estimation related to developing skin cancer. Within this line of thinking, it is interesting to remark that although we used two markers of epistemic modality, it appears that the effect of the marker in the sentences coupled with prevention behavior had a stronger influence in the likelihood assessment. This could either signify that epistemic modality is important for behavioral health prevention, or that this effect stems from the fact that the clause referencing prevention behavior was at the end of the narrative, indicating a recency effect (Monsell, 1978).

However, we did not find the hypothesized interaction effect. Hence, we cannot say in what way tense and epistemic modality may interact. In our second experiment, we found – for the first time in our thesis – an effect of tense. We changed several parameters compared to the studies in Chapters 3.1 and 3.2, such as using narratives to transport information rather than individual sentences and a between-participant design for tense. These changes may have increased the saliency of tense, as participants were exposed longer to a specific tense (present vs. future).

Interestingly, the effect of tense was only found in the experiment with the outcome variable *affective likelihood*. This could indicate that the effect of tense in a within-language experimental design may be dependent on the affect heuristic. The affect heuristic describes the process of taking affective cues to make a probability judgement rather than weighing pros and cons to take an informed decision (Slovic et al., 2005). From our experiments, it appears that the effect of tense may be overwritten when a person is asked about a cognitive elaboration of likelihood compared to affective an affective one. This suggests that the effect of tense may only be detectable when cognitive processing relies on affective cues to make a risk assessment. Before suggesting possible explanations for this finding, this needs to be replicated.

Besides the effects of the linguistic extension of the theoretical framework, we were further interested in how our findings can contribute to associated health-psychological research. We can conclude that adjusting the certainty of epistemic modality regarding modal modifiers (i.e., adverbs signaling the degree of probability) did influence participants' likelihood estimation on another person developing skin cancer, especially when focusing on the prevention behavior. This means that when using such modal modifiers in health-psychological research, researchers should be aware that they can influence risk perception and may consult related linguistic literature on the nature of the modal modifiers used (such as in Nuyts, 2001; Robertson &

Roberts, 2020). Further, the relationship between tense and skin cancer likelihood from the data in this study is less clear, although it appears that the tense used could influence likelihood estimation for developing skin cancer when participants' elaborate on an emotional ground. Thus, using the present tense rather than the future tense could increase effectiveness for health messages when people use heuristics to evaluate a probability judgement. However, this statement should be confirmed by future research.

Notably, future orientation as a personality trait did not appear to play a role when assessing the likelihood of developing skin cancer in either experiment. This contradicts previous research on future orientation that found future-oriented persons to exhibit more prevention behaviors compared to less future-oriented persons (e.g., Heckman, 2009) or that future orientation moderates the relationship between temporal framing and perceived risk (Kees, 2010). Our study differs in that we did not ask participants to rate their own skin cancer risk. This may have weakened the association of future orientation as participants did not need to envision themselves in the future.

3.3.6 Future directions

Our data suggest that some research avenues may be promising in terms of health message framing. First, as our study did not find the hypothesized three-way interaction, we are still not sure how tense and epistemic modality interact. Along the same line, future research should consider investigating other determinants of epistemic modality (e.g., modal verbs). Second, our study suggests that narratives may be better suited to evoke an effect of the grammaticalization of the future. However, future research should consider individual outcome variables too (i.e., first-person rather than third-person evaluation). This would help comparing it to previous research on skin cancer risk and on future orientation. Third, a question that remains unanswered is whether the effect of tense only emerges in context where cognitive elaborations are low (i.e., when affective mechanisms are involved). This context-dependent effect should first be replicated to effectively answer this question and to further investigate possible mechanisms that could account for this result. Fourth and finally, to our knowledge, research on future orientation has only investigated future orientation towards outcomes related to the participants themselves. As our study showed no effect of future orientation, it would be interesting to

investigate, whether future orientation may be a bias that applies only towards the person themselves (i.e., what our results suggest) or whether it can also be found in outcomes that apply to other persons.

GENERAL DISCUSSION

4. GENERAL DISCUSSION

4.1 Summary and discussion of the main results of this thesis

The first study within our empirical work was aimed as proof-of-concept (Chapter 3.1) to establish initial evidence that the grammaticalization of the future could impact perceived temporal distance in a psycholinguistic experimental design. Previous experimental research focused on outcomes related to future discounting (e.g., Sutter et al., 2018; Thoma & Tytus, 2018). Our study, was the first concerned with exploring underlying cognitive mechanisms and their effect on mental representations of the future.

Following M. K. Chen's (2013) LSH and one of its proposed mechanisms, we investigated whether differing degrees of FTR influence mental representations of future events. Concretely, we examined whether the perceived temporal distance of temporally identical future events, were perceived differently on a timeline when expressed with varying degrees of FTR. The study of Chapter 3.1 included four consecutive psycholinguistic experiments based on a series of sentences that described events happening in the future. Future time reference was manipulated in a within-participant design and participants had to rate the temporal distance of these events on an analog-visual scale. Two experiments were conducted with French-speaking participants and two with German-speaking participants. We consistently found no effect of the grammaticalization of the future on perceived temporal distance, neither within- nor between-languages. In all four experiments, we checked that the lack of effect was not due to a lack of sensitivity of our data by running Bayes factors.

We adjusted the four experiments consecutively, considering possible methodological issues that could be responsible for not finding the hypothesized effect of FTR. Beyond those considerations within our methodological setup, we need to address three general observations concerning our methodological approach. First, the future events described in the sentences read by the participants were not only temporally marked by the tense, but also by temporal adverbs (e.g., *In a few months, Anna will start her master's degree*). These adverbs may have had a more pronounced effect in anchoring the described future events on the timeline than the tenses. We already made this proposition in a previous chapter (Chapter 3.1). However, considering the expansion of the theoretical framework discussed in Chapter 3.3 and the associated notion of epistemic modality, this proposition becomes more substantial. As temporal adverbs can be part

of epistemic modality and epistemic modality may interact with FTR, this paradigm might not have been suitable to detect an effect of tense alone. Second, compared to traditional psycholinguistic research that mostly constitutes of cross-linguistic research, we mainly analyzed within-language differences. This deviation from the usual approach was important for our proof-of-concept study in Chapter 3.1 and its value for subsequent research related to health-psychological outcomes. Hence, future studies that do not focus on health-psychological outcomes should consider studying cross-linguistic effects. Third, as temporal distance in this investigation did not seem to be influenced by using differing tenses, it may be that the proposed mechanism by M. K. Chen (2013) does not have a relevant impact on mental representations of future events. In the theoretical framework discussed in Chapter 2 we explored other cognitive mechanisms such as memory. It could be, that instead of temporal distance, the grammaticalization of the future may influences memory traces. We explored this possibility in the second study.

The aim of the second study was to explore a different cognitive mechanism and check the proposed hypothesis that the grammaticalization of the future influences memory. As detailed in Chapter 2, memory is affected by temporality and therefore may be affected by the linguistic marking of time. We tested this proposition using a psycholinguistic experiment based on a series of sentences that contained health-psychological information. Participants had to read the sentences carefully and subsequently complete a recognition memory task on the information they had read. Again, future time reference was manipulated in a within-participant design and we analyzed the number of correct answers from the recognition task. We found no effect of the grammaticalization of the future on recognition memory. We used Bayes factors to confirm that our data were sensitive enough. To the best of our knowledge, previous studies concerned with the effects of the grammaticalization of the future did not investigate its effect on memory, so this is the first study to consider this question. Compared to the first study (Chapter 3.1), the second study (Chapter 3.2) did not use different temporal adverbs to mark future events, but rather a very abstract one ("in the future") that did not refer to a certain point in time (e.g., *Wenn dir in der Zukunft übel ist, wirst du dich mit Ingwer besser fühlen* [In the future, if you have nausea, you will feel better by eating ginger]). So, it is less likely that the temporal adverb, which is part of epistemic modality, would have interfered with the effect of tense. Three other methodological considerations arise as to why we did not find an effect in this study. First,

participants had enough time to read the sentences and to think whether or not they had read about certain remedies. Comparing this to our third study (Chapter 3.3), where we found some effect of tense when we measured affective likelihood compared to when we measured cognitive likelihood, it is possible that the experimental setup chosen for this study hindered the hypothesized effect of the grammaticalization of the future by eliciting some cognitive elaboration. This would indicate that the proposed effect may only be detectable in situations where information is processed with an affective bias causing a potentially lower cognitive elaboration (e.g., Slovic et al., 2005). Second, in the study of Chapter 3.2 as well as in the study of Chapter 3.1 we used the grammaticalization of the future as a within-participant condition. This means that participants read both versions with present and future tense. Maybe this experimental setup affected the attentional mechanism that the grammaticalization of the future should have caused. This means that by switching between sentences in the present and future tense, it may have not been possible for differing mental representations to form from the information available, because participants may have not engaged with the tense in the sentence but rather with the changing remedies. Third, in the same studies (Chapters 3.1 and 3.2), we used single sentences to convey the information. Maybe this exposure was too short to create a proper mental representation of future events, and therefore the mental representations between the two versions did not differ significantly. As we hypothesized to find an effect of FTR on memory, we can assume that using one sentence was not enough information – at least in terms of tense – to cause different mental representations of the future. It is likely that due to the use of single sentences, the mental representations of participants were not updated according to the tense presented, but rather according to the remedies presented. All these methodological considerations led us to make significant changes in the last study (Chapter 3.3) presented here.

In the third study, we wanted to address the methodological issues that had arisen during the two previous studies (Chapters 3.1 and 3.2) and considered changing the initial theoretical perspective. Fortunately, the work of Robertson and Roberts (2020) pointed us to a new direction and we extended the initial idea by acknowledging that FTR does not only constitute of the differences of grammaticalization and obligatoriness of use in different tenses, but also that it may be interact with epistemic modality. Epistemic modality hereby pertains to utterances that imply some sort of possibility, probability or inferred certainty. In consequence, Robertson and Roberts (2020) argued that FTR most likely does encode probability of occurrence rather than

temporal distance. We tested this new proposition in an applied health-psychological context, where we chose the perceived probability of developing skin cancer as cognitive mechanism impacted by the grammaticalization of the future. That is, participants had to evaluate skin cancer likelihood of four fictitious characters. Epistemic modality and tense were experimentally manipulated, with epistemic modality as within-participant design and tense as between-participant design. We further included a measure of individual future orientation to account for individual differences across participants and to see whether they may impact the effect of the grammaticalization of the future. We conducted two experiments that mainly differed in their outcome variable as one asked about cognitive likelihood estimation and the other about affective likelihood estimation. This approach was chosen because research on likelihood and risk assessment found differences in how those two outcomes related to behavioral measures (e.g., behavioral change was predicted by affective likelihood measure but not by cognitive likelihood). This indicates differences in how those two outcomes are processed (E. Janssen et al., 2012). The results of the first experiment (Chapter 3.3.3), where we used a question to encourage participants to elaborate on the likelihood (i.e., *What do you think are Annas' chances of getting skin cancer at some point in her life?*), showed an effect for epistemic modality, but not for tense. Further, we did not find the interaction hypothesized by the extension of our theoretical framework (Chapter 3.3). From this specific experiment we can deduct that epistemic modality is an important determinant to infer a certain likelihood in the future. In the second experiment we used a question that encouraged an affective decision (i.e., *How strongly do you feel are Annas' chances of getting skin cancer at some point of her life?*), which is usually associated with lower amount of cognitive elaboration. Interestingly, in this experiment we found again an effect for epistemic modality, but also one for tense. Across all our empirical chapters, this is the only experiment that found an effect of tense. By comparing this experiment to others we can identify certain methodological adjustments that may have helped to reveal the effect. As discussed above, participants read narratives rather than sentences, which gave them more exposure to the tense and more time to engage with the character's story. Further, participants were only exposed to one tense rather than both. Yet, if these were the only two determinants of the effect of the grammaticalization of the future, then we should have found this effect in the first experiment as well. Therefore, this could point to a limitation of the proposed effect of the grammaticalization of the future, in that it is only relevant when cognitive elaboration is lower

because of an affective component. However, this observation needs to be confirmed by future research. Another noteworthy observation in this last study (Chapter 3.3) is the lack of individual susceptibility (i.e., future orientation as trait) to the effect of the grammaticalization of the future. Given that future orientation is usually an important individual factor in how people evaluate risks and likelihoods in the health-psychological context (Joireman et al., 2012), its apparent lack of influence is striking. In the next chapter we discuss more in-depth what our results mean for the proposed theoretical framework and what conclusions we can draw from them.

4.2 Evaluation of the proposed framework

The aim of this section is to evaluate the theoretical framework proposed in the beginning of this thesis (Chapter 2). Firstly, we assess general observations linked to our empirical chapters (see Chapter 3). Then, we describe the within and between language effects, that we found, and extend this part beyond our studies. After, we evaluate the expansion of the theoretical framework and whether epistemic modality can offer additional value to the theory. Lastly, we discuss the proposed health-psychological applications based on our results.

4.2.1 Theoretical framework revisited

The theoretical framework proposed in Chapter 2 was based on theoretical considerations from varying disciplinary fields. Building on M. K. Chen's (2013) LSH, we included Slobin's (2003) TfS hypothesis and literature on mental representations (Johnson-Laird, 1983) to give us a theoretical base from where we could anticipate effects on mental representations of the future. The aim was to bring these fields together in a psycholinguistic framework to study the proposed effect of the grammaticalization of the future. We identified several cognitive mechanisms that could be studied in psycholinguistic paradigms to experimentally evaluate the claims made by the LSH. The main cognitive mechanisms that we hypothesized would affect mental representations of the future were temporal distance and memory (due to attentional mechanisms).

From the first two studies (see Chapters 3.1 and 3.2) of this thesis, we can observe that the grammaticalization of the future – at least in terms of using different tenses – did not affect mental representations of future events. Neither regarding temporal distance (Chapter 3.1) nor memory (Chapter 3.2). This would either indicate that the grammaticalization of the future does not follow our theoretical considerations and has either no effect or an undetectable one in our

experimental setups. As our theoretical framework is interdisciplinary and dependent on many considerations it is not easy to locate its shortcoming. We can identify three possible factors that might have influenced our outcome.

4.2.1.1 Conceptualization of the future and shift towards epistemic modality

The first factor pertains to the conceptualization of the future. How we conceptualize the future is not trivial given that time is an abstract entity that is only defined by metonymy (Lakoff & Johnson, 1999). This means that time cannot not be defined by itself but has to rely on figure of speech or external concrete entities. For example, the course of time can be defined by the ticking of the clock that indicates that after a certain amount of ticks an hour passed. As explained in the theoretical framework (Chapter 2), time is usually transmitted via temporal metaphors that translate the abstract temporal entity to a concrete spatial entity (Boroditsky, 2000; Lakoff & Johnson, 1980). For example, the clause *summer break lies ahead of us* uses spatial markers (i.e., in front of us) to refer to a certain point in time. This type of conceptualization has shown to affect temporal mental representations across languages, in that time is differently spatially organized depending on the language we speak (Casasanto & Boroditsky, 2008). Maybe this conceptualization of time does not translate well to mental representations of the future. As the future is an isolated category within the domain of time, it is possible that this conceptualization did not elicit enough categorical difference between differing degrees of FTR. Thus, temporal distance may be relevant between different categories of time such as past, present and future. However, within the category of the future – following the results of this thesis – it appears that temporal distance is not affected by grammatical differences in referring to future events. Continuing this line of argumentation, it seems more plausible that FTR may rather encode probability, as we can expect more categorical difference along with differences in probability.

That FTR could be conceptualized as probability was not evident from our initial theoretical framework (Chapter 2), because we had based our linguistic background on Dahl's (2000) typology study that was also used in the LSH (M. K. Chen, 2013) to distinguish between languages that mark the future obligatorily and languages that do not necessarily mark the future. Together with Bybee's et al. (1991, 1994) considerations on how FTR becomes more grammaticalized over time, we classified the different ways to mark the future linguistically as high vs. low degree of FTR. Other studies had used a similar system to classify FTR within and

between languages (e.g., J. I. Chen et al., 2019; Sutter et al., 2018; Thoma & Tytus, 2018). However these studies also yielded mixed results regarding the LSH.

We adapted our initial theoretical framework (Chapter 2) by considering Robertson and Roberts' (2020) suggestion that studying FTR should not only consider the grammaticalization of the tense system but also acknowledge that modality is a common form of FTR. In their original considerations, Bybee et al. (1991, 1994) had already stated that FTR usually evolves from modal expressions that retain their modal meaning (e.g., ability, obligation, possibility, probability) to grammaticalized particles (i.e., grams) that lose or change their specific meanings over time. Since Robertson and Roberts (2020) argue that epistemic modality has to be considered when studying the grammaticalization of the future, they conclude that what is linguistically marked in FTR is not temporal discounting (i.e., attention directed towards temporal distance), but rather probability discounting (i.e., attention directed towards how likely an event is). So, in the last study (Chapter 3.3) we tested the proposed interaction of FTR between tense and epistemic modality. Although we did not find the proposed interaction, we found an effect of epistemic modality and one of tense. This would indicate that the proposition that FTR marks probability rather than temporal distance should be considered in future research.

From these still scarce results concerning the role of epistemic modality when studying the effects of the grammaticalization of the future, we can conclude that it is probable that FTR may be more likely to mark probability than the temporal distance, which we initially proposed (Chapter 2). Nevertheless, what also becomes apparent is that the linguistic definition and classification of what exactly constitutes FTR and which aspects can be considered for this kind of psycholinguistic research is not clear-cut. It seems possible that depending on differing situational contexts, different aspects of FTR are more or less relevant and can have different cognitive effects. Thus, we would not yet fully disregard that FTR may be connected to temporal distance, but may depend on the context (i.e., what does the context imply about temporality or probability). We will discuss this further in Section 4.4, which is concerned with future directions of research.

4.2.1.2 Within- vs. between-language effects

Another factor that may have influenced our results is the way we used the psycholinguistic framework to explore within-language differences. Classical psycholinguistic

paradigms that investigate the role between language and thought usually rely on cross-linguistic explorations (e.g., Casasanto, 2008; Lucy, 2016). For example, previous research into the TfS hypothesis such as investigating the domains spatial relations (e.g., Bowerman & Choi, 2001), motion event construal (e.g., Athanasopoulos & Bylund, 2013; Flecken et al., 2014) or grammatical gender (Konishi, 1993; Sato et al., 2013) was usually cross-linguistic. This approach would also have been a viable route for the studies reported in this thesis, as we explored the domain of future events and its typological differences across languages. Especially since M. K. Chen's (2013) investigation is based on the idea that differing obligatoriness to mark the future grammatically between languages has far-reaching effects for the people speaking those languages, such as the amount of retirement savings they will accumulate over time. However, to properly investigate this claim in the framework of linguistic relativity we would have needed a nonlinguistic paradigm rather than one relying on language.

For example, a recent study by Sato et al. (2022) explored exactly this idea and compared English (obligatory marking of the future tense) to Finnish speakers (no future tense marking) using a nonlinguistic task. Participants were asked to rate the similarity of a pair of photographs, which either depicted an action event in two out of three moments (e.g., mash a banana: beginning/middle or beginning/end) or the same action event at the same moment (e.g., mash a banana and a potato in the middle). Sato et al. (2022) found that Finnish speakers represented the proximal future as the continuity of the present (i.e., pictures were rated more similarly when the first two temporal frames where compared), meaning that these two temporal frames pertained to the same temporal category, whereas the English speakers rated the same temporal frame as more distinct. However, the more distant temporal frames did not show any difference in similarity between Finnish and English speakers. Compared to M. K. Chen's (2013) hypothesis, this finding suggests rather a difference in the expansion of what constitutes the present rather than how far or close the future appears. This could be a further reason as to why we did not find any effect in our first study (Chapter 3.1), where we compared French and German speakers. It would be interesting to adapt this study and change the timeline to measure the expansiveness of the present, for example, by using a circle marking the present that can be manually expanded. This would further indicate whether some element of temporal distance is encoded in FTR.

In this thesis, we decided to explore the effects of the grammaticalization of the future using mental representations and TfS (Slobin, 2003) as a theoretical foundation. As the TfS

hypothesis provided a useful framework to identify also within-language effects, we deviated from the traditional path of cross-linguistic experiments to further investigate the possible applications in health-psychological contexts. In this context it was important to examine within-language effects, because if we had found a relevant effect of the grammaticalization of the future, we could have designed more effective health-psychological intervention just by changing the tense of a health message. However, our results do not indicate that such an easy and cost-efficient intervention could work. We discuss this point more in-depth in the following Chapter 4.2.2.

With the still scarce evidence that we have comparing within and between language effects, we can mainly conclude two aspects. First, there may be a possible effect pertaining to linguistic relativity that is detectable in languages that are on the extreme poles concerning the obligatoriness of the future tense (see Sato et al., 2022). However, this effect did not affect temporal distance in the way M. K. Chen's (2013) hypothesis predicted. But we rather observed differences in the expansion of the present. This is an interesting finding to keep in mind for future research. Second, within the two languages that we investigated, we found little evidence for the effect of the grammaticalization of the future on mental representations of future events, at least when considering the cognitive mechanisms identified within the framework of TfS. The only account where we found future tense to be relevant was when accounting for epistemic modality and using an outcome related to affective probabilistic reasoning.

4.2.1.3 Linguistic definition of FTR

The last factor that may have influenced our results is the choice of linguistic definition of what refers to FTR. In our investigation, we followed Dahl's (2000) typology, where they described a range of differences in how obligatory it is in different languages to mark the future with a future tense. Further, we looked at Bybee et al.'s (1991) investigation into how different expressions evolve through time to more grammaticalized grams that are marked in the future tense. We combined these findings to talk about low and high degree of FTR and used this as our criteria to predict the effect of language on mental representations of the future. Rightfully, we have to specify that this is not an exact grammatical distinction. Some linguists are still debating about whether or not in some languages (e.g., English and German) the future tense should be regarded as part of the modal verbs rather than pertaining to the tense system (e.g., T. Janssen, 1989;

Nuyts, 2001). For example, the future tense construction in German is technically formed using the modal verb *werden*. Semantic analyses concerning this modal verb show that it is also used in contexts that are not only temporal (i.e., referring to a future situation), but also certainty, possibility and importantly probability (Di Meola, 2013). As such, it is likely that temporal distance may not have been marked by the examined future tenses (especially German) altogether. This is further indication, that future tense – especially when constructed using a modal verb – does not mark temporal distance, but rather probability.

Nevertheless, in our last investigation, where we expanded the theoretical framework to account for epistemic modality, we found an effect of tense. However, this effect was only apparent when we changed the dependent variable to measure affective likelihood. This further indicates the validity of the expansion of the theoretical framework (Chapter 3.3).

4.2.2 Health-psychological applications

Another aim of this thesis was to evaluate the value of the proposed theoretical framework (see Chapter 2) in applications relevant to health-psychological contexts. This aspect was developed through past research suggesting that the way we think about the future can impact our mental health and health-related behaviors (e.g., A. MacLeod, 2017; Thorstad & Wolff, 2018). As the proposed effect pertains to linguistic differences it was evident that we wanted to explore the health-psychological applications using health messages, which would affect mental representations of future outcomes. To our knowledge, this is the first investigation that explores health-psychological applications derived from the theoretical framework offered by studies of language and thought.

However, the idea that language influences how people react to health messages is not a new notion. Tversky & Kahneman (1981) reported that using either a positive or negative frame to describe a situation would change how people evaluate such situations. These kind of framing effects are still considered today in health-psychological investigations (e.g., O'Keefe & Jensen, 2007, 2009). Although, temporal framing effects also exist in health-psychological research, they rather refer to how a message focusses on immediate vs. future-oriented health outcomes (e.g., Kees, 2010). This is different from what we would understand as temporal framing in this thesis, since we focused on grammatical differences without changing the frame or meaning of the message.

With this purpose in mind, it was important to establish linguistic differences within a language and assess the effect of those differences. In the first study that assessed memory effects applied to health-psychological outcomes (Chapter 3.2), we did not find any effect that using the present or future tense is more effective in communicating health messages. However, in the last study (Chapter 3.3) we found an effect of tense, when information was processed affectively (rather than cognitively) to reach a decision on the likelihood of developing skin cancer. Further, we found an effect of epistemic modality in both experiments of the last study (Chapter 3.3). To mark epistemic modality, we used modal adverbs in sentences related to UV exposure and prevention behaviors that carried different probabilistic meaning (i.e., high vs. low probability). For this effect of epistemic modality, we can coin the term probabilistic framing, as it renders health-messages more or less effective depending on the concrete modal adverb used. Nevertheless, this improved effectiveness needs to be confirmed by future behavioral studies.

For now, there is little reason to conclude that using the present tense to convey health messages is more effective than using the future tense, as we either found no effect or a very small one. However, if we believe that there is a reliable effect – as found in our last experiment (Chapter 3.3) – and that this effect could increase with repeated exposure, we should not yet disregard this linguistic tool in health-psychological research. But this hypothesis should of course be investigated further. Future research should explore whether there are specific cognitive mechanisms (such as probabilistic reasoning) affected by the grammaticalization of the future, which have direct implications for health-psychological research in that they produce more or less efficient health messages. For example, by designing an experiment with continuous exposure to health messages with differing degrees of FTR and concrete behavioral outcomes (e.g., such as the number of implemented prevention behaviors).

4.3 Strengths, limitations and future research

The greatest strength of this thesis was that we formulated a theoretical framework to investigate the effect of the grammaticalization of the future. This allowed us to engage with and address former criticism towards the LSH and systematically examine different proposed cognitive mechanisms that may be influenced by the grammaticalization of the future using psycholinguistic experimental paradigms. Further, we identified potential applications in the

health-psychological context. This led to an innovative series of experiments portrayed in this thesis. Additionally, using the theoretical framework (Chapter 2) helped us to identify methodological and conceptual issues that arose across the experimental chapters.

Methodologically, we initially opted for mostly within-language experiments that relied on finding sentence processing effects within participants as suggested by the TfS hypothesis (Slobin, 2003). This approach was generally an advancement from previous correlational studies that studied the effect of the grammaticalization (e.g., S. Kim & Filimonau, 2017; Liang et al., 2018) and a change from other experimental studied that mainly examined the effect of the grammaticalization of the future on temporal discounting and intertemporal choice preference (e.g., J. I. Chen et al., 2019; Sutter et al., 2018; Thoma & Tytus, 2018).

However, our first two studies (Chapters 3.1 and 3.2) showed null effects for the effect of FTR. These results may point to a methodological limitation of this thesis, which pertains to the choice of mainly within-language comparisons. We already elaborated on the justification of the choice of this experimental design in Section 4.2.1.2. Nevertheless, this choice does not represent traditional research on language and thought, which is mainly cross-linguistic, and could have contributed to the null effect found in the first two studies (Chapters 3.1 and 3.2).

Apart from this intentional methodological choice, we adjusted other parameters across the experiments of this thesis, even to the extent of changing from sentence processing and within-participant design to text processing (i.e., narratives) and between-participant design. We found some effect of FTR in the last study (Chapter 3.3), although it is not clear whether this is due to the methodological changes or the change in the studied outcome (i.e., affective likelihood). So, future research should clarify this issue by exploring the cognitive mechanisms we had initially identified (Chapter 2), while applying the methodological caveats raised here and along the general discussion. Along the same notion, future research could investigate whether some cognitive mechanisms are tied to certain semantic contexts and therefore affected only contextually (i.e., a sentence referring to temporal or probabilistic notions).

Further, we should not disregard that the proposed experimental settings may have little external validity in terms of real-life effects. Future research could also consider an experiment with behavioral outcomes (e.g., number of implemented prevention behaviors depending on the degree of FTR used) to approximately address this issue.

Apart from these methodological strengths and limitations, we can also discuss conceptual ones. Lucy (2016) summarized persisting problems related to research on language and thought in their overview by mainly referring to problems pertinent to the conceptualization of language structures and cognitive effects. This may also be the case for this thesis in two different ways. The first relates to the conceptualization of language structures, specifically, to how FTR is defined among different linguistic currents. We experienced along this thesis that defining the linguistic scope for FTR is not a trivial endeavor. First, the on-going linguistic dispute on whether languages that have a future tense that is composed of a modal verb (such as English or German) should be considered formally as future tense or should rather be categorized as modal expressions. Second, the linguistic variety to convey information about future events is large (e.g., temporal adverbs, modal constructions, periphrastic and inflectional constructions considered future tense) and varies greatly in how formalized FTR is between languages (e.g., obligatoriness of certain grammatical expressions). This complicates the comparison of languages with differing structures, as it is difficult to establish which linguistic devices are more or less important to signal FTR. Further, this also contributes to the issue that we can only study a reduced version of the linguistic diversity, which a language offers to refer to the future. It is likely that depending on which aspects of FTR we focus on, different cognitive and conceptual domains are involved. This is an element that needs to be considered in future research. Concretely, we propose that future research should abandon the simplified classification of FTR originated by the LSH and address linguistic debates surrounding the categorization of the future tense in some languages. It is especially important to consider the variety of FTR that the languages in question offer and explore the semantic value that these markings entail and how they could affect different cognitive mechanisms.

In the context of conceptualizing the future, there are also some open questions that future research should address: Do the grammatical differences that we considered and that future research will consider, really create enough categorical difference (e.g., present vs. future, short vs. long temporal distance, low vs. high likelihood) to be detected experimentally? This is not a trivial question. However, research assessing cross-linguistic differences with nonlinguistic paradigms may also be suitable to offer insight, such as the study by Sato et al. (2022). This study indicated that the conceptualization of the future tense may pertain to the expansiveness of the

present rather than the temporal distance to the future. Such research could help adapt the theoretical framework by adjusting the conceptualization of the future.

4.4 Conclusion

The results of this thesis raise some important questions. One specific question that can be extracted from the general discussion pertains to whether we should abandon the notion that FTR solely refers to the future tense as suggested by M. K. Chen (2013) or recognize that linguistic diversity of FTR within and between languages is considerably large. In light of the findings in this thesis, future research should consider the complexity and possible multiple semantic meaning that different realizations of the future may carry and discard the notion transmitted by the LSH that FTR is reducible to only one aspect (i.e., obligatoriness to mark the future). Nevertheless, we can acknowledge that if an effect of the grammaticalization of the future exists within languages, it is rather small (as found in the last experiment) and may not substantially help health messages to be more effective. Future research should address the methodological and conceptual concerns raised in this discussion and try to close some of the open questions.

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APPENDICES

A) Supplementary materials: Chapter 3.1 PROOF-OF-CONCEPT

Supplementary materials for the Chapter 3.1 PROOF-OF-CONCEPT can be found following the link to the Open Science Framework (OSF): https://osf.io/s2axr/

The following data can be obtained:

- Data and R-Script from Experiment 1
- Data and R-Script from Experiment 2
- Data and R-Script from Experiment 3
- Data and R-Script from Experiment 4

The following materials can be obtained:

- Additional analysis between-language comparison
- Items used (Experiment 1 to Experiment 4)
- Pre-registration of Experiment 1

B) Supplementary materials: Chapter 3.2 EXPLORING ALTERNATIVE COGNITIVE MECHANISMS AND HEALTH-PSYCHOLOGICAL APPLICATIONS

Supplementary materials for the Chapter 3.2 EXPLORING ALTERNATIVE COGNITIVE MECHANISMS AND HEALTH-PSYCHOLOGICAL APPLICATIONS can be found following the link to the OSF: https://osf.io/t8rhc

The following data can be obtained:

- Data and R-Script from the experiment conducted on recognition memory

The following materials can be obtained:

- Pretest
- Complete list of items
- Additional analyses

C) Supplementary materials: Chapter 3.3 EXPANDING THE FRAMEWORK

Supplementary materials for the Chapter 3.3 EXPANDING THE FRAMEWORK can be found following the link to the OSF: https://osf.io/r2sv6/

The following data can be obtained:

- Data and R-Script of the pretest
- Data and R-Script of Experiment 1 (cognitive)
- Data and R-Script of Experiment 2 (affective)

The following materials can be obtained:

- German version of the CFC-14
- General information on skin cancer
- Narratives
- Pre-registration

CURRICULUM VITAE & LIST OF PUBLICATIONS

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Education

2018 – 2022	PhD in Psycholinguistics, University of Fribourg
2015 – 2017	Master of Science in Psychology, Specialization in Clinical Psychology, University of Zurich
2011 – 2015	Bachelor of Science in Psychology, Minors Biology and Neuroinformatics, University of Zurich
2013 – 2014	Exchange Semester, Humboldt University of Berlin

Professional Appointments

Teaching and Mentoring Experience

Jun 2022	Presentation, Biogen Baar: How to support your trans colleagues to foster a safer work environment
May 2022	Guest Lecture, University of Fribourg – Department of German Studies: *Einführung in die Psycholinguistik*
Sep 2018 – May 2020	Teaching Assistant, University of Fribourg – Department of Psychology: *Introduction to R*
Sep 2019	Public Lecture, University of Fribourg: *How to cope with stress*
Mar 2019	Guest Lecture, University of Fribourg – Department of Psychology: *Trans persons and Stigma*
Sep 2015 – May 2017	Statistics Tutor, University of Zurich – Chair for Psychological Methods, Evaluation & Statistics: *Statistics II*

Research and Clinical Experience

Aug 2018 – Dec 2022	PhD Student, University of Fribourg – Psycholinguistics and Applied Social Psychology
Jan 2017 – Jul 2017	Research Assistant, University of Zurich – Psychological Methods, Evaluation & Statistics
Sep 2015 – Feb 2016	Research Internship, University of Zurich – Psychopathology & Clinical Intervention
Mar 2015 – Aug 2015	Clinical Internship, Psychiatric University Hospital Zurich – Forensic Psychiatry

Publications

Jäggi, T., Sato, S., Gillioz, C., & Gygax P. (2022). Is the future near of far depending on the verb tense markers used? An experimental investigation into the effects of the grammaticalization of the future. *PLoS ONE 17*(1): e0262778. DOI: https://doi.org/10.1371/journal.pone.0262778

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