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# HUNGARIAN PRE-VERBAL FOCUS: REPRESENTATION AND INTERPRETATION

## DOCTORAL THESIS

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**Contents**

## Acknowledgement

# 1 Introduction

When we communicate via language, we have the option to mark certain pieces of information in our message as especially relevant, important, or new. Such marking of bits of information is called linguistic focus marking. Consider the example in (1a) (linguistically focused elements will be set in small capitals henceforth).

(1)  a. It is his WALLET that John lost at the party.
     b. John lost his wallet at the party.

In example (1a), the element *wallet* is focused, while the same linguistic element is not in (1b). The focus containing sentence in (1a) may be used to convey the message that it is his wallet that John lost, as opposed to some other object, such as a key or a cellphone. The phenomenon of focus is ubiquitous in languages, and it has attracted substantial attention in the fields of both theoretical linguistics and psycholinguistics. The current Thesis also sets out to investigate this phenomenon, and asks two central questions.

The first question pertains to the mental representation of the linguistically focused information. The question of representation becomes especially intriguing considering the functional definition of focus above: if linguistic focus serves to indicate that a certain piece of information is new or especially important, can we show that focused information is represented differently in the mind than non-focused information? For example, is *wallet* represented differently in the addressee if she hears (1a) as opposed to (1b)? We will address this question by examining three processes related to the representation of focused information: i) the encoding of the linguistically focused information (i.e. the process of forming the representation of the focused element in the mind), ii) the retention of the representation associated with the focused element in memory, and iii) the accessibility to this representation in memory, i.e. the ease with which such a representation is retrieved. To investigate these questions, we set out to test the hypothesis that focus modulates the attention of the addressee during the processes of encoding and retention. Additionally, we also hypothesized that representations associated with linguistically focused elements are more easily accessed in memory. We also propose that the observed attention capturing properties of focus can be accounted for by relying on the extra-linguistic factor of prominence: since focus is the most prominent part of the sentence by virtue of its phonologically, syntactically, or morphologically marked nature, it captures the attention of the addressee. Thus, prominence is a factor which accounts for our observations pertaining to the representation of focused elements.

The second question relates to the interpretation of focus containing sentences. It has long been observed that sentences with focus are interpreted exhaustively, i.e. in a way that the assertion in the focus containing predicate is considered to be true only for the piece of information marked for focus. For example, hearers of (1a) will most probably infer that John did not lose anything else apart from his wallet at the party. The source of this interpretational component has also long intrigued researchers: the central question is whether exhaustivity is an immanent syntactic-semantic feature of focus constructions, or whether it is calculated via the involvement of more general pragmatic principles. We address this question by testing the hypothesis that the exhaustive interpretation of focus constructions is generated as a scalar type pragmatic implicature.

Finally, we make an attempt to offer an explanation for the exhaustive interpretation of focus based on results pertaining to its attention controlling properties by claiming that exhaustive interpretation can be derived from the interplay of linguistic focus marking and the mechanisms of attention. More specifically, we conjecture that exhaustivity is the consequence of the selective nature of attention which is guided by linguistic focus.

Before turning to the details, let us present the Thesis points and the related Studies below.

**THESES:**

**Thesis 1** (see **Study 1**):
Encoding: Focused elements are allocated more attention during Working Memory encoding

**Thesis 2** (see **Study 1**):
Retention: Focus modulates the refreshing of the representation associated with the focused element in Working Memory

**Thesis 3** (see **Study 2**):
Alternatives: Focus activates the representation of a set of alternatives in Working Memory

**Thesis 4** (see **Study 2**):
Retrieval: Focus enhances the accessibility of the focused element in Working Memory

**Thesis 5** (see **Study 1**):
Focus is a grammaticalized means to express prominence

**Thesis 6** (see **Study 3**):
Contextually available sets motivate the use of the pre-verbal focus

**Thesis 7** (see **Study 4 & 5**):
Context modulates the rate of exhaustive interpretation associated with the pre-verbal focus

**Thesis 8** (see **Study 4 & 5**):
Context modulates the mental processes associated with the computation of exhaustivity

**Thesis 9** (see **Study 4 & 5**):
The exhaustive interpretation of the pre-verbal focus is best seen as a scalar type implicature

**Thesis 10** (see **Study 1**):
Exhaustivity associated with focus is derivable from its attention capturing properties

**STUDIES:**

**Study 1:**
Káldi, T., & Babarczy, A. (2021). Linguistic focus guides attention during the encoding and refreshing of working memory content. *Journal of Memory and Language,* 24.

**Study 2:**
Káldi, T., Szőllősi, Á. & Babarczy, A. (to appear in *Frontiers in Psychology*). Hungarian structural focus: accessibility to focused elements and their alternatives in Working Memory and delayed recognition memory

**Study 3:**
Káldi, T., Madarász, L., & Babarczy, A. (2020). Contextual triggers of the Hungarian pre-verbal focus structure – A guided production study. In V. Hegedűs & I. Vogel (Eds.), *Approaches to Hungarian,* 16:73–96.

**Study 4:**
Káldi, T., Babarczy, A., & Bende-Farkas, Á. (2016). Hungarian Focus: Presuppositional Content and Exhaustivity Revisited. In J. Emonds & M. Janebová (Eds.), *Language Use and Linguistic Structure, Proceedings of the Olomouc Linguistics Colloquium 2016,* 245-262. Palacký University Press.

**Study 5:**
Káldi, Tamás, and Anna Babarczy. 2018. "Linguistic Exhaustivity Inference Is Context Dependent: A Visual-World Eye-Tracking Study on Hungarian Focus." *Acta Linguistica Academica,* 65(4):547–95.

## 2 Focus

### 2.1 Focus in general

An idea that we want to communicate can be expressed through various linguistic forms depending on what aspect of that idea we consider important, new, or especially relevant. For example, the sentence in (2a), in which *Carl* is given prosodic prominence, may answer the question *who likes herring?* In this case, the prominent part of the sentence corresponds to new information required by the question. Also, (2a) may express that the person who likes herring is Carl and not someone else. Thus, in this case, prominence may mark contrast with respect to the sentence *Ted likes herring*.

(2)     a.      CARL likes herring.
        b.      Carl likes HERRING.

Alternatively, if *herring* is prominent, as in (2b), the sentence may express that it is *herring* and not some other seafood that Carl likes. Also, the presence of prosodic prominence in (2b) may express that the item *herring* conveys a new piece of information, one that is not recoverable from the discourse. In this case, the sentence may be an answer to the question *What seafood does Carl like?* Thus, examples in (2) demonstrate that the linguistic form of an utterance will reflect the status of certain pieces of information conveyed by that utterance. Items expressing new, important or especially relevant information (such as *Carl* and *herring* in their respective examples), are called the focus of the sentence. When an expression is not given prominence (such as *Carl* in (2b)), it may signal that information carried by this expression has been introduced into the discourse earlier. This expression denotes the entity about which the statement is made, and this is called the topic of the sentence. Topic and focus are two central notions of information structure, i.e. the linguistic form which is used to package information in linguistic expressions (Chafe 1976; Krifka 2008). The present Thesis concentrates on focus.

Over the course of the past sixty years, several attempts have been made to provide a unified theory of focus. However, this endeavor has proven to be particularly difficult, since i) focus marking may take various communicative roles (as exemplified via the examples in (2)), and ii) there are a multitude of strategies employed by languages to mark expressions for focus. As a consequence, accounts of focus marking in the domain of linguistics are highly divergent. Some authors argue that the function of focus marking is to bring a piece of information into the foreground while backgrounding the rest of the proposition expressed by a sentence (e.g. Krifka 1992; Stechow 1991). Others see the focused item as the part of the sentence that the speaker assumes to contain new or unpredictable information for the listener, or is especially informative to the listener (Halliday 1967; Jackendoff 1972; Knud 1994). A third family of answers maintains that the function of linguistic focusing is to evoke a set of alternatives with which the referent of the item marked for focus is contrasted as the one that is of relevance in the discourse (Rooth 1992; É. Kiss 1998; Krifka 2008). An additional account posits that sentences containing linguistic focus are answers to implicit questions in discourse, and that the focused element constitutes the part about which the implicit question is made (Roberts 1998). What is common to these approaches is that they place focus marking firmly in the domain of language and assume that focus has some sort of semantic meaning clearly encoded by its associated grammatical structure.

Another strand of research seeks to capture the core properties of focus outside the domain of linguistics, and concentrates on its psychological aspects. Accounts in this strand emphasize the attention capturing properties of focus. For example, Sanford et al. (2006) has shown that linguistic expressions are better remembered if they are marked for focus compared to when they are in a neutral, non-focused position. Based on this finding, the authors conclude that the representation of the expressions corresponding to the focused element is enhanced, since focus "captures the attention" of the addressee, and consequently, focused expressions are subject to deeper processing. The depth of processing enhances the memory representation of the focused element. In line with this reasoning, Stevens & Roberts (2019) argue that linguistic focus marking is a way to encode

prominence in grammar, and as such, it is a solution to the problem of communicating information efficiently while reducing the risk of it being lost in a noisy environment. Ferreira & Lowder (2016) propose a model integrating the depth of processing approach with the linguistic approach. The authors argue that what goes on here is that since old, presupposed or given information is predictable, it requires no more than superficial processing on the part of the addressee, while the parts of the sentence expressing new and unpredictable information will be processed in more detail.

Despite the considerable diversity of its functions and interpretations discussed in the literature, authors in the theoretical linguistic, psycholinguistic and psychological domains agree that linguistic focus has certain central properties that can be captured by a concise definition. In order to lay the groundwork for further discussion, we adopt one of these definitions as formulated by Stevens (2017): focus constitutes the part of the sentence which conveys the most informative or important piece of information within the context of that sentence, and which is marked as such by some linguistic means.

## 2.2 Focus in Hungarian

It is also important to mention another characteristic of focus latent in the discussion so far: focus seems to be universally present in human languages (É. Kiss 1995; Stevens & Robert 2019). In the examples in (2), focus is marked by prosody, which is one option in English. Another one would be to use a cleft construction, such as *it is herring that Carl likes* in which *herring* is marked for focus by syntax (and prosody if the sentence is uttered) (an example is also provided in (1a)). Languages may employ a variety of different focus marking strategies, such as syntax, prosody, morphology, or a combination of these. In Hungarian, for instance, which is the language used for the experiments reported in the current Thesis, the focused element occupies an immediately pre-verbal position and bears the main pitch accent in the sentence. Hence, we shall refer to this construction as the pre-verbal focus henceforth.

Since the purpose of the present Thesis is not to describe the structural properties of Hungarian focus in detail, but to reveal psychological aspects related to its processing and to investigate some of its interpretational properties, we present a brief, informal characterization of the focus construction at hand, as exemplified in (3a) (for an extensive discussion of Hungarian information structure, see e.g. Gyuris 2012).

(3)  a.  Mari egy KALAPOT próbált fel.
         Mary.NOM a hat.ACC try.PST3SG up
         Mary tried on a HAT.
     b.  Mari felpróbált egy 'kalapot.
         Mary.NOM up-try.PST3SG a hat.ACC
         Mary tried on a hat.

The sentence in (3a) is an example of a pre-verbal focus (preVf), also referred to as identificational focus (É. Kiss 1998). In this construction, the focused element sits immediately pre-verbally and the verbal modifier, which is responsible for modifying the meaning of the verb or for expressing aspect occupies a post-verbal position (É. Kiss 2002). Also, the focused element bears a so-called eradicating stress, i.e., it is assigned a prominent sentential stress which "eradicates" all subsequent stresses in the remaining part of the focus containing clause (Kornai & Kálmán 1988). The sentence in (3b) is an example of a post-verbal focus (postVf), also referred to as in-situ, presentational, or information focus (É. Kiss 1998). In this sentence, the post-verbal element is assigned main stress and carries new information, while the verbal modifier occupies the immediately pre-verbal position. In both sentences the subject noun phrase corresponds to the topic of the sentence.

As noted in the Introduction, we aim to contribute to a general understanding of focus by examining the phenomenon in a language that is typologically different from those primarily studied so far, such as English or German. The examination of Hungarian focus serves this purpose well. In the Germanic languages at hand, the

information structural roles of focus and topic may either be expressed through prosody (cf. sentences in (2)), or through particular syntactic structures, such as the cleft construction (1a), or passivization, while word order is primarily maintained for the expression of grammatical roles, like subject and object. In other words, grammatical roles are marked via the configuration of constituents. Hence, these languages are categorized as configurational languages. On the other hand, in Hungarian, the configuration of constituents expresses information structural roles as opposed to grammatical roles (É. Kiss 1995). Since information structural roles are dependent on discourse, the category of languages to which Hungarian belongs is called discourse configurational languages. We contend that a general focus theory has to accommodate findings on languages belonging to different typological categories. Since evidence informing such theories comes mainly from configurational languages (such as English and German), we consider it important to extend the investigation also to discourse configurational languages, such as Hungarian. Accordingly, one of the goals of the present Thesis is to study the psychological and interpretational characteristics of the Hungarian pre-verbal focus in particular, and thus to contribute to extending our knowledge on linguistic focus in general.

## 2.3 Focus as the most prominent part of the sentence

Ever since focus, as an information packaging device was first recognized and analyzed, prosodic prominence has also been associated with it. The first observations regarding prominence as its definitive characteristic were discussed in the theoretical literature. For example, one of the first accounts was formulated by Halliday (1969), who observed that in English one has the option to select an element within an 'information unit', and to assign phonological prominence to this element marking it for focus. Later, the analysis of focus as a discourse function was developed, still heavily relying on English data with the aim to capture its core properties and to account for its realization (see e.g. Chomsky 1971). Such accounts also identified prominence as a definitive property. For example, Rochemont (1986), adopting the current version of Chomskian generative framework of the time, claimed that any phonologically prominent constituent will be interpreted as focus in the S-structure representation of the sentence (*If 'a' is prominent, then 'a' is [+ focus]*, p. 33).

As investigation was further extended to other languages, it was established that focus marking may not only be realized by phonological prominence, but by a dedicated construction type (e.g. cleft), syntactic position (e.g. the pre-verbal position in Hungarian), or morphology (e.g. in Quechua, see e.g. O'Rourke, 2005). These observations not only showed that the discourse function of focusing is universal, but also that the traditional Chomskian syntactic analysis of focus could not be applied to a variety of languages. Hence, the term discourse configurationality was developed, and new approaches to focus appeared (see É. Kiss 1995 for a comprehensive discussion). However, one central claim regarding focus persisted: prominence was and has been central in accounts of focus. In line with this, a theoretical treatment of the Hungarian sentence intonation by Kornai & Kálmán (1988) claimed that focus is the most prominent element in the sentence. The authors propose an analysis in which elements may be marked for **f** (i.e. focus) in the post-lexical representation of a sentence. If **f** marking occurs, a so called Eradicating Rule applies which will delete all accents following the **f** marked element until the next **f** marked element or phrase boundary. This is the stress type that has been referred to as eradicating stress in the literature on Hungarian focus. Kornai & Kálmán (1988) also suggests that the eradicating stress is stronger than any other stress in the sentence. In other words, a focus marked element will be the most prominent one. In another influential analysis, Szendrői (2001) examining focusing in three typologically different languages, English, Italian, and Hungarian, built on the generalization that the focus in a clause is any syntactic constituent within which the main stress of the intonational phrase corresponding to that clause is realized (also see Reinhart 1995). Szendrői claims that while in English it is possible to express focus in situ by placing the main stress on the focused element, in Italian and Hungarian the default positions of highest prosodic prominence within the sentence are the right-periphery and left-periphery respectively. Therefore, in order for focus to be expressed, elements 'move' to these prominent positions. Another work by Büring (2008) also examined a number typologically different languages, in which focus is expressed in various, seemingly

unrelated ways. However, Büring claims that this variety in focus marking strategies is governed by one simple principle, which he terms the Prominence Theory of Focus Realization: *Focus needs to be maximally prominent* (p. 2). In Büring's account the different focus realizations in languages are the result of of how this principle applies depending of the characteristics of the given language: headedness, strategies of syntactic and prosodic adjustment (i.e. movement, boundary insertion/deletion), the phonetic realization of phrase boundaries, and so on. To conclude, even this short and simplified outline of theoretical accounts illustrates that although certain theories may diverge in technical details, prominence, as a definitive element of focus is central to each.

Results of empirical studies using acoustic measurements have supported the view that focus is indeed the most prominent part of the sentence (for results in Germanic languages, see e.g. Gussenhoven 2008, Spalek et al. 2014). In a particularly interesting study, Genzel et al. (2015) carried out acoustic measurements on the Hungraian preVf. The investigation of this focus type is especially interesting, as in Hungarian focus is not only marked prosodically, but also syntactically, hence it is different from the in situ prosodic focus commonly observed in the well-studied Germanic languages. The authors used a production paradigm experiment in which participants were instructed to read contextually embedded preVf sentences. The manipulated contextual factors were i) givenness of background, and ii) contrastivity of focus. Experimental questions included whether i) focus is given prosodic prominence, ii) the non-focused part of the sentence is reduced in prominence, and iii) givenness and contrast have an effect on the prosodic realization of preVf sentences. Analysis of acoustic data revealed that in preVf the focused element is always realized with a more prominent prosody (higher F0 and steeper fall), however, the non-focused background part remains unaffected. Regarding the third question, the authors found that the accent on the focused element is not affected if the focus expresses contrast, while there is a deaccentuation of the background part in the presence of contrast, or if the background is explicitly given earlier in the context. Hence, Genzel et al. (2015) provide sound empirical evidence for the claim that prominence is a central characteristic also to the Hungarian pre-verbal focus construction.

Mády (2015) approached the question of focus prominence drawing upon a distinction along the dimension of prosodic plasticity: English is claimed to be a prosodically plastic language, since prosody alone can express focus by accenting the focused element (in-situ focus). In other words, the same string of elements can be realized in speech with a range of different prosodic patterns depending on the information structural status of these elements. However, as Hungarian expresses focus via a structural configuration, the use of prosodic prominence to mark focus becomes redundant: syntax alone would be sufficient. The author examined the prosodic realization of focused elements in contextually embedded preVf sentences in two conditions. In one condition the preVf expressed identification (narrow focus), in the other condition it expressed contrast. Results showed that the focused elements were marked by emphasis in both conditions, however, the realization of this marking was not consistent in speakers. Thus, Mády (2015) concluded that although prosodic marking of focus is present in Hungarian its use is optional supporting the view that syntactic marking may be sufficient.

Taken together, prominence also plays a role in focus marking in Hungarian. On the one hand, it is marked by a dedicated syntactic position, such as the immediately pre-verbal slot. On the other hand, it is marked by prosodic emphasis, as Genzel et al. (2015) and Mády (2015) jointly suggest.

Interestingly, the role of prominence in focus marking can not only be studied via the investigation of natural languages. In a compelling work, Stevens & Roberts (2019) proposes that focus is not strictly a grammar-internal feature of languages (as for example gender marking), but that it emerges governed by language external constraints or pressures on communication. The authors argue that if this is indeed the case, the emergence of a strategy analogous to focus in natural languages should emerge also in the case of non-verbal communication. In order for the analogy to be valid, focus needs to be defined in a way that this definition does not only apply for linguistic focus, but also for the non-verbal analogy. Hence, Stevens & Roberts (2019) propose a broad definition applicable within communication theory, and claim that focus is the selective application of redundancy to a piece of information within a message. The authors identify two constraints on communication

that determine the allocation of redundancy. One of these constraints is the need to combat noise. To achieve this, redundancy is applied to critical elements. To illustrate the point, the authors provide the example of adding redundancy during spelling, whereby a word like *cat* may be spelled out as "Charlie Alpha Tango" instead of "cee ay tee". The strategy is frequently used in situations where noise may disrupt the transmission of information, such as aviation. The other constraint is efficiency. Adding redundancy requires extra effort, therefore, in order to optimize the efficiency of communication, redundancy is applied selectively only to portions of the utterance that are new or especially important, while portions that are old, or recoverable from the context are not made redundant. Thus, peaks of prominence are created in the flow of utterances whereby the pattern of redundant and non-redundant chunks are created. This pattern of prominent and less prominent portions maps approximately onto the pattern of focused and backgrounded material in speech (see also Stevens 2016).

In order to test the hypothesis that a focus like phenomenon emerges in non-linguistic communication, Stevens & Roberts (2019) applied a non-linguistic communication game and investigated whether redundancy is indeed applied selectively. Factors of pressure such as noise, effort and time limitation were introduced as manipulated variables to study how such a strategy of distributing redundancy analogous to focus develops as the need for efficiency increases. The game was played by two participants who saw a grid on a screen. The task was to transmit information about patterns of lines in the cells. The game was played in turns, participants communicated by clicking on cells. The background or given information corresponded to overlapping lines from earlier rounds, whereas new information corresponded to lines that had not been presented. Results showed that when there was no pressure on communication, no peaks in the distribution of redundancy was observed. However, as pressure was increased, focus like patterns emerged in the distribution of redundant and non-redundant messages. Interestingly, accuracy was relatively consistent under different degrees of pressure suggesting that economizing does not lead to a deterioration in the ability to communicate.

To conclude, in information theoretic terms linguistic focus is a grammaticalized means of adding redundancy selectively to an utterance. In natural languages, redundancy may be added via the application of prosodic prominence, the use of a prominent syntactic position, morphological marking, or a combination of these. We find the information theoretic approach especially appealing, as it not only facilitates hypothesizing about how focus emerges, but also provides a basis for hypotheses about how focus is processed and represented in the mind.

## 3 Representation

According to the definition of focus adopted for the present Thesis, the focused part of the sentence carries information that is especially informative or important within a given context. This formulation motivates a set of conjectures regarding the psychological aspects of linguistic focus, some of which were tested in the experiments reported below. Before turning to these conjectures, let us consider an everyday scenario, such as (4), in which a focus containing sentence is used. Also, let us take into account some of the tasks that the mind has to perform in order to process that sentence.

(4)     Background:     The interlocutors know that Carl is coming over for dinner tonight.
        A:              I wonder if Carl likes seafood.
        B:              Well, he likes HERRING.
        A:              That's great! I'll go and see if we have some in the freezer.

The first utterance of speaker A refers to a set of seafoods whose members are potential alternatives, such as shrimp, mussels, cod, herring etc. Speaker B's response selects one member from this set. As the expression referring to this element carries the most relevant piece of information in B's sentence, it is marked for focus. Upon hearing B's response, A encodes this piece of information into her mind (namely that herring was selected from the contextually given set of alternatives), retains it for a certain period of time, and retrieves it when

opening the freezer and starts searching for the package of herring. In short, upon hearing B's response, A's tasks include encoding, retaining and retrieving information corresponding to the focused expression. In order to carry out these tasks, A uses her Working Memory (WM): the cognitive system responsible for storing, processing and manipulating information needed for a given cognitive task for a limited period of time (Baddeley 2003). Irrespective of theoretical stance, it is agreed that WM carries out the above tasks by holding information in an elevated state of availability for the purposes of a current task for a limited amount of time (Adams et al. 2018). The information that A's WM uses to solve the task at hand uses the mental representation of the information carried by the focused expression. The predictions tested in the experiments reported below pertain to processes related to such representations. More specifically, they bear on the formation of the representation of the focused element in WM (i.e. its encoding), its retention, and its retrieval. One of the central claims of the present Thesis is that linguistic focus directs the attention of the addressee to the focused element. As a corollary, it is assumed that the focused element is subject to more in-depth processing which in turn results in the formation of a more detailed representation (for earlier results see e.g. Sanford et al. 2009; Sturt et al. 2004). Therefore, we also ask how fine grained the representation of focused elements may be in the case of the Hungarian focus construction.

The situation in (4) illustrates a further point regarding focus representation prominently discussed in the literature: the representation of the set of alternatives to the focused element. In intuitive terms, speaker B's sentence implies that among different kinds of seafood it is herring that Carl likes, and not any of its alternatives, such as shrimp, mussels, cod etc. In other words, focus is interpreted in terms of the alternatives that it evokes. As will be discussed in greater detail in Section 3.2.2 (see also **Study 2** in Appendix), the set of alternatives is contextually determined. For example, in the situation in (4), the context is created by speaker A's sentence in which seafood is mentioned. Had speaker A mentioned the set of foods in general (for example in the form of a question: *I wonder what food Carl prefers*), the set of alternatives would be larger and would probably include pork, pasta, mushrooms, cheese etc. The general point is that whatever the context, a set of alternatives is always relevant for the interpretation of focus. This idea provides the basis for the so-called alternative semantics approach to focus (Rooth 1985, 1992; Kenesei 2006). Based on the theoretical considerations of this approach, it is reasonable to assume that alternatives are also activated in the mind. In other words, the alternative semantics approach to focus interpretation may have psychological reality. This assumption has been tested with confirmatory results by a broad array of studies using configurational languages (see Section 3.2.2). In the current work, we ask whether this is also true for a discourse configurational language, such as Hungarian.

Taken together, the present Thesis addresses the following issues pertaining to focus representation: the encoding of focused elements (i.e. the formation of focus representations in memory), the retention and retrieval of the representation of the focused element, the semantic detail of the representation associated with the focused element, and the representation of its alternatives.

Regarding the three WM processes, our point of departure is a functional characterization of focus, neatly summarized by Sanford et al. (2006), which claims that focus serves to capture the attention of the addressee. Based on this, we formulated the following predictions with respect to the Hungarian pre-verbal focus (preVf).

- Encoding: The focused element is allocated more attention during the process of encoding.
- Retention: The focused element is allocated more attention during the process of attentional refreshing.
- Retrieval: The focused element is more readily accessible in WM.

Regarding the representation of alternatives, our point of departure was the alternative semantics approach to focus (Rooth 1985, 1992). In line with the results of psycholinguistic research on languages such as English and German, we assumed the following:

- Alternatives: PreVf activates a set of alternatives in the mind.

In the following, each of these conjectures are discussed in greater detail.

### 3.1 Memory representation processes

### 3.1.1 Encoding

Brassai's (1860, 1865) observations on the structure of Hungarian sentences, made more than one and a half centuries ago, neatly introduces our discussion pertaining to the encoding of focused elements. The author divided the sentence into two parts and claimed that the expressions in the part that we today identify as focus "practically lay a basis for the meaning of the sentence in the listener's mind, i.e., they are calling attention, and pointing forward, connecting the mental activity of the listener with that of the speaker" (1860, p. 341; translation by É. Kiss 2008, p. 55). This functional characterization is especially appealing, since it precisely foreshadows the course of psycholinguistic investigation on focus investigating how attention is modulated during the encoding of focused elements. This strand of research is centered on the idea that focus functions as an attention capturing device (Sanford et al. 2006). In the present Thesis, the tenability of this functional characterization will be tested in the case of the Hungarian pre-verbal focus construction with the use of a method that measures the psychophysiological correlates of attention allocation, namely through pupillometry. We contend that using this method is especially important, since the question at hand has been investigated primarily with methods that allow rather indirect conclusions.

For example, in a seminal paper, Bredart & Modolo (1988) used it-cleft constructions, a type of syntactic focus, to investigate whether the so-called Moses illusion is modulated by focus. The authors presented anomalous cleft sentences (e.g. *It was Moses who took two animals of each kind on the Ark*) in a sentence verification task and measured how frequently participants spotted the anomaly as a function of whether the incongruous item (i.e. *Moses*) was focused or unfocused. The results indicated a higher detection rate in the focused condition lending support to the idea that focus indeed guides the attention of the addressee to the focused element. Other studies carried out in a similar vein revealed that focused information is identified more rapidly (Cutler & Fodor 1979), and incongruence of visual and verbal stimuli is more readily detected if the linguistic expression causing the incongruence is focused (Hornby 1974).

In a particularly interesting work, Weber et al. (2006) (see also Sedivy et al. 1999) tracked participants' eye-movements while presenting verbal instructions with contrastive focus in a visual world paradigm experiment. Each trial consisted of two sentences: the first one introduced a referent (*Click on the purple scissor*), while the second one either referred to a contrast element (*Now, click on the red scissor*) or a non-contrastive referent (*Now, click on the red vase*). The authors manipulated the presence of contrastive pitch accent on the adjective and the noun. The visual stimuli included objects corresponding to the noun expressions in the sentences. The main question of the study was whether listeners are able to use information from contrastively accented adjectives for an early determination of reference. The result showed that the presence of the adjective facilitated the looks to the contrast object. More interestingly, the authors found an interaction: when the adjective was contrastively accented, it facilitated the looks to the contrastive object even more. While these results clearly show that the function of contrastive focus is to guide the attention of the listener, the paradigm used by Weber et al. (2006) introduced a special context and used focus in a special, contrastive way. Thus, although the findings are revelatory, the question remains whether the conclusion regarding the attention controlling effect of focus can also be extended to other, non-contrastive uses.

A few studies investigated the modulation of attention by linguistic focus using eye-tracking in reading paradigms. In one such study, Birch & Rayner (1997) argued that if focus marking indeed leads to a better, or "privileged" state of activation for the focused item, and it also makes this item more accessible in memory, then the process of encoding associated with a focused item should also be more elaborate as reflected by eye-movements. To investigate this possibility, the authors compared the reading times of syntactically focused and non-focused elements. The results showed that there was a greater probability of regressions and a greater length of regression-fixations to focused elements suggesting that higher level processes such as integration and the analysis of information-structural status are more active during the encoding of focused elements. The authors

concluded that focused elements are subject to more elaborate encoding, and contend that their findings explain the observations on higher detection rates of anomalies, incongruence, or errors such as those reported in Bredart & Modolo (1988), Cutler & Fodor (1979), and Hornby (1974).

The attention capturing properties of focus have also been investigated with the change detection paradigm. For example, Sturt et al. (2004) reasoned that if we can show that focused elements are more accessible in WM, and their representation is more detailed (or more fine grained), we can conclude that focused elements are subject to more elaborate encoding. More elaborate encoding is, in turn, the result of higher attention allocation to the focused element. The authors tested this conjecture by presenting participants with short texts containing a cleft sentence in which the target word was either focused or not. Critical probes were the same texts containing one change: the target word was either replaced by a semantically related word, or a semantically unrelated word. The results revealed that the detection rates were equally high irrespective of focus in the unrelated condition. However, in the semantically related condition, focus made a difference: while changes were significantly less likely to be detected when the critical noun was not focused, detection rates remained high in the related condition when it was in focus. Based on these results, the authors concluded that focus indeed directs attention to the focused element.

The brief survey of studies above clearly illustrates the main approaches that have been taken to study the relationship between attention and linguistic focus: the conjecture that focus guides the attention of the addressee to the focused element has primarily been studied using rates of anomaly or error detections, the speed with which referents are identified in the visual world, by measuring gaze patterns during the reading of focused elements, or by change detections rates. Note, however, that the evidence provided by these studies is either restricted in scope or is rather indirect with regards to our original question, namely how focus modulates attention during the encoding of the focused element.

Thus, our primary goal has been to take a step towards applying a method that enables the examination of attention allocation more directly, and to test the conjecture that linguistically focused elements receive more attention during encoding. As will be seen, the applied method involves measuring the psychophysiological correlate of attention allocation, namely pupil dilation.

The measurement of pupil size served to gauge attention allocation during the encoding of the focused element, i.e. the formation of its representation in WM. We chose this measure, since it has been shown by a wide range of studies that cognitive tasks are reliably accompanied by phasic pupil dilation changes. For example, pupil dilation positively correlates with cognitive load (see e.g. Hess & Polt 1964; Kahneman & Beatty 1966; Goldinger & Papesh 2012; Hyönä & Alaja 1995), mental effort as modulated by incentive to solve a cognitive task (Heitz et al. 2008), and attentional load (see e.g. Hoeks & Levelt 1993; Aston-Jones & Cohen 2005; Sara 2009; Mathôt et al. 2013; Johnson et al. 2014; Koelewijn et al. 2015). Due to its reliability, Beatty & Lucero-Wagoner (2000) proposed that change in pupil size should be seen as a reporter variable for human cognitive processes.

Two studies among those investigating the relationship between change in pupil size and attention allocation bear special relevance for our purposes. Firstly, Kang, et al. (2014) showed that such changes are strictly time-locked to changes of attention allocation. This is especially relevant, since linguistic stimulus unfolds over time by nature, therefore we needed a measure that is reflective of attentional processes during the time course of processing the focus containing sentences. Secondly, Ariel & Castel (2014) demonstrated that attention is allocated selectively during WM encoding depending on the degree of importance of the item to be encoded, and this is reflected in pupil dilation. This finding is also important, since it reflects on the definition adopted for our Thesis: if focus refers to the portion of an utterance which is especially informative or important, this should be reflected in pupil measures. It is also interesting to mention that not only pupil size changes under constant luminance levels are reliable indicators of cognitive load, but also the modulation of the pupillary light reflex: after constriction incurred by the presentation of a bright stimulus, the rate with which pupil size recovers is modulated by the content of the stimulus (erotic, violent or neutral) (Henderson et al. 2014) or by the

attentional load it requires for performing a certain cognitive task (Fabius et al. 2017). As will be detailed in Section 3.1.1 (see also **Study 1**), we used the modulation of the pupillary light reflex to investigate the cognitive load associated with the encoding of linguistically focused elements.

### 3.1.2 Refreshing

After the information related to the focused element has been encoded, its representation has to be maintained in WM before it can be used. Consider again the scenario in (3) above, in which speaker A is going to check if there is herring in the freezer: after encoding the information that it is herring that Carl likes, speaker A has to maintain this piece of information in her memory to use it later in the search task. The attention based process of actively maintaining information in WM is called refreshing (Vergauwe & Langerock 2017; Souza, et al. 2018). During the process of refreshing, attention is actively allocated to the memory representation to be maintained so that it can be retrieved more efficiently when needed. Thus, the accounts which claim that the function of focus is to guide the attention of the listener should also apply here. In line with the above, we conjecture that more attention is allocated to the representation of a focused element while it is maintained in WM.

Two independent findings jointly support our conjecture. First, it has been found that focused elements are more accessible in WM (see e.g. Sturt et al. 2004; Sanford et al. 2006; Sanford et al. 2009; Ward & Sturt 2007; Almor & Eimas 2008; and Section 3.3 for further details). Second, it has also been found in the non-linguistic domain, that the elements that are refreshed at a higher rate (i.e. receive more attention during memory retention) are also more accessible in WM. For this reason, it seems reasonable to assume that the representations of focused elements also receive a higher rate of refreshing.

The above mentioned findings in the non-linguistic domain come from two strands of research. One of these is the literature on the retro-cue effect. In retro-cue experiments, a set of items are presented on a screen, and the participant is informed that they will have to perform a WM task with relation to this set. The stimuli then disappear and a visual cue is shown (retro-cue) marking the location or a certain feature of one element in the memory set (e.g. an arrow pointing at the location where the target stimulus appeared on the screen, or a color sample showing the color of the target item etc.). The participant is later asked to perform a memory task with the cued element. The results of these experiments reveal that WM performance is better for cued items than for non-cued items, i.e. cuing a particular item leads to a so-called retro-cue benefit. The underlying assumption behind the retro-cue paradigm is that directing attention to a feature (e.g. location, shape, color) of a previously present item brings the representation of that item into the center of attention, which amounts to refreshing its memory trace.

Another set of findings has been reported in studies using the blank screen paradigm. In a blank screen experiment, participants are shown a visual memory set together with some verbal instruction, which they have to carry out later during the trial. After the presentation of the visual stimulus, a blank screen is displayed, during which gaze patterns are measured. The rationale behind the paradigm is as follows. It is assumed that participants construct a mental representation of the visual scene and in the absence of that visual scene task-relevant aspects of its representation are attended. The focus of attention is reflected by the location of fixations: participants fixate on screen regions that had earlier been occupied by task-relevant items. Studies investigating the effects of these so called "looking-at-nothing" phenomena have established that looks-at-nothing corresponding to an item improve WM performance for that item and all item-related information (Richardson & Spivey 2000; Spivey & Geng 2001; Hollingworth & Henderson 2002; Altmann 2004; Richardson & Kirkham 2004; Hoover & Richardson 2008; Vankov 2009; Johansson et al. 2012; Kuo et al. 2012; Johansson & Johansson 2014; Laeng et al. 2014; Scholz et al. 2016; Martarelli et al. 2017).

Taken together, results in the retro-cue literature and the findings on the looking-at-nothing effect show that the more refreshing a memory representation gets during retention, the more likely it will be retrieved successfully.

Let us now turn to our original research question regarding attention allocation during the retention of focused elements: given that i) linguistically focused elements are more accessible in WM similarly to ii) memory items that are refreshed at a higher rate during memory retention, it seems reasonable to conjecture that linguistically focused elements are also more accessible in WM *because* they are allocated more attention during retention, i.e. they are refreshed at a higher rate. This is also a conjecture that we set out to test.

### 3.1.3 Retrieval

Finally, speaker A retrieves the information that it is herring that she has to look for in the freezer. This mental process has also been investigated by an array of studies which have shown that focus enhances the memory accessibility of the focused element (see e.g. Sturt et al. 2004; Sanford et al. 2006; Sanford et al. 2009; Ward & Sturt, 2007). The main idea behind these studies is a functional characterization of focus rooted in the theoretical domain which maintains that focus primarily serves to foreground information (e.g. Krifka 1992; Stechow 1991), which is new, important or non-presupposed (Jackendoff 1972; É. Kiss 1998), and most probably also serves to direct the attention of the hearer to the focused expression (Erteschik-Shir & Lappin 1979).

A widespread approach to studying the memory accessibility of focused elements has been using lexical decision paradigms. For example, Almor & Eimas (2008), in the vein of the so-called identification account, proposed that the primary function of focus is to facilitate the identification of the focused item in order to enhance the efficiency of the discourse integration of linguistic elements. To test this hypothesis, the authors investigated how syntactic focus (i.e. the cleft construction) modulated the accessibility of linguistic elements immediately after the focus-containing sentence has been processed in a lexical decision paradigm. The results showed that participants responded faster when the antecedent of the target word was focused compared to when it was not, lending support to the hypothesis that focused elements are more accessible in online processing.

In an especially interesting study by Sanford et al. (2009), the authors presented cleft and pseudo-cleft sentences together with an additional sentence containing an anaphoric expression in a self-paced reading experiment. The antecedent of the anaphoric expression was either co-referent with the focused element in the previous sentence, or its antecedent fell outside the scope of focus. Reaction time measures on reference resolution revealed that focus facilitated the anaphora resolution suggesting that the focus enhances the memory accessibility of linguistic elements, and serves discourse integration efficiently.

Based on these, we conjecture that in the case of the Hungarian pre-verbal focus, focused elements are also more accessible in WM. Additionally, we also make the tentative suggestion that the immediately pre-verbal element in a preVf construction has a finer representation than an element in a neutral, non-focus position.

## 3.2 The nature of memory representations

### 3.2.1 The semantic detail of representations

For example, an influential study by Sturt et al. (2004), already outlined in Section 3.1, investigated the accessibility to focused elements using a change detection paradigm and found that these elements are not only more readily accessible in WM, but their representation is also more fine grained (in the sense of Hobbs 1990), i.e. they are represented in finer detail in the mind. Such observations led to the formulation of the so called granularity account of focus representation (Sanford et al. 2006).

### 3.2.2 Representation of focus alternatives

Let us return to the example (4) for a moment repeated in (5) for convenience.

(5)    Background:    The interlocutors know that Carl is coming over for dinner tonight.
        A:    I wonder if Carl likes seafood.
        B:    Well, he likes HERRING.
        A:    That's great! I'll go and see if we have some in the freezer.

When speaker A opens the freezer, she has to access the information that it is herring that Carl likes, and not some other seafood (e.g. alternatives, such as shrimp, mussels, cod etc.). That is, there is a semantically or contextually relevant set of competing alternatives from which she has to select the element corresponding to the focused expression in speaker B's sentence. This example illustrates another question that arises with relation to the representation of focus: the representation of focus containing sentences is intimately related to the generation of a set of alternatives on which focus operates. This idea is rooted in the alternative semantics approach to focus (Krifka 1992, 2008; Rooth 1985, 1992) which emphasizes that "focus indicates the presence of alternatives that are relevant for the interpretation of linguistic expressions" (Krifka 2008, p. 55). In Rooth's analysis, each focus containing sentence has two semantic values: an ordinary semantic value and a focus semantic value. For example, the ordinary value of the sentence *Carl likes FISH* is the propositional content [Carl likes fish], while its focus semantic value is a set of alternative elements which are of the same type as the focused element, i.e. possible x elements in the proposition [Carl likes X]. Since we are talking about the *representation* of focus, it is especially important to emphasize that what constitutes the set of alternatives is not a set of expressions, but a set of denotations, i.e. a set of representations associated with linguistic expressions that can occupy the position of x. A notable analysis of Hungarian focus in the vein of alternative semantics was provided by Kenesei (2006), in which the author claims that "whether or not the contrasting complementary set is explicit, in the case of contrastive focus a complementary set is always created" (p. 137). This theoretical approach, as Gotzner & Spalek (2019) also argues, has the major advantage that it enables us to model a variety of interpretational effects with one single mechanism. For example, this theoretical account can accommodate the function of marking new information as well as its contrastive and corrective uses (for details see Gotzner & Spalek 2019). These theoretical considerations have inspired a great wealth of experimental work on the activation of focus alternatives centering on two questions: i) does the theoretical consideration that focus activates a set of alternatives have psychological reality, ii) if so, what constitutes the set of focus alternatives?

Regarding the question whether focus indeed activates a set of alternatives, a wide range of experimental studies has been conducted with confirmatory results (for a comprehensive overview see Gotzner & Spalek 2019). One strand of studies has shown that potential alternatives already introduced in the discourse are more accessible (Sedivy et al. 1996; Weber et al. 2006; Watson et al. 2008; Kim et al. 2015). For example, using a similar paradigm as Weber et al. (2006) (see Section 3.1.1), Watson et al. (2008) presented sentences with or without contrastive pitch accent referring to objects on a visual scene while measuring eye gaze patterns. After a first instruction introducing a set of objects (e.g. *Click on the camel and the dog*), a second instruction asked participants to manipulate one of these objects (e.g. *Now, move the dog above the triangle*), while the third instruction either referred to the alternative (e.g. *Now, move the CAMEL below the square*) or to a non-alternative phonological cohort (*Now, move the CANDLE below the square*). The authors observed that participants fixated more on the alternative (*camel*) than on the cohort (*candle*) during the processing of the third instruction when it was contrastively accented. In other words, participants generated strong expectations regarding the focus alternative if the critical word in the third instruction was contrastively accented as opposed to when it was not, suggesting that focus boosts the accessibility to the representation of potential alternatives already present in the discourse.

In a study on the activation of unmentioned alternatives, Braun and Tagliapietra (2010) showed using a lexical decision priming paradigm that decision times are lower for possible contrastive alternatives than for pure semantic associates if the prime word is contrastively focused. The authors concluded that the faster reaction

times were a correlate of a higher activation of contrastive alternatives. In a subsequent study, also using a priming paradigm, Husband & Ferreira (2016) observed that initially all related items are activated during the processing of a focus containing sentence, and after this initial burst of activation non-alternatives are suppressed, while the activation of alternatives is maintained.

Gotzner et al. (2017) investigated the activation of mentioned and unmentioned focus alternatives in a series of two experiments employing probe recognition and lexical decision. The authors presented short texts in which the first sentence designated a set (e.g. *In the fruit bowl there are peaches, cherries and bananas*), the second sentence made reference to two elements of this set (e.g. I bet *Carsten ate cherries and bananas*), while the third sentence mentioned the third element and contained a focus sensitive particle or marked focus via pitch accent (*No, he ate only/even/_ ate PEACHES*). After the text, a probe word was presented which was either part of the introduced alternative set (*cherries*), was of a related semantic category, but not mentioned earlier (*melons*) or a non-related control (*clubs*). The authors found longer RTs associated with the rejection of the unmentioned alternatives (*melons*), and the recognition of the mentioned alternatives (*cherries*) in the case of all focus types, which they interpreted as interference effect: since focus activates a cohort of competitors, it takes more time to respond to an element from this cohort than to an unrelated element. Since the probe recognition paradigm does not allow to directly compare the effects on mentioned and unmentioned alternatives (the former have to be recognized, while the latter recognized and then rejected), the authors repeated the experiment using a lexical decision task and using the particle *only* and pitch accent as focus marking in which the potential confounding effect originating from different response types could be eliminated. The recognition of target words showed that RTs were lower for mentioned alternatives and also for unmentioned alternatives than for unrelated control words. The authors interpreted these results as priming effects, and concluded that both mentioned and unmentioned alternatives of focused elements receive a higher activation.

Regarding the question of what constitutes the set of focus alternatives, two views prevail, as fleshed out by Gotzner (2017). The permissive view, based on Rooth (1992), claims that it is the context that serves to designate the alternative set, therefore, alternatives are selected based on pragmatic principles. On the other hand, the restrictive view claims that only those elements can constitute such a set that are semantically contrasted (Wagner 2006). Consider example (6) (adopted from Wagner 2006).

(6)　　a.　　He produces high-end convertibles. What did he bring as a present to the wedding?
　　　　b.　　He brought a CHEAP convertible.
　　　　c.　　*He brought a BLUE convertible.

According to the restrictive view, since color has no relation to quality or cheapness, being blue (6c) cannot constitute an alternative to being high-end, as being cheap can (6b). In contrast, the permissive view predicts that semantically unrelated, but contextually relevant alternatives may also be activated, such as *blue, large* etc. Psycholinguistic experiments addressing this question support the permissive view (see e.g. Gotzner 2017, Jördens et al. 2020).

With regards to Hungarian focus, no experimental data is available on the accessibility and representation of focused sentential elements and their alternatives. However, one study (Pléh & Sinkovics 2011) investigated the retention of sentences with preVf as opposed to neutral sentences. The authors formulated their research questions based on earlier work on English, which revealed that a change in a sentence's semantic content is still detected after 40 seconds, while a change in the surface syntactic form neutral with respect to semantic content (e.g. transformation from active to passive) is not reliably detected in this amount of time (Sachs 1967, see also Johnson-Laird & Stevenson (1970) who found similar results after 50 seconds). Pléh & Sinkovics (2011) asked the question whether this pattern of recognition can be observed also in the case of preVf sentences and their neutral word order counterparts. The question, as the authors explain, is especially interesting, since the use of preVf as an information structural device is motivated by discourse semantic factors. In other words, the seemingly surface syntactic feature of word order in the case of preVf is used to express information structural

roles. Hence, it may be that word order in the case of preVf is not strictly a surface property. This motivates the hypothesis that in the case of Hungarian, not only propositional information should be preserved for a longer period of time, but also word order when it marks a discourse-semantic feature, such as focus. The authors tested the hypothesis by using a change detection paradigm: participants heard a continuous array of sentences (i.e. target sentences), and at unexpected points they were prompted to decide whether they had heard the just presented sentence (i.e. the test sentence) before. In the conditions relevant to our point, the target was a neutral sentence, and the test sentence was its counterpart with a preVf word order. Additionally, a control condition was included in which the target sentence was also neutral, and the target contained a change which did not affect either the propositional content of the sentence or its information structure. The number of interposed sentences (i.e. the amount of delay) was also a manipulated variable, which corresponded to 0 (0 sec), 2 (8 sec), 4 (16 sec), and 10 sentences (40 sec). The dependent variable was correct recognition rate. Results showed that while changes in the control condition were ignored already after two intervening sentences, changes to information structure were preserved even in the condition with the longest delay. The authors conclude that although the original hypothesis proposed by Sachs (1967) and Johnson-Laird & Stevenson (1970) is valid, it needs to be refined, since there are formal syntactic configurations, such as the Hungarian pre-verbal focus, which are also maintained in memory for longer periods. Most probably this is so, as this particular configuration serves to mark discourse-semantic roles. Note, that if this account is to be maintained, it is hard to explain why passive counterparts of target sentences were not recognized in the original studies (Sach 1967, Johnson-Laird & Stevenson 1970). After all, passive is also a syntactic means used to express information structural roles (see e.g. Leiss 1992, Lambrecht 1994, Doherty 2004, Pitz 2006). However, this question extends beyond the scope of the present work, since our aim was to investigate the accessibility of the focused element and its alternatives.

In sum, research has revealed that focus indeed activates the representation of a set of alternatives (whether these be mentioned or unmentioned), and also that the set of alternatives is defined contextually. However, these results come primarily from English and German, and no data is available on Hungarian. Based on theoretical considerations (such as Krifka 1992, 2008; Rooth 1985, 1992; Kenesei 2006), and data on Germanic languages (see e.g. Gotzner & Spalek 2017), we conjecture that a set of alternatives is also activated in the case of the Hungarian pre-verbal focus.

### 3.3 Theses related to the representation of the focused expression

In what follows, findings pertaining to the representation of the focused expression in preVf will be outlined as addressed in **Study 1** and **Study 2**. **Study 1** used pupillometry and the blank screen paradigm to investigate the encoding and retention of focused elements, while **Study 2** used a change detection paradigm to investigate the activation of focus alternatives and the retrieval of the focused elements.

### 3.3.1 Thesis 1. Encoding: Focused elements are allocated more attention during Working Memory encoding

One objective of **Study 1** was to investigate attention allocation during the encoding of focused elements using pupillometry. As mentioned earlier, pupil size is a reliable reporter variable of attention allocation, and thus it may also be used to measure whether linguistic focus modulates attentional load during the processing of focus containing sentences. Experiments 1 and 3 measured pupil size while focus containing sentences such as (7a) were presented and participants memorized them for later use in the experimental tasks. Analogous control sentences were also presented in which critical sentential elements occupied the same relative position as the focused element in the experimental condition (7b). Pupil sizes from the focus and control sentences were compared.

7. a. A kutya A KECSKÉT keltette fel.
the dog.NOM the goat.ACC wake.PST.3SG up
The dog woke up the GOAT.
  b. A kutya a kecskét fel-keltette.
the dog.NOM the goat.ACC up-wake.PST.3SG
The dog woke up the goat.

Results from the two experiments consistently revealed that pupil dilates more while focus containing sentences are processed. We take these data to clearly indicate that focus indeed modulates attention allocation, and that the processing of focus incurs greater attentional load. Thus, these findings corroborate the conjecture that linguistically focused elements are allocated more attention during encoding, i.e. during the formation of the memory representation corresponding to the focused elements.

### 3.3.2 Thesis 2. Retention: Focus modulates the refreshing of the representation associated with the focused element in Working Memory

Another objective of **Study 1** was to investigate attention allocation to the representation of the focused element during WM retention. More specifically, we aimed to test the conjecture that the representation of focused elements receives a more intense refreshing. In order to achieve this, we used a blank screen eye-tracking experiment in which we measured and compared the amount of looks to the location of the object corresponding to the second NP (cf. 7a and 7b) in both Experiment 1 and 3. The two experiments differed in terms of the experimental task. Experiment 1 employed a decision task: after the blank screen, participants were presented one visual probe and had to decide if the given object was presented in the given location earlier during encoding or not. Experiment 3 employed a selection task: participants were presented the same set of visual stimuli as during the visual encoding phase and had to select all the objects mentioned in the test sentence (e.g. to select the images depicting the goat and the dog). The two different task types were used to study potential task effects observed earlier on linguistic processing in general (for an extensive review see Knoeferle 2019) and on the processing of preVf in particular (see e.g. **Study 4 and 5**). The rationale for using these two task types is as follows. In the case of the decision task, we hypothesized that since participants knew they would have to respond to only one visual probe, they would employ a strategy in which the focused element gets priority. After all, it was sufficient to consider only one probe for the successful completion of the decision task. Thus, in the decision task, the task-relevance of the two elements to be held in memory was unequal. In this scenario we predicted that due to its foregrounded status (see definition applied), the focused element would get a priority, and thus it would be refreshed at a greater rate. On the other hand, in the selection task both items were of equal relevance, since they both had to be responded to. Thus, we predicted that no prioritization would occur and the difference in refreshing rates between focused and non-focused elements would be lost.

In line with our predictions, the results of Experiment 1 showed that the location of the object corresponding to the second NP received more looks if this NP was focused than if it was not. In other words, in the decision task experiment, the representation of the focused element was refreshed at a higher rate than its non-focused counterpart. These results confirm the conjecture that focus directs the attention to the focused element not only during encoding, but also during retention.

However, the measurements in Experiment 3 yielded an exact reverse pattern: less looks were detected to the location of the image corresponding to the focused element than to its non-focused counterpart. We offered a post hoc explanation to account for the reversed trend using the findings of Lemaire et al. (2018). The authors of this study found that in the case of complex span tasks, in which memoranda are to be recalled in a serial fashion (just as in Experiment 3), a so-called Least Activated First refreshing schedule is selected and used. According to this schedule, refreshing occurs in a cyclic fashion and in each cycle the least active memory representation is selected for refreshing. This is a reasonable assumption, since the least active representation needs refreshing if it is also to be retrieved later. Thus, we reasoned that in the case of the selection task of

Experiment 3, the Least Activated First schedule was used: the focused element may have had a higher activation as a consequence of its stronger encoding (cf. pupil data on encoding), or, in other words, the activation of elements to be held in WM were unequal. However, the non-focused and consequently least active element was also task-relevant. For this reason, this latter element received priority for refreshing.

Taken together, our findings support the idea that focus *modulates* attention allocation during the retention of the focused element: if the focused element is foregrounded and primarily task-relevant, its representation receives more attention, however, if a non-focused element of equal task relevance is also present, the Least Activated First refreshing schedule is selected, and the non-focused element is refreshed at a higher rate.

### 3.3.3 Thesis 3. Alternatives: Focus activates the representation of a set of alternatives in Working Memory

One of the goals of **Study 2** was to investigate the activation of focus alternatives using two change detection experiments. Participants were presented preVf and neutral sentences embedded in short texts, and were later given a sentence probe about which they had to decide if it was the same as any of the sentences in the story or it contained a change. When the sentence contained a change, the critical word (i.e. the focused element or its non-focused counterpart in the original sentence) was either replaced by a semantically related or a semantically unrelated but contextually suitable alternative. This manipulation was included to test the predictions of the restrictive versus permissive views on focus alternatives. Experiment 1 tested WM performance, while Experiment 2 tested Long Term Memory (LTM) performance. The experimental variable was correct rejection rate: a higher rate of correct rejections was interpreted as higher activation in WM.

First of all, no reliable difference between the rejection rates of probe types containing a semantically related and semantically unrelated but contextually suitable alternative was found in neither experiments. Therefore, our results are inconclusive regarding the restrictive versus permissive views on focus alternatives. For this reason, the distinction between the semantically and contextually related elements in the two probe types are collapsed and we refer to these commonly as alternatives.

The conjecture that preVf activates a set of alternatives is jointly supported by the results of Experiment 1 and 2. In Experiment 1, the result of the statistical analysis of the difference in rejection rates between preVf and neutral sentences just missed the level of significance ($p = .061$). A reliable difference was found, however, in Experiment 2: the rate of correct rejections was lower for preVf sentences than for neutral sentences. We contend that this overall effect is a consequence of semantic interference (Baddeley 1966) and is in line with our conjecture: Since the function of focus is to mark the presence of alternatives, not only the focused element, but also its alternatives are activated. In the long term, these activated elements interfere with each other, which is reflected in the deterioration of memory performance for these items. The almost significant difference in WM may have also reflected this higher activation.

To conclude, the experiments testing the WM and LTM performance on the correct rejection of focus alternatives jointly support the conjecture that preVf activates the representation of a set of alternatives in Working Memory.

### 3.3.4 Thesis 4. Retrieval: Focus enhances the accessibility of the focused element in Working Memory

Apart from the activation of alternatives, **Study 2** also investigated the access to the representation of the focused element in memory. Access was measured using recognition rates and related RTs of unchanged (i.e. same) probes in both WM (Experiment 1) and LTM (Experiment 2). Since recognition data did not show reliable differences, we will concentrate on RTs.

RTs in Experiment 1 were lower for preVf sentences than for neutral sentences, i.e. preVf had a facilitative effect on recognition. Since RT has been shown to be a correlate of the durations of processes (or stages) that take place when the correct recognition of an item occurs (Sternberg, 1969), we conclude that these results

support our conjecture that the representation of the focused element is more accessible in WM. RTs, however, in Experiment 2 showed no reliable difference between the two sentence types.

Based on these findings, we suggest that the facilitative effect of preVf in WM and the lack of this effect in LTM shows that focus has primarily a local function in organizing discourse and in contributing to efficient communication.

### 3.4 Thesis 5. Focus is a grammaticalized means to express prominence

The definitions and characterizations of linguistic focus unanimously make reference to the observation that the focused element is the most prominent part of the sentence (see Section 2.3). Perhaps the most lucid explanation comes from Stevens & Roberts (2019), who propose that focus amounts to conventionalized or grammaticalized prominence marking across languages. This universal characteristic is claimed to be responsible for the attention controlling function of focus (see e.g. Birch & Rayner 1997). **Study 1** also set out to investigate this claim based on the following rationale: if non-grammatical ways of prominence marking trigger the same refreshing schedules as focus, the formulation that focus is the linguistic equivalent of prominence marking gains further empirical support. In order to test this conjecture, Experiments 2 and 4 measured attention allocation to unimodally and multimodally presented items during the retention phase using the same experimental setup as Experiment 1 and 3. Based on findings in the literature (Goolkasian & Foos 2005; Delogu et al. 2009; Heikkilä et al. 2014), we assumed that multimodally presented items are more prominent. Thus, we expected to see similar patterns of attention allocation in the case of multimodally presented items as in the case of preVf. Experiment 2 used the decision task of Experiment, while Experiment 4 used the selection task of Experiment 3.

Results were in line with our predictions. In the case of the decision task, the multimodally presented item received more refreshing during the retention phase. On the other hand, when the task was to select all items presented earlier, the unimodally, i.e. the less prominent element received more attention. Thus, we concluded that our results support the conjecture that focus is a grammaticalized means of marking prominence.

### 3.5 Findings on the representation of pre-verbal focus: Summary and conclusion

**Study 1** and **Study 2** were motivated by theoretical and experimental observations centered on the idea that focus serves to highlight important parts of a message by some grammatical means, and thus it functions as an attention capturing device (Sanford et al. 2006). The studies had two primary goals: i) to investigate the attention capturing properties of focus using novel, more direct experimental methods, and ii) to extend this investigation to a discourse configurational language, typologically different from those studied until now. In order to achieve these goals, we concentrated on four aspects of focus representation in WM: i) the encoding of focused elements, ii) the retention of focused elements, iii) the activation of the alternatives to focused elements, and iv) the retrieval of the focused elements.

**Study 1** showed that focused elements receive more attention during encoding, and it has also been revealed that focus modulates attention allocation during retention depending on task demands: if the relevance of focused and non-focused elements is unequal, the focused element is allocated more attention. However, if the relevance of these elements is equal, the element of lower activation, i.e. the non-focused one receives priority for refreshing. In order to support the validity of this suggestion, the General Discussion of **Study 1** provides the description of two real life scenarios in which these two task types have to be performed for successful communication. However, we also suggest that further research is needed along these lines to support the ecological validity of our claims regarding the selection of refreshing schedules for the representation of focused elements.

The results of **Study 1** are in line with electrophysiological measurements which have also shown that focus marking modulates attentional processes. Wang et al. (2011), for example, studied attention allocation in congruent and incongruent question-answer pairs in which incongruence was caused by the lack of prosodic focus marking in the answers. The authors found larger N400 effects in the case of congruent pairs, based on which they concluded that focused elements are subject to more in-depth processing, since these are allocated extra attention. Yang et al. (2019) reached similar conclusions using written stimulus and question-answer pairs. Additionally, Wang et al. (2013), investigated the interaction of processing prosodic focus and emotion words in an EEG experiment, and found that both types of linguistic expression recruit extra attentional resources. Chen et al. (2014), also using EEG measurements, presented contextually embedded target sentences and investigated the effects of focused and non-focused elements while manipulating the newness of these elements in the given contexts. Results showed a larger P2 and a larger positivity for focused elements suggesting more attention allocation for focused information. Additionally, the authors found different activation patterns in the case of new elements, based on which they concluded that the processing of focus and new information involve different cognitive processes. We find these results especially interesting, since they suggest that attention allocation and the expression of certain information structural roles, which are otherwise both associated with focus, dissociate. This idea will gain relevance in Section 4.2.5, in which we show that exhaustivity, an interpretational component commonly associated with focus, may be derivable from its attention capturing properties. In an fMRI study, Kristensen et al. (2013) compared activations in a spatial attention task and in a language task using anomalous "Moses" sentences as in Bredart & Modolo (1988). In this task, the use of prosodic focus marking on the critical word was also manipulated besides the presence of the anomaly. Results indicated that the spatial attention task and focus marking in the language task activated common cortical areas. Based on these, Kristensen et al. (2013) concluded that focus modulates a domain general attention network.

The brief survey on EEG and imaging results above support the conclusions of behavioral studies on the attention capturing properties of linguistic focus. We believe that our results contribute to these findings in at least three important points. First, note that the majority of the above studies used question-answer pairs and prosody to mark focus. Thus, responses measured during the processing of focused elements may have come from violations of expectations regarding how the discourse is about to unfold. In contrast, **Study 1** presented out of context sentences, therefore the effects of focus marking per se could be studied in a more direct way. Second, the blank screen paradigm not only allowed us to investigate whether the attention system is modulated by focus during WM retention, but also revealed *what* receives priority for attention allocation during this process. The finding that focus not only modulated attention, but that task-type and the target of attention allocation interact adds to the wealth of knowledge accumulated in the field. Third, our findings complement the results of the above studies which used prosody as a focus marking device with data on the processing of a syntactically and prosodically marked focus type, such as preVf. Hopefully, these findings contribute to completing the picture on how the processing of information structure and attention interact.

**Study 2** showed that the representation of the focused element is more readily accessible in WM, however, this is not the case in LTM. Based on these findings, we suggested that focus serves local purposes in discourse. This suggestion is in line with brain imaging studies which have shown that the processing of focus containing sentences activates areas also implicated in discourse processing (Spalek & Oganian 2019). **Study 2** also investigated the activation of focus alternatives, and found that the alternative semantics approach to focus seems to have psychological reality, and the Hungarian pre-verbal focus also activates a set of alternatives.

Taken together, **Study 1** and **Study 2** have demonstrated that i) focused elements receive a stronger encoding, ii) focus modulates attention allocation to the representation of the focused element during retention, iii) preVf also activates alternatives, and iv) the focused element is more readily accessible in the short term. Hence, the Hungarian pre-verbal focus also exhibits the characteristics that have been identified in configurational languages.

## 4 Interpretation

The second part of the Thesis discusses a question related to the interpretation of preVf extensively dealt with in the literature, namely, exhaustive interpretation. We ask the question whether exhaustivity is an inherent property coded in the syntactic or semantic representation of sentences with preVf, or whether it is derivable from extra-grammatical factors, and as such, belongs to pragmatic inferences. As answer, we will propose that the exhaustive interpretation associated with preVf emerges as a pragmatic phenomenon and is best analyzed as a scalar implicature.

**Study 3** and **Study 4** addressed this question in a series of visual world eye-tracking experiments investigating *how* sentences with preVf are processed. In these experiments, we asked whether different mental inferential processes take place while the exhaustive interpretation of preVf sentences and sentences with lexically marked exhaustivity are being processed. To lay the groundwork for these investigations, we first provide an outline of the theoretical and experimental findings on exhaustive interpretation, briefly summarize the pragmatic theory of scalar implicatures, and present a short overview on the processing of scalar expressions. Next, we formulate our hypotheses and present our results.

## 4.1 Background

### 4.1.1 Theoretical accounts of exhaustive interpretation

Native speaker intuition suggests that preVf sentences are interpreted exhaustively. For example, in the case of (8b), exhaustive interpretation means that the sentence is true if and only if Mary did not try on any other garment present in the universe of discourse except for the hat. In other words, focus is perceived to exhaustively identify the set of referents to which the focus containing predicate holds. Thus, in truth-conditional terms, the preVf should be equivalent to sentences that contain an overt focus operator, such as *only* in (8a) (only-f henceforth) marking exhaustivity lexically. Intuition also suggests that the tendency to interpret the so-called post-verbal focus exhaustively (8c) (postVf henceforth), is weaker than in the case of preVf. In Part 2 of the present Thesis we will concentrate on these intuitions.

(8)     a.      Mari csak egy KALAPOT próbált fel.
                Mary.NOM only a hat.ACC try.PST3SG on
                Mary only tried on a HAT.
        b.      Mari egy KALAPOT próbált fel.
                Mary.NOM a hat.ACC try.PST3SG on
                Mary tried on a HAT.
        c.      Mari fel-próbált egy kalapot.
                Mary.NOM up-try.PST3SG a hat.NOM

Theories dealing with exhaustivity associated with preVf belong to one of three groups. We shall call these the operator based-, presupposition based-, and pragmatic theories. The operator based theories consider exhaustive interpretation to be encoded in the structure itself, and posit that exhaustivity is part of the truth conditions of preVf sentences. According to one of the most influential studies advocating this view (É. Kiss 1998), the immediately pre-verbal position is associated with an exhaustive operator in the syntactic representation. Consequently, focus selects a subset of the contextually available alternatives to which the proposition of the focus containing sentence holds. In the case of (8), this set may be the following: {hat, necklace, gloves, blouse etc.}. Since *hat* occupies the position associated with the exhaustive operator, the set {hat} is exhaustively designated and all other possible alternatives are excluded. According to É. Kiss (1998), this analysis is supported by observations on the difference in the logical relationships between sentences containing postVf, such as those in (9), and preVf sentences, such as those in (10). The test presented in (9) and (10) is known as the 'coordinate test', and was originally proposed by Szabolcsi (1982).

(9)    a.    Mari felpróbált [egy kalapot és egy kabátot].
              Mary tried on [a hat and a coat].
      b.    Mari felpróbált [egy kalapot].
              Mary tried on [a hat].

(10)    a.    Mari [EGY KALAPOT ÉS EGY KABÁTOT] próbált fel.
              Mary tried on [A HAT AND A COAT].
      b.    Mari [EGY KALAPOT] próbált fel.
              Mary tried on [A HAT].

According to the author, the intuition that (9b) is a logical consequence of (9a), however, (10b) is not a logical consequence of (10a) can be considered as independent evidence for the inherent exhaustivity of preVf.

In our view, the operator based analysis has at least two main weaknesses. One is that it is too heavily reliant on speaker intuition. As will be seen later, there are ample experimental results suggesting that indeed there is a strong tendency for preVf to be interpreted exhaustively, however, this remains a tendency, and the exhaustive interpretation is not reliably generated. Also, experimental evidence suggests that it is modulated by factors such as task (**Study 3**), context (**Study 4**), or cognitive control abilities (Babarczy & Balázs 2016). Meaning components coded at the level of syntax or semantics should not exhibit such variability. The second weakness is that positing an operator is circular. What makes us claim that the immediately pre-verbal position is associated with an exhaustive operator? Because preVf exhaustively designates a subset of the contextually available set. Why does preVf designate this subset exhaustively? Because it is associated with an exhaustive operator. One might argue that examples such as the one in (11) provide independent evidence for the existence of the focus operator. The example in (11) is unquestionably an ungrammatical Hungarian sentence: *is* (*also*) is a particle that introduces the presupposition that there are other entities apart from the {hat} to which the predicate holds. The operator based account accurately predicts that this particle cannot occur in the pre-verbal focus position, since it is incompatible with the semantic property of the exhaustivity operator.

(11)    *Mari egy KALAPOT is próbált fel.
        ?Mary also tried on a HAT.

(12)    … akiket útjukra többek között [ANNA LINDH SVÉD KÜLÜGYMINISZTER] kísér majd el.
        and they will also be accompanied by among others [THE SWEDISH FOREIGN MINISTER ANNA LINDH]

However, there is an abundance of attested constructions whose occurrence is not predicted by the operator based theory. For example, (12) (taken from Wedgwood 2006 pp. 14) states that apart from the individual denoted by the subject (i.e. Anna Lindh), the proposition of the sentence is also true for other individuals. If the operator view is correct, an expression, such as *among others* should also be incompatible with the pre-verbal focus position. Corpus data shows the opposite.

Kenesei (1989) takes a different approach, and claims that the exhaustive inference is borne out by the relation between the presupposed and asserted part of preVf sentences, and that the asserted part contains an element of identification. Consider example (13a).

(13)    a.    PÉTER aludt a padlón.
              PETER slept on the floor.
      b.    the x that slept on the floor was Peter
      c.    for all x, x slept on the floor if and only if x was Peter

According to Kenesei (1989), such sentences carry an existential presupposition (there exists an x), and the asserted part identifies the variable in the presupposition (x is the focused element). Thus, the preVf sentence exemplified in (13a) can be captured as (13b). The novelty of Kenesei's formulation is apparent if we consider (Yc), which corresponds to the analysis of the operator based approach (see e.g. Szabolcsi 1982): in this case,

exhaustivity is directly coded in the representation of the sentence. Contrary to this analysis, Kenesei (1989) proposes that exhaustivity is the result of the identification in the asserted part: if a referent is identified in the universe of discourse, others will be excluded by necessity. Moreover, the theory proposes that such an identification implies the denial that the assertion is true for other elements in the universe of discourse (i.e. It is not true that Mary slept on the floor, for the example in (13)). The author calls this interpretational mechanism 'exclusion by identification' (see also Kenesei 2006). We consider Kenesei's approach especially appealing, for two main reasons. Firstly, it neatly accommodates the observation that negated preVf sentences still carry an existential element. As a matter of fact, as Kenesei (1989) also proposes, this observation can be considered as evidence for the claim that preVf sentences carry an existential presupposition. For example, the sentence in example (14) still presupposes that there was someone who slept on the floor.

(14)    Nem PÉTER aludt a padlón.
        It was not PETER, who slept on the floor.

Secondly, the postulate that preVf sentences contain an element of identification is in itself not incompatible with the observation that the rate of exhaustive interpretation of preVf (i.e. the probability that a preVf sentence is interpreted exhaustively) is variable depending on context (see **Study 4** and **Study 5**), and on cognitive factors, such as processing load (see e.g. Gerőcs et al. 2014). However, we believe that one weakness of Kenesei's account is the lack of independent motivation for the claim that the identificational component of the asserted part is necessarily an exhaustive identification. As we shall see later in the Section on the experimental results on preVf interpretation (Section 4.1.2), and on findings related to Thesis points 6 - 9, this claim is hardly tenable.

An alternative, presupposition based account was proposed by Kálmán & van Leusen (1993) who suggested that the exhaustive interpretation is not an inherent property of preVf sentences, but it is rather the property of the contexts that license their use. In this account, sentences with preVf presuppose a context in which exhaustivity is already present. The presupposition based analysis is supported by observations as those in (15) and (16) (p. 12).

(15)    A: Karl is a vegetarian.
        B: No, IRMGARD is.
        B's paraphrase: No, the person who is a vegetarian is Irmgard.

(16)    A: Karl is the director.
        B: No, IRMGARD is.
        B's paraphrase: No, the person who is director is Irmgard.

According to the authors, the response in (15) is infelicitous, since the context of the response (i.e. A's utterance) does not satisfy the exhaustivity requirement: the first sentence does not imply that there may not be other vegetarians in the universe of discourse. The reason why B's response in (15) is infelicitous becomes especially clear, if we consider the paraphrase of the focus containing sentence, according to which there exists one unique person who is vegetarian. The uniqueness implied by the response and the lack of it in the context are in conflict, which causes the response to be infelicitous. The situation is different in (16), since both A's sentence and B's reply imply uniqueness (cf. paraphrase), therefore, the second can serve as a correction of the first. Kálmán & van Leusen's (1993) analysis of preVf sentences is especially appealing, since it takes context into account, a consideration that is almost never mentioned in the operator based analyses. As will be seen later, our results underline the importance of contextual factors with respect to the exhaustive interpretation of preVf.

Wedgwood (2003) provides a third, pragmatic based account claiming that exhaustive interpretation can be derived from the principle of Relevance (Sperber & Wilson 1995). Consider the example in (17) borrowed from Wedgewood (as presented by Kas & Lukács 2013).

(17)     a.     Egy KÁVÉT kérek!
                 A coffee.ACC ask.PRES.1SG
                 A coffee, please!

         b.     Kérek egy kávét.
                 ask.PRES.1SG a coffee.ACC
                 A coffee, please!

Example (17) illustrates that in certain contexts even postVf sentences can be interpreted exhaustively, since that is the optimally relevant interpretation. In the context of (17), a set of alternatives are present containing other beverages such as tea, soda, or beer. It is quite unlikely that after hearing any of the sentences in (17), a waiter would turn up serving a coffee and an additional beverage. Based on Relevance, the waiter assumes that the speaker is maximally informative, and does not hold information back. Since exhaustivity is derivable form Relevance, Wedgwood (2005) argues that it is unnecessary to posit an exhaustive operator, and suggests that preVf is underspecified for exhaustive interpretation. In our view, the pragmatic account is especially appealing, since it can accommodate a number of experimental findings which show that exhaustive interpretation arises from a combination of linguistic and extra-linguistic factors such as the context, and general inferential cognitive mechanisms involved in language processing. Let us now turn to these findings.

**4.1.2 Experimental findings on the exhaustive interpretation of the pre-verbal focus**

The question of exhaustivity was not only investigated in the theoretical, but also in the experimental domain. The first experimental work by Onea and Beaver (2009) formulated two assumptions to test the hypothesis regarding the status of exhaustivity. These assumptions were also central in our experiments reported in **Study 3** and **Study 4**, therefore they bear special relevance here. The first of these posits that "if exhaustiveness were a truth conditional effect conventionally associated with immediately pre-verbal focus, and if evidence is given that the exhaustiveness inference is false, then people would contradict a sentence containing immediately pre-verbal focus" (p. 19). This assumption predicts that in a context in which the proposition of a sentence holds for entities other than the referent of the focused expression, the sentence should be rejected, provided the operator based view is tenable. The second assumption builds on the first one: "if pre-verbal focus conveys the same truth-conditional information as an explicit exhaustificational operator (like *only*), then we would expect people to contradict exhaustiveness (i) inferences triggered by pre-verbal focus and (ii) those triggered by explicit exhaustiveness operators in similar conditions and at a similar rate" (p. 19). This assumption establishes the rationale, also adopted in **Study 3** and **Study 4,** for comparing constructions lexically marked for exhaustivity, such as only-f sentences, with sentences that contain preVf to investigate the source of exhaustive interpretation in the latter construction. The results of a test carried out on preVf sentences using non-exhaustive contexts and comparisons with lexically marked focus constructions in these contexts will inevitably reveal whether the construction at hand is *truth conditionally exhaustive* or not. This is exactly the test that Onea and Beaver (2009) carried out. Participants were presented with images in which two agents performed some operation on an object (e.g. Two kids both catching a butterfly) and heard a sentence in one of the following three forms i) a preVf sentence (18a), ii) a lexically marked focus sentence (only-f) (18b), or iii) a postVf sentence with the agent as topic (18c).

(18)  a.    MARCI fogott meg egy lepkét.
            Marci.NOM catch.PST3SG VM a butterfly.ACC
            MARCI caught a butterfly.
      b.    Csak MARCI fogott meg egy lepkét.
            only Marci.NOM catch.PST3SG VM a butterfly.ACC
            Only MARCI caught a butterfly.
      c.    Marci megfogott egy lepkét.
            Marci.NOM VM catch.PST3SG a butterfly.ACC
            Marci caught a butterfly.

The task of the participants was to verify the sentence-picture pairs using one of three response schemes: i) *Yes, and …*, ii) *Yes, but …* and iii) *No, …* with a corresponding completion clause. In line with the assumptions above, the authors hypothesized that if the exhaustive interpretation of preVf is semantically determined, rejection rates for this sentence type and only-f sentences should pattern similarly i.e. participants will dominantly choose the *No, …* response type for both sentence types. On the other hand, if exhaustivity is linked to pragmatic inference, preVf and postVf sentences should pattern together. Results showed that participants were more likely to accept preVf sentences than only-f sentences suggesting that focus exhaustivity is not truth conditional. Interestingly, the authors observed a tendency that postVf sentences were more likely to be accepted (i.e. a higher rate of *Yes, and …* type responses were observed) than preVf sentences, which suggests that the tendencies with which preVf and postVf sentences are interpreted exhaustively differ, and that preVf sentences are more likely to be interpreted exhaustively. This result was later confirmed by Gerőcs et al. (2014) who also showed that postVf sentences are less likely to be interpreted exhaustively, only-f sentences are most likely, while preVf sentences fall between.

Although unquestionably an important contribution, the work by Onea & Beaver (2009) has been criticized on a number of methodological issues. For example Kas & Lukács (2013) raised the possibility that the inclusion of only-f sentences may have introduced a permissive response bias resulting in a higher acceptance rate of preVf sentences. Gerőcs et al. (2014) formulated the concern that the participants may have made their choice independently of exhaustivity expressing their agreement or disagreement with other aspects of the picture-sentence pairs. Furthermore, Kas & Lukács (2013) pointed out that due to the low number of critical trials used in the experiment, results may be too sensitive to individual variation in participants.

Considering findings by Wedgwood (2005) and by Onea & Beaver (2009), Gerőcs et al. (2014) tested the hypothesis that the exhaustive interpretation of preVf is activated as an implicature in Relevance theoretic terms. To test this hypothesis, the authors conducted a picture-sentence verification experiment presenting preVf and post verbal focus sentences with images depicting non-exhaustive scenarios. Furthermore, the time allowed for making a response was also manipulated: in the short time condition, participants had to respond within 1000ms, whereas in the long condition a 3000ms limit was introduced. The experiment was designed based on the assumption that the computation of implicatures requires extra cognitive effort (Bott & Noveck 2004). Thus, if the time to carry out the picture-sentence verification task is limited, respondents will not be able to recruit the necessary cognitive resources to derive the exhaustive implicature, and will accept preVf sentences presented with pictures depicting non-exhaustive scenarios. On the other hand, if exhaustivity is semantically determined, the rejection rate of preVf sentences in non-exhaustive scenarios should be higher in the short time condition than those of postVf sentences (or those containing a post-verbal focus) in which exhaustivity is indeed pragmatically generated. The results showed that in the time limited condition, the rejection rates significantly dropped, and that the two sentence types patterned together. The results lend further support to the pragmatic view.

Two empirical studies investigating the exhaustive interpretation of preVf in children bear relevance in our case. One of these is Kas & Lukács (2013) which was the first study to investigate the effect of different focus types

and age on exhaustive interpretation in children (age groups: 6, 10) and adults. The rates of exhaustive interpretation were measured in the case of four focus types in a picture-sentence verification paradigm: i) SVO post-verbal object focus (similar to example (2a)), ii) SVO pre-verbal subject focus with verbal particle, iii) SOV pre-verbal object focus without verbal particle and iv) SOV pre-verbal object focus with verbal particle (similar to example (2b)). Neutral, focusless sentences were included as control. Results showed that adults were less likely to accept focus sentences than neutral ones when presented in a non-exhaustive scenario. Nevertheless, the acceptance rates of focus sentences was still relatively high at ~40% and ~65% for subject and object focus sentences, respectively. In the case of children, no effect of focus on acceptance rates was found. Interestingly, across groups, an effect of focus type was shown: results revealed that participants were more likely to reject subject focus sentences in non-exhaustive scenarios than object focus sentences. Additional analyses revealed that while this difference was a tendency in children, it reached significance in adults. Altogether, the results of Kas & Lukács (2013) suggest that the operator based view of exhaustive interpretation is not tenable for three main reasons: First, the operator view does not predict the relatively high acceptance rate of focus sentences in non-exhaustive scenarios. Note that the rationale for this argument also follows from the first assumption formulated by Onea & Beaver (2009) above. Second, the effect of focus type is not predicted either, since the operator based theory posits the same kind of [+ exhaustive] operator in the case of both subject- and object focus constructions. Third, the observed high rate of intra-subject variability is also against the semantic view which predicts a deterministic relationship between focus and exhaustive interpretation. Hence, the authors conclude that the operator view is hardly tenable, however, they maintain that based on their results it is not possible to adjudicate between the presupposition and pragmatic accounts based on the results.

Babarczy & Balázs (2016) tested the hypothesis that the exhaustive interpretation associated with preVf is computed as an implicature in Relevance theoretic terms. As a methodological innovation, the authors employed a three point scale in the sentence-picture verification task arguing that it enables a finer distinction between semantically false and pragmatically infelicitous sentences. In the case of semantically false sentences, the lowest value of the three-point scale is expected, while in the case of semantically and pragmatically appropriate sentences, the highest value. However, if focus is indeed underspecified for exhaustivity, as theory suggests, and preVf sentences are semantically true but pragmatically infelicitous in non-exhaustive contexts, the dominance of middle values is expected when participants have to rate preVf sentences presented with pictures depicting a non-exhaustive scenario. The authors hypothesized that if sensitivity to pragmatic implicature develops with age (see e.g. Bott & Noveck 2004, Kas & Lukács 2009) the rate of middle values in the case of preVf sentences presented with non-exhaustive pictures should reflect this tendency and should also increase with age. To test this prediction, the experiment was carried out in four age groups (~4-year-olds, ~6-year-olds, ~7-year-olds and adults). Results were in line with the predictions: the older age groups (7-year-olds and adults) gave a significantly higher rate of middle values for preVf sentences in non-exhaustive contexts than the two younger age groups. This, as the authors argue, reflects that sensitivity for pragmatic enrichment indeed develops with age. In line with the experimental results of Gerőcs et al. (2014), theory also suggests that the derivation of implicature is associated with extra cognitive effort. Thus, the authors correlated the rate of middle values with performance on WM and cognitive control tasks in children. These cognitive abilities, as the authors posit, are necessary to simultaneously maintain the semantic and pragmatically enriched interpretations of preVf sentences so that they can be evaluated with respect to the context they are presented in. Thus, those children who perform better in these tests, should reveal a higher degree of sensitivity to implicated meaning. In other words, performance on cognitive tests and the tendency to rate preVf sentences in non-exhaustive scenarios with a middle value should positively correlate. After clustering the participants based on their performance on the cognitive tests into three groups, the authors examined the rate of middle values given in the corresponding condition in these groups. Analyses revealed that those children were more likely to use the middle value in their evaluation of preVf sentences with non-exhaustive pictures who performed better in the cognitive tests. The authors admit that since cognitive performance was *measured* and not manipulated, the results may not have a high degree of

explanatory power. Still, they claim, the best explanation for the observed results is that the exhaustive interpretation of preVf is a pragmatic phenomenon and its derivation requires extra cognitive cost.

To summarize, studies both in the theoretical and experimental domain agree that preVf has a tendency to be interpreted exhaustively. However, while the "traditional" theories posit that this interpretational component is grammatically encoded by an exhaustive operator, alternative accounts either claim that exhaustivity is presupposed or that it is computed as a pragmatic implicature. Experimental findings support the latter view. Note, that while these findings consistently demonstrate that the rate of exhaustive interpretation is not a semantic property of preVf, the theoretical conclusions these studies differ in their specificity regarding the status of exhaustivity as a pragmatic phenomenon. Some studies, such as Onea & Beaver (2009), Kas & Lukács (2013) and Babarczy & Balázs (2016) purely state that exhaustivity is computed as a pragmatic inference rather than a semantic entailment. Gerőcs et al. (2014) is more specific, and claims that the exhaustive interpretation of preVf should be analyzed as a conventional implicature computed as the most relevant interpretation in Relevance theoretic terms. The authors base their argument on the observation that in their experimental setup preVf sentences were interpreted exhaustively at a higher rate than postVf sentences. As the reasoning goes, the higher rate observed in the case of preVf follows from the fact that the pre-verbal position conventionally marks the question-answering constituent, and as such, corresponds to the Question Under Discussion (QUD) in the sense of Roberts (1998). Hence, the authors propose that a preVf sentence is interpreted as an answer to an accommodated QUD as opposed to a postVf which is used to introduce new information. Since questions are conventionally answered with a maximally informative response, preVf is also interpreted exhaustively by convention. One of the goals of the present Thesis is to claim that contrary to Gerőcs et al. (2014), the exhaustive interpretation of preVf is not a conventional implicature, but is best seen as a conversational, and more specifically a scalar type pragmatic inference. Hence, we now turn to the theory of scalar implicatures, and experimental findings pertaining to this inference type.

### 4.1.3 Scalar implicature

One of our central claims regarding the interpretation of preVf is that exhaustivity is generated as a scalar type implicature. For this reason, we provide a short introduction to scalars here. According to Gricean and neo-Gricean theory (see e.g., Grice 1957, 1975; Horn 1972; Gazdar 1979), the interpretation of certain expressions is associated with the so-called scalar implicature. For example, such an interpretation is found in (19b) derived from (19a) through Grice's (1975) maxims.

(19)   a.   Some (of the) guests went home.
       b.   Some but not all of the guests went home.
       c.   Some and possibly all of the guests went home.

Since (19c) entails (19a) (i.e., in all worlds where (19c) is true (19a) must also be true), the quantifier expressions in them (*all* and *some*) form a scale: *all* < *most* < *many* < *some* (Horn 1972; Gazdar 1979). According to the theory, the pragmatically enriched or implicated meaning of *some* corresponds to (19b), i.e., an upper-bounded interpretation, while the interpretation corresponding to (19c) is a lower-bounded interpretation.

According to Grice's formulation, the implicature is generated through the Maxim of Quantity: if we assume that the interlocutors are cooperative, their contribution will be optimally informative. For this reason, if in the given case it was true that all of the guests went home, then the speaker would not opt for using the less informative alternative in (19a). Therefore, the fact the speaker did use the sentence in (19a), implies (19b) in terms of the Maxim of Quantity. Relevance Theory (Sperber & Wilson 1986, 1995) uses a similar reasoning: the greatest cognitive effect achieved in the speaker if upon hearing (19a) (s)he generates the interpretation that corresponds to (19b).

### 4.1.4 Exhaustivity as a scalar type implicature: A theoretical proposal

One of the major issues addressed in the current Thesis concerns the source of exhaustive interpretation associated with preVf. We claim that it arises as a conversational implicature. More specifically, we propose that within the taxonomic category of conversational implicature, preVf exhaustivity should be seen as a scalar type inference. In the present Section we lay the theoretical groundwork for this proposal.

Before turning to our proposal, a note regarding the distinction between the *source* and *status* of exhaustive interpretation of focus constructions is due. According to an influential work by Roberts (1998), discourse unfolds through either explicit or implicit questions. The question that is accepted by the interlocutors at any point of the conversation is referred to as the Question Under Discussion (QUD). Assuming the presence of a QUD, the information content of any utterance can have either an at-issue or a non-at-issue status depending on whether that information constitutes an answer to the current QUD or not. This is also relevant for exhaustivity: Destruel et al. (2015) has shown that while exhaustivity is an at-issue content in the case of only-f sentences, the exhaustive interpretational component of preVf is not-at-issue. While the differentiation makes neat predictions on the contexts in which only-f and preVf sentences may be felicitous, admittedly it does not account for the source of exhaustive interpretation.

As far as the source of exhaustivity is concerned, we have seen that results of experimental work consistently reject the claim that exhaustivity is part of the semantic representation of preVf sentences, and suggest that this interpretational component is generated as some kind of pragmatic inference. The majority of these works do not specify the type of pragmatic inference (e.g. Onea & Beaver 2009; Kas & Lukács 2013; Babarczy & Balázs 2016), however, Gerőcs et al. (2014) makes the claim that exhaustive interpretation arises as a conventional implicature. Conventional implicature has been defined as a type of pragmatic inference which arises from the meaning of the implicature triggering word (20a), or construction (20b) (Grice 1975).

(20)   a.   The queen is English and therefore brave.
       b.   Bohumil Hrabal, a Czech author, wrote the novel Cutting it Short.

In the case of (20a), a speaker using the word *therefore* implicates (but does not assert) that being brave follows from being English, likewise in (20b) the appositive structure implicates (but does not assert) that Bohumil Hrabal was a Czech author. As the name of the inference type also suggests, these implications are a conventional part of the meaning of the implicature triggering expressions. Therefore, their interpretation should hardly exhibit variability in different hearers or contexts. In the case of the exhaustive interpretation of the preVf construction, however, the experimental results show exactly the opposite: all of the authors cited above observed a high degree of inter-subject variability for preVf sentences. Also, it has been observed by Kas & Lukács (2013) that different preVf types, like subject and object focus are associated with different degrees of exhaustivity. These results can hardly be accommodated by the conventional implicature view of preVf exhaustivity.

In order to establish our claim regarding the source of exhaustivity, it is not only important to discuss why it is not a conventional implicature, but also to demonstrate why it should be analyzed as a conversational implicature. Therefore, in what follows, we consider the relevant defining properties of conversational implicatures in turn, and investigate if the exhaustive interpretation of preVf can be characterized by these properties.

First of all, one of the central characteristics of conversational implicatures is that they are cancellable, i.e. conversationally implicated speaker meaning can be suspended without leading to logical contradiction (Grice 1975; Levinson 2000). Therefore, cancellability is also a crucial property that differentiates between truth conditional meaning and implicated inference, since if a truth conditional meaning is suspended, it does lead to a logical contradiction. To illustrate the point via our case, let us present examples (21a) and (21b). If exhaustivity is part of the truth conditions of a sentence, as in the case of only-f in (21a), the inference that apart from Alíz,

no one else travelled to Hague is not cancellable: a sentence claiming that Benedek also travelled results in a logical contradiction. Along similar lines, the same would apply to preVf in (21b), if we were to assume that the exhaustive interpretation associated with preVf is truth conditional, triggered by a [+ exhaustive] operator.

(21)  a.  Csak ALÍZ utazott el Hágába. Nem, Benedek is elutazott.
          Only ALICE travelled to Hague. No, Benedek also travelled.
      b.  ALÍZ utazott el Hágába. Nem, Benedek is elutazott.
          ALICE travelled to Hague. No, Benedek also travelled.
      c.  ALÍZ ÉS BENEDEK utazott el Hágába.
          ALICE AND BENEDEK travelled to Hague.
      d.  ALÍZ utazott el Hágába. Más nem.
          ALICE travelled to Hague. (And) exactly her.
      d.  ALÍZ volt az, aki elutazott Hágába.
          It was ALICE who travelled to Hague.

However, while (21a) is clearly an instance of contradiction, in the case of (21b) one has to rely on intuition to judge whether the two sentences indeed contradict in the same way as those in (21a). Experimental evidence may help to adjudicate. A wide array of studies used experimental tasks in which participants had to make a judgement about the acceptability of preVf sentences in depicted non-exhaustive scenarios (see Section 4.1.2). These sentence-picture pairs are analogous to (21b) in that the pictures negate exhaustivity, just as the second sentence does in (21b). Results unanimously show that people have a tendency to accept such sentence-picture pairs. Hence, we contend that the exhaustivity inference in preVf is cancellable.

Another central characteristic to conversational implicatures is calculability. In Levinson's (2000) formulation (but see also Grice 1975), an inference is calculable if it is derivable assuming the premises that pertain to a rational conversational activity. Such premises are defined in Grice's Cooperative Principle (Grice 1975). We propose that exhaustivity is also calculable: if a speaker uses a preVf sentence, such as the one in (21b), one can calculate the inference that apart from Aliz no one else travelled to Hague assuming that the speaker is obeying the Cooperative Principle and thus observes the Maxim of Quantity. Had the speaker known that Benedek also travelled to Hague, (s)he would have also made reference to him using for example a sentence in (21c). This line of thought will be taken up again when our claim regarding the scalar implicature view is explained below.

Reinforceability is also considered to be a definitive characteristic of conversational implicatures (see e.g. Huang 2017). Reinforceability means that it is possible to make the implicature explicit without producing a sense of redundancy. Consider (21c), in which the exhaustive inference is made explicit by the phrase *Más nem* (~*(and) no one else*). Intuitively, this pair of sentences is acceptable as non-redundant, and can be potentially used in a communicative scenario. The findings of an experiment reported in **Study 4** may provide some evidence that this is correct, despite the fact that this experiment was not specifically designed to test this intuition. In a sentence completion task, participants were instructed to complete preVf sentences with expressions of the type *Más nem* or *Nem más* (~*(and) exactly her*). Results showed that participants used the *Más nem* type of expressions to complete preVf sentences in 54.5% of the cases suggesting that the reinforcement of the exhaustivity inference is acceptable, and that it does not create a sense of redundancy.

A further property of conversational implicatures is non-detachability: an expression which has the same semantic content as the one triggering the implicature will carry the same implicature (Huang 2017). We propose that a sentence type whose semantic content is very similar to that of preVf sentences is the cleft construction exemplified in (21d). Regarding its semantic makeup, Dékány (2010) proposed that a cleft sentence presupposes the existence of a set of entities in the universe of discourse to which the predication part of the sentence may hold (e.g. {Alíz, Benedek, Cili}), and at the same time it identifies the subset of this set ({Alíz}). Note that this analysis is analogous to Kenesei's (1989, 2006) formal treatment of preVf which also claims that preVf consists of an existential presupposition of a set and a component of identification on this set. With regards to the

interpretation of these sentence types, both Kenesei (1989, 2006) and Dékány (2010) propose that exhaustivity emerges as the identification part in the two sentence types creates a complementary set, and excludes elements by necessity. This has been called 'exclusion by identification'. As pointed out in Section 4.1.1, we see no independent evidence for this claim regarding the identification in preVf. Likewise, we do not see that this claim is justified in the case of clefts. Dékány proposes that the identification in clefts is exhaustive analogously to how É. Kiss (1998) makes her case with regards to the exhaustivity in preVf using Szabolcsi's (1982) coordinate test. Consider examples in (22).

(22)   a.   ALÍZ ÉS BENEDEK  voltak azok, akik elutaztak Hágába.
            It was ALICE AND BENEDEK who travelled to Hague.
       b.   ALÍZ volt az, aki elutazott Hágába.
            It was ALICE who travelled to Hague

According to Dékány (2010), (22b) contradicts (22a), therefore, the clefted constituent expresses exhaustive identification. In our view, this proposal is not tenable for two reasons. The first is that it is too heavily reliant on speaker intuition. The second is that experimental evidence suggests that the cleft construction *tends* to have an exhaustive interpretation, but that this interpretation is not necessarily derived. For example, Gerőcs et al. (2014) found in a sentence-picture matching experiment that the rate of exhaustive interpretation for cleft was around chance level (54%). However, as exhaustivity was observed as a tendency, this inference is not a semantic one. In our view, this latter observation supports the idea that the exhaustive interpretation of preVf is non-detachable: a sentence type with a similar semantic makeup, such as the cleft construction may also give rise to the same exhaustivity inference.

Finally, universality has also been identified as a definitive property of conversational implicatures (Huang 2017): since conversational implicatures are motivated (cf. the Cooperative Principle and calculability), and not arbitrary, these inferences should be derived universally in languages. Indeed, it has been observed that the exhaustive interpretation is associated with focus in a vast array of languages (Destruel et al. 2015; van Rooji & Schulz 2017).

To sum up, we have argued that the exhaustive interpretation associated with preVf can be characterized by a number of defining characteristics of conversational implicature. For this reason, we contend that the exhaustive interpretation of preVf should not be seen as a conventional, but as a conversational implicature.

More specifically, we propose that exhaustivity in preVf is best analyzed as a scalar type of implicature. This conjecture is based on theoretical and empirical considerations. As outlined in Section 4.1.3, certain expressions form a scale of informativity (e.g. <*all, most, many, some*>, <*always, often, sometimes*>). Theory suggests that when a weaker term is used (e.g. *some* as opposed to *all*), the hearer calculates an upper-bounded interpretation on the assumption that the speaker does not hold relevant information back. Hence, scalars are calculable, just as other types of conversational implicatures. We propose that the construction types only-f and preVf can also be ordered on a scale of informativity: <only-f, preVf>, in which preVf constitutes the weaker term by virtue of being underspecified for exhaustivity. Consider sentences in example (23) and suppose there is a set of three individuals {Alíz, Benedek, Cili} in the universe of discourse to whom the proposition [x travelled to Hague] potentially holds.

(23)   a.   ALÍZ utazott el Hágába.
            ALICE travelled to Hague.
       b.   ALÍZ ÉS BENEDEK utazott el Hágába.
            ALICE AND BENEDEK travelled to Hague.
       c.   ALÍZ, BENEDEK ÉS CILI utazott el Hágába.
            ALICE, CILI AND BENEDEK travelled to Hague.

If exhaustivity is a conversational implicature, it should be calculable. We propose that this is indeed the case: upon hearing (23a), the hearer will calculate an upper-bounded interpretation and infer that unlike Aliz, Benedek and Cili did not go to Hague. Else, the speaker, obeying the Cooperative Principle (Grice 1975) or the Principle of Relevance (Sperber & Wilson 1986), would have uttered (23b) or (23c) depending on who exactly travelled to Hague. The analysis is analogous to the one on the expression *some* outlined in Section 4.1.3. As experimental results also suggest (see Section 4.1.2), only-f is a stronger alternative for preVf since it codes exhaustivity lexically. Hence, we propose that only-f and preVf form a scale of informativity with respect to exhaustive interpretation in which only-f is the more informative, stronger term.

A number of criticisms may be formulated with regards to the scalar view of preVf exhaustivity outlined above. In the following, we address each in turn.

First of all, one may object that the analogue between the upper-bounded interpretation of *some* and the upper-bounded, i.e. exhaustive interpretation of preVf is inconsistent, if these expressions are to be analyzed with relation to their respective scales. While *all*, the more informative alternative in the scale <*all, some*>, has a lower-bounded interpretation, the pragmatically enriched interpretation of *some* is upper-bounded, therefore the interpretations of the two elements differ. However, this relationship does not hold in the case of only-f and preVf: exhaustivity is present in both, albeit it is lexically determined in only-f, whereas it is pragmatically determined in preVf. In other words, both have the same upper-bounded interpretation, but assumingly for different reasons. This is clearly not characteristic of the 'classical' entailment scales (i.e. Horn scales, Horn 1972), where there is an asymmetric entailment relationship between the elements of the scale such that the stronger element entails the weaker one, but not vice versa. However, we contend that despite the observation that the scale <only-f, preVf> is not characteristic of classical entailment scales, preVf exhaustivity can and should be analyzed a *type of* scalar inferences: not only scales of strict ordering licensed by logical operators have been identified, but also scales of partial ordering, most of which are determined by world knowledge or current contextual factors Hirschberg (1985). In order to imply that we do not consider the exhaustivity inference in preVf a scalar inference strictly in the classical, Hornian sense, we will refer to it as 'scalar *type* implicature'.

One technical objection regarding the scalar analysis may be that the theory of scalar implicatures was developed to account for observations concerning lexical scales, such as <*all, most, many, some, (few)*>, <*always, often, sometimes*>, <*must, should, may*> etc., and not sentence types. This objection may be invalid at least for two reasons. First, it has been observed in the literature that certain clause types can also be ordered on a scale of informativity. The analogue between lexical and clausal type of scalars as represented in (24).

(24)    scalar:   <x, y>
        clausal:  <X(p), Y(p)>

The category of clausal type scalars includes pairs of expressions such as <(p *or* q), (p *and* q)>, or <(*know that* p), (*believe that* p)>. Since ordering on a scale is an attribute of both lexical and clausal expressions, we contend that the formal difference is irrelevant for our purposes. Second, what is assumed to be lexical is a matter of linguistic analysis. In a Chomskian generative framework, the above strict distinction between lexical elements and clause types can indeed be made. However, if one takes a lexicalist approach, and assumes that the sentence types at hand are constructions, i.e. pairs of linguistic form and meaning or conceptual representation (see e.g. Goldberg 2006), the distinction is immediately blurred.

The observation that preVf sentences void of any discourse context tend to be interpreted exhaustively might also contradict the proposed analysis. Note, that we relied on a contextually available set to flesh out the scalar view of exhaustivity (e.g. {Aliz, Benedek, Cili} in the case of (23)). However, if we present a series of out-of-context preVf sentences in an experiment, the rate of exhaustive interpretation is expected (and has been replicated) to be fairly high, and to be reliably above chance level (Kas & Lukács 2013; Gerőcs et al. 2014). The question arises: how can an upper-bounded interpretation be generated in the absence of a set? In other words, if our proposal regarding scalar implicature as the source of exhaustivity in preVf is correct, we must assume

that the interpretation and even the use of preVf sentences is intimately tied to the generation or presence of alternatives. Indeed, in Section 3 we have shown that this has been addressed both in the theoretical and the experimental domain: Kenesei (2006), for example, proposes that "whether or not the contrasting complementary set is explicit, in the case of contrastive focus a complementary set is always created" (p. 137). Furthermore, the experiments reported in **Study 2** on preVf, in line with results on other focus constructions in Germanic languages (see e.g. Gotzner 2017 for an overview), suggest that the representation of such a set is indeed generated in the mind.

To further motivate our reasoning regarding the relationship of preVf and alternative sets, we shall address the question also from the perspective of production and context: if we are correct, those contexts should motivate the use of preVf in which the presence of a set is relevant. Such a set is necessary for the focus to operate on for the generation of an upper-bounded interpretation. These contexts will include either identification (É. Kiss 1998), such as the one in (25a), or contrast (Kenesei 2006), such as (25b).

(25)  a.  What did Peter lose?
      b.  Peter lost a wallet at the party.
      c.  Why is Peter sad?

(25)  a.  (Nem,) (Péter) egy ÓRÁT  vesztett el (a buliban).
          (No,) He lost a WATCH at the party.
      b.  (Mert) (Péter) elvesztett egy órát.
          (Because) He lost a watch.

The context created by the question in (25a) contains a relevant set for the focus: the set of objects that Peter could potentially lose (e.g. {wallet, key, watch}). Likewise, the context created by the sentence in (25b) evokes a relevant set: a set of objects that Peter lost (i.e. {wallet}). On the other hand, there is no such set introduced in (25c). More precisely, the set introduced by (25c) contains sentence level alternatives such as {He got fired, His dog died, He lost a watch}, and therefore such a set is irrelevant here. Following from the above reasoning, we predict that a response to (25a) and (25b) will contain a preVf (25a), while a response to (25c) will not necessarily do so. In this latter context a more likely response contains a neutral word order, such the one in (25b). In other words, if a set is relevant in a context, preVf is licensed, else, it is not. Provided that this reasoning gains empirical support, the scalar view of exhaustivity is further corroborated: if a contextually available relevant set is a necessary condition for the use of a preVf construction, then the associated exhaustive interpretation will be by necessity an upper-bounded interpretation. This is exactly the kind of interpretation that is associated with other scalar terms, such as *some* and *often*. Our conjecture regarding the property of preVf licensing contexts was tested in **Study 3**.

Finally, as a brief detour, let us present an account of the exhaustive interpretation of context-free preVf sentences by Zimmermann et al. (2020), who adopt the QUD framework. This approach is especially relevant for our argument, since it also assumes different degrees of informativity in the case of only-f and preVf and thus nicely fits the theoretical account above. The authors conducted an experiment with out-of-context sentences and found a high rate of exhaustive interpretation for preVf. The explanation for this tendency is based on three considerations. The first one is the assumption that a context-free preVf sentence is an answer to an accommodated QUD. The second is the claim that preVf is the default answer to *wh*-questions. The third is the observation that the *wh*-element may have a singular form (*ki* ~ who-SG) or plural (*kik* ~ who-PL) depending on speaker expectations about the number of corresponding referents in the answer. A question with a *wh*-SG is compatible with both a preVf and an only-f construction as an answer with the element that corresponds to the *wh*-word in focus. With these three taken into account, the reasoning is fleshed out in a Gricean manner: when one hears a preVf sentence, she accommodates a QUD. Also, she supposes that "if the speaker wanted to make an unambiguous reference to a question with plural expectation on the answer space, she could and should have done so by using the more explicit exclusive structure [i.e. *only*-f]" (p. 233). Since the

speaker did not use such an explicit marking of exhaustivity, the hearer accommodates a singular QUD, exhaustivity is triggered, and hence expects a unique discourse antecedent (i.e. Alíz). The QUD based analysis proposed by Zimmermann et al. (2020) is especially relevant, since it ranks the preVf and only-f constructions in terms of exhaustivity along a scale of informativity, or explicitness lending further theoretical support to our claim that the exhaustive inference associated with preVf is best analyzed as a scalar type implicature. Note, however, that the authors themselves do make an explicit reference to such a scale in their analysis.

In sum, both theoretical considerations and experimental data seems to suggest that the exhaustive inference associated with preVf should be seen as a scalar type implicature. Studies reported in the present Thesis investigated this conjecture using the method of eye-tracking which enables the online study of sentence processing and interpretation. Hence, in the following Section we provide a brief outline of the findings on the processing of scalar implicature.

### 4.1.5 Processing models of (scalar) implicature generation

Since our experiments used the visual world paradigm, which allows the online investigation of the interpretational processes associated with linguistic stimuli, the theories and empirical findings related to sentence processing in general and to implicature generation in particular are of special relevance here.

Models of sentence processing fall into two categories, which we will refer to as modular and interactive models. Modular models, as their name suggests, posit that within the module corresponding to language (Fodor 1983), certain sub-processes exist, each responsible for different stages of linguistic processing. In such models, bottom-up processes dominate, and it is posited that sentences are first processed by a parser, in which the syntactic representation of the sentence (or a phrase) is built with the help of basic principles or heuristics (see e.g. Kimball 1973; Frazier & Fodor 1978; Rayner et al. 1983). When the representation of a phrase has been built up, it is passed on to semantic and pragmatic interpretation. Interactive models, on the other hand, claim that sentence processing is regulated by various sources of information, such as context, world knowledge, expectation, frequency, etc. from the very onset of the process. Thus, according to these accounts, bottom-up and top-down processes are equally present in the stage of both syntactic parsing and semantic-pragmatic interpretation (see e.g. Bates & McWhinney 1989; Spivey-Knowlton & Tanenhaus 1998; Trueswell et al. 1994; Trueswell et al. 1999).

In the processing literature on scalar implicature, the dichotomy of modular and interactive models also prevails. In loose terms, the modular model is inspired by the Gricean reasoning outlined in the previous Section to the extent that the labor of generating a scalar implicature is divided between semantics and pragmatics in two consecutive steps: the truth-conditional meaning of the scalar-containing expression has to be calculated before the pragmatically enriched interpretation is reached. The cognitive effort made after the calculation of the semantic meaning is measurable in the elongated time course of scalar activation relative to those interpretations associated with purely semantic processing. Such differences have been reported in an extensive array of experimental work (see e.g., Noveck & Posada 2003; Bott & Noveck 2004; De Neys & Schaeken 2007; Tomlinson et al. 2013; Huang & Snedeker 2009). Authors reporting these results advocate the modular model.

Since the methodology and results of Huang & Snedeker (2009) are especially relevant to both **Study 3** and **Study 4**, we will briefly describe these here. The authors tested the modular model by using the visual-world paradigm comparing the interpretational processes related to the scalar term *some*, a term whose interpretation is purely semantic, such as *all* and two numerals as controls (*two* and *three*). During the experimental trials participants heard instructions containing one of these quantifiers (e.g., *Point to the girl who has two/three/all/some of the socks*) and were presented four image quadrants. The target images depicted the lower-bounded (semantic) reading in the all-condition, an exact reading in the number-conditions, and the upper-bounded (pragmatically enriched) reading in the some-condition. The experimental task was to carry out the instruction while fixations on the images were monitored. Based on the modular model, the authors expected that eye-tracking data would show a slower convergence on the target image for the pragmatically interpretable some-instructions than for

the semantically interpretable number- and all instructions. The results showed the expected latency differences: participants' looks converged on the target image in the some-condition later during the period between quantifier onset and the end of the sentence than in the all-condition. According to Huang & Snedeker (2009), the observation that interpretational processes related to semantically interpretable expressions were faster than those related to pragmatic ones shows that the modular model is suitable for capturing the differences between semantic and pragmatic interpretation as carried out in the mind.

The modular model has been criticized both on theoretical and empirical grounds. To our mind, one of the most important theoretical criticisms was formulated by Geurts and Rubio-Fernández (2015). The authors develop their main point using Marr's (1982) three levels of analysis: they claim that Grice's theory never intended to answer questions related to 'how'; it is a theory of 'what' and 'why'. Or, as the authors claim, "Grice never meant to advance a processing theory" (Geurts & Rubio-Fernández 2015, p. 446): the steps of pragmatic reasoning are not necessarily carried out in the mind as Grice and his followers made it explicit in the formulation of their theory. One simplified example of such reasoning was outlined in Section 4.1.3. Since Geurts and Rubio-Fernández (2015) question the psychological reality of the semantics – pragmatics divide as formulated in the Gricean theory, they also inevitably claim that the the modular model of linguistic interpretation, or of the "two-system models" in their terminology (ibid., p. 465) is untenable. Such systems are attractive, since the process of generating interpretations can be divided into routinely or automatically run processes (i.e., semantic processing) and into those that require more attention and effort (i.e., pragmatic processing). As the authors' reasoning goes, the system would have to be able to decide whether to opt for a pragmatically enriched interpretation or not. In order to achieve this, an intermediary module is needed which constantly monitors the output of the semantic module and makes evaluations about whether processing should be continued by the pragmatic module based on context, world knowledge, etc. However, for the system to work, the intermediary module should be at the level of sophistication of the pragmatic module. Consequently, as Geurts and Rubio-Fernández (2015, p. 465) put it, "the whole point of a two-system architecture is lost". The criticism of two-system models ultimately boils down to the difficulties of how the two components should interact with each other. Clearly, Geurts and Rubio-Fernández (2015) take a strong view against strictly relating the theoretical concepts of the semantics – pragmatics division to actual mental processes of implicature derivation.

As mentioned above, a prominent competing alternative to the modular model is the interactive model, which claims that contextual factors have an effect on the rate and time course of implicature generation. The model therefore predicts that under certain circumstances, the latency differences observed by Huang and Snedeker (2009) and a number of other authors advocating the modular model should disappear. A wide array of experimental work has been inspired by this hypothesis (see e.g. Grodner et al. 2010; Degen & Tanenhaus 2011; Bergen & Grodner 2012; Breheny et al. 2013; Degen & Tanenhaus 2015; Foppolo & Marelli 2017).

Two experimental studies bear special relevance here, therefore they will be summarized briefly in the forthcoming paragraphs. Grodner et al. (2010) aimed to revise the modular model put forward by Huang & Snedeker (2009) by criticizing their methodology on three critical points and suggesting that under certain conditions the observed differences in latency between semantic and pragmatic interpretations disappear. First, the authors claimed that ambiguity is present longer during the expression *some of the* than during *all of the*: upon hearing *some*, the listener does not know whether the *some of the socks* or the shorter *some socks* expression will be used. While the former is clearly associated with scalar implicature, the latter is not necessarily so. Thus, in Huang & Snedeker (2009) this ambiguity was resolved later in the *some of the*-condition than in the case of *all of the*-condition giving rise to the possibility that the delay was observed since participants had to "wait" until the identification of the disambiguating *of* at the end of the expression and not because the computation of upper-bounded reading takes place after the semantic analysis. Second, Grodner et al. (2010) raise the concern that the number of trials using numerals was disproportionately higher than those using *some*. Also, both the numerals and *some* were used to describe small sets of maximally three elements. These two characteristics of the method may have reduced the acceptability of *some* making its processing and interpretation difficult leading to an

increased latency of identifying the image representing the upper-bounded interpretation. Third, the authors raise the possibility that a bias was also introduced confounding the results resulting from principles of human visual perception: since human vision is geared to preferring visual scenes with more objects, participants may have looked at images containing more objects first independently of the linguistic stimulus. For this reason, participants identified the target in the *some of the*-condition later not because upper-bounded interpretations are processed later, but because they first looked at the competing image containing more objects. In order to control for these potential confounds, Grodner et al. (2010) conducted a refined version of Huang & Snedeker's (2009) visual world eye tracking experiment with the following modifications. No numerals were used, the expression *summa* was used instead of the temporarily ambiguous *some of the*, a neutral *nunna* (*none of the*) condition was introduced and participants were informed about the number of objects to be presented in the visual display. The results of the experiment showed no difference in eye gaze patterns between the conditions based on which the authors concluded that under the appropriate (contextual) conditions, the difference between computing semantically entailed and pragmatically implicated meaning can be eliminated providing strong evidence against the modular view.

Degen & Tanenhaus (2011) also examined whether the modular model is tenable, and sought to answer the following questions: what factors contribute to i) the computation of scalar implicatures and ii) the time course of these computations in the case of *some*. Using rates of acceptability judgements, reaction times and eye tracking, the authors have shown that the number of objects on which *some* operates is crucial: if the elements fall within the subitizing range, the use of some decreases, reaction times increase, and the time course of identifying the target set becomes sluggish. Since in Huang & Snedeker's (2009) study the number of objects fell within the subitizing range in each trial, it is highly likely that their results were confounded by at least this factor. The findings in Degen & Tanenhaus (2011) also suggest that the modularity account is hardly tenable and that sentence processing is a highly integrative process whereby contextual factors are taken into account throughout the processes of interpretation.

For the sake of exposition, in what follows we provide a non-exhaustive list of the contextual factors that have been found to have an effect on the rate and/or time course of implicature generation. These factors include the knowledge-state of interlocutors (Bergen & Grodner 2012), the linguistic form expressing the upper-bounded meaning and also the felicity of its use in the given context (Grodner et al. 2010; Degen & Tanenhaus 2011), or the number of elements that certain quantifiers associated with scalar implicature operate on (cf. subitizing range) (Degen & Tanenhaus 2010). Although the studies listed here differed, sometimes substantially, in their methodology, a common finding is that contextual factors can eliminate the rate and time course differences between the generation of "purely" semantically interpreted meanings and those tied to scalar inferences. As will be seen later, the results of the experiments reported in **Study 3** and **Study 4** are in line with the interactive models of implicature generation.

In line with the vast majority of experimental data supporting the interactive view of sentence processing and implicature generation, we also adopt the interactive view. This will gain relevance when we formulate our hypotheses regarding the processing of preVf sentences and the derivation of exhaustive interpretation in the next Section.

## 4.2 Theses related to the interpretation of the pre-verbal focus

In what follows, the Thesis points and experimental findings related to the interpretation of preVf will be outlined. In order to test the hypothesis that the exhaustive interpretation associated with preVf is derived as a scalar type implicature (Thesis point 9), we formulated and tested three main predictions. These correspond to Thesis points 6, 7, and 8. The first prediction is related to the contextual availability of sets and the use of preVf (**Study 3**), the second one concerns the rate of exhaustive interpretation (i.e. the probability with which preVf is interpreted exhaustively) (**Study 4** and **Study 5**), while the third one concerns mental processes associated

with the generation of exhaustive interpretation (**Study 4** and **Study 5**). What is common in the predictions tested here is that they all take context into account as a critical factor. To our knowledge, no study before the ones included in the present thesis had investigated the effect of context on preVf production and interpretation before. Also, the studies concerning interpretation presented here (**Study 4** and **Study 5**) are the first to investigate the process of preVf interpretation using the online method of eye-tracking and the visual world paradigm.

### 4.2.1 Thesis 6: Contextually available sets motivate the use of the pre-verbal focus

First of all, we predicted that the presence of a relevant set in the context plays a crucial role in licensing preVf constructions: if such a set is available, the preVf construction is used (cf. also Kenesei 2006). This prediction was tested in **Study 3**, in which we investigated the effect of a contextually available and relevant set on the production of preVf constructions using a guided production task in the form of an online survey. Two experiments were conducted. In both of these participants were presented a short text describing a context and a cloud of randomly arranged words. The experimental task was to create sentences that naturally fit the context by clicking the words in the cloud. Contexts either contained a set or they did not. In contexts with sets the set was either introduced explicitly (by enumeration) or implicitly (by a question, or via a reference to a category). Target sentences (i.e. the ones produced by participants) either expressed identification or contrast with respect to these sets. The dependent variable in the experiments was the proportion of preVf and postVf constructions produced in the different context conditions.

Results revealed that the presence of a set in the contexts motivates the use of a preVf construction. The effect is observable even when this set is implicitly present in the context. On the other hand, if no set is present, the preVf construction is not reliably produced. These results are in line with the prediction formulated in Section 4.1.4. Thus, we conclude that the scalar implicature view of the exhaustive interpretation of preVf has been further corroborated: the interpretational component at hand is an upper-bounded interpretation. However, these results can only be taken as evidence for the scalar view together with the results of **Study 4** and **Study 5**. These will be jointly discussed in the Section on Thesis point 9 (Section 4.2.4).

### 4.2.2 Thesis 7: Context modulates the rate of exhaustive interpretation associated with the pre-verbal focus

We predicted that the presence of a contextual restriction on the number of referents to which the proposition of a preVf sentence can potentially hold has an effect on the rate of exhaustive interpretation of that sentence. Since it has been established that our primary interest is the source of exhaustivity, and not its status, and that this question hinges on whether exhaustivity is truth conditional or not (in the vein of the two assumptions by Onea and Beaver 2009), we formulate all our following predictions in a way that only-f serves as a basis for comparison. Since the source of exhaustivity is indeed truth conditional in only-f, this construction is suitable for a baseline measurement.

**Study 4** used task type as an independent variable to manipulate the presence of contextual restriction. The two experiments of relevance for the purposes of the present Thesis are Experiments 3 and 4. In Experiment 3, participants performed a forced choice task, i.e. they were instructed to choose only one image they considered to be compatible with the test sentence, while in Experiment 4, they could choose any number of images. The forced choice task corresponded to a restrictive context, while the multiple choice task corresponded to a non-restrictive context.

The results of Experiment 3 employing the forced choice task showed that there was no difference in the rate of exhaustive interpretation between preVf and only-f (100% in both sentence types). This is not a surprising result, and it is predicted by all focus accounts. More interestingly, the results of Experiment 4 revealed a difference: while the rate of exhaustivity was still at ceiling in the case of only-f sentences (93%), preVf sentences were interpreted exhaustively at a significantly lower rate (65%). As outlined earlier, such high variability is not

expected if exhaustivity is triggered by an operator or if it is part of the conventional meaning of the construction. The results thus strongly suggest that the exhaustive interpretation of preVf is computed as an implicature: since preVf is underspecified for exhaustivity, participants occasionally generated a non-exhaustive interpretation in the non-restrictive context, however, when the context of the task restricted the number of choices, exhaustivity was consistently generated. Nevertheless, one could raise the objection that since contextual restrictions were manipulated through task types, such a conclusion is highly indirect and thus its validity is questionable.

For this reason, **Study 5** investigated the same question using textual contexts in which the restriction on the possible interpretational alternatives (or the lack of it) was made explicit in the descriptions of situations, such as the one exemplified in (26). Consider the only-f and preVf sentences in the two scenarios in (26). (Note, that both sentence types are felicitous in both contexts).

(26) Background: After the conference, the participants took part in an informal reception. There was a table offering different drinks: wine, beer, coke, etc.
Restrictive context: Each participant could have one drink at the reception.
Non-restrictive context: Each participant could have as many drinks as they wanted at the reception.
Only-f: Aliz csak egy SÖRT ivott meg a fogadáson.
'Alice only drank a BEER at the reception.'
PreVf: Aliz egy SÖRT ivott meg a fogadáson.
'Alice drank a BEER at the reception.'

In (26), the restrictive context restricts the number of drinks that Aliz could have, whereas the non-restrictive context imposes no such restriction. The possible combinations of the two context types and the two sentence types result in four scenarios. Let us now consider what the different accounts predict with respect to the rate of exhaustive interpretation associated with the two sentence types in each of these scenarios. According to the semantic view (or operator-based view), the rate of exhaustive interpretation should be the same in all of them: in only-f sentences exhaustivity is marked explicitly, while in preVf sentences, the [+exhaustive] operator ensures that the sentence is interpreted exhaustively irrespective of context. Therefore, the rate of exhaustivity should be equally high in both sentences. The conventional implicature analysis proposed by Gerőcs et al. (2014) also predicts a uniformly high rate of exhaustivity: if the exhaustive reading is a conventional element of the interpretation associated with preVf, it should be interpreted exhaustively in all contexts. In contrast, the scalar implicature account predicts that while the rate of exhaustive interpretation should be uniformly high in only-f sentences in both contexts, this rate in the case of preVf should be comparable to only-f sentences exclusively in the restrictive contexts, while it should be lower in the non-restrictive contexts. The lower rate of exhaustive interpretation of preVf in non-restrictive contexts is expected if we assume that the construction at hand is underspecified for exhaustivity and accept that it is non-at-issue content.

In **Study 5,** two experiments (Experiment 1 and 2) were carried out to compare the rates of exhaustive interpretation in preVf and only-f. Experiment 2 was conducted to introduce methodological refinements and to determine if the results of Experiment 1 are replicated.

The results of both experiments were in line with the prediction of the scalar implicature view: while the rate of exhaustivity in only-f sentences was not affected by context, in non-restrictive contexts, the rate of exhaustivity dropped in the case of preVf sentences significantly. In order to further investigate the interaction of context and rate of exhaustivity in preVf, **Study 5** included an additional experiment in which preVf and postVf sentences were presented in restrictive and non-restrictive contexts. The rationale for including the postVf sentence was that there is a consensus regarding its status of exhaustive interpretation: both theory (e.g. Surányi 2011) and experimental results (Gerőcs et al. 2014; Tóth & Csatár 2017) support the claim that whenever a postVf sentence is interpreted exhaustively, this interpretation is computed as a conversational implicature. Thus, **Study 5** predicted that if the conversational implicature view is tenable, a comparison of the rates of

exhaustive interpretation of preVf and postVf in restrictive and non-restrictive contexts should reveal no difference: in restrictive contexts both sentence types should be consistently interpreted exhaustively, while in non-exhaustive contexts the rate of exhaustive interpretation should drop for both sentence types. To test these predictions, the experiment was conducted again using preVf and postVf sentences. The results were in line with the predictions. While the rate of exhaustive interpretation was at ceiling in the restrictive contexts for both sentence types, these rates dropped uniformly in the non-restrictive contexts. Given i) that there is consensus regarding that exhaustivity of postVf should be analyzed as an implicature, and ii) that a uniform pattern was found in the rate of exhaustivity in preVf and postVf in the two context types, we contend that the view that exhaustivity in preVf should be analyzed as scalar implicature is further corroborated.

### 4.2.3 Thesis 8: Context modulates the mental processes associated with the computation of exhaustivity

We predicted that the presence of a contextual restriction on the number of referents to which the proposition of a preVf sentence can potentially hold has an effect on how the exhaustive interpretation of that sentence is calculated in the mind. More specifically, we predict that the presence of such a contextual restriction has an effect on whether non-exhaustive interpretational alternatives (such as those in 26b, 26c with respect to 26a) are entertained. The specific theory-based predictions we formulate here assume the interactive model of implicature generation (see Section 4.1.5). Consider again the four context-target sentence combinations exemplified in (26). The operator based view of exhaustive interpretation predicts no difference in the calculation of exhaustive inference in the case of the two sentence types in the two contexts: since, by virtue of the operator, exhaustivity is coded structurally and/or semantically in preVf, non-exhaustive alternatives should not be considered during the interpretation of preVf sentences in a non-restrictive context. This is also predicted for only-f sentences, in which exhaustivity is marked lexically. The account positing that exhaustivity arises as a conventional implicature also predicts that non-exhaustive interpretational alternatives should not be entertained in any of the contexts, since the conventionalized "meaning" of the preVf construction is exhaustive. This renders only-f and preVf similar, since by convention, *only* is also interpreted exhaustively. On the other hand, the scalar implicature account, along with the interactive view on implicature generation predicts that while in restrictive contexts non-exhaustive alternatives should not be considered, and therefore the exhaustive interpretation associated with only-f and preVf should be computed similarly, in non-restrictive contexts, the non-exhaustive alternatives should also be considered in the case of preVf as opposed to only-f. This is expected, since conversational implicatures are not semantically represented and they are not conventionalized either, but have to be computed based on context, task-related goals etc. In the case of preVf, this computation involves the exclusion of non-exhaustive interpretational alternatives when context does not directly support the exhaustive reading. The most important findings of these studies are presented below.

**Study 4** and **Study 5** used the visual world paradigm to investigate mental processes associated with the computation of exhaustive interpretation. In both studies participants heard a sentence while looking at a set of four images. One of the images corresponded to an exhaustive scenario (target image), the other one corresponded to a non-exhaustive scenario (alternative image), while the other images served as distractors. The rate of exhaustive interpretation was operationalized as the rate of exhaustive image choices, while the rate with which the non-exhaustive interpretational alternative is considered during processing was estimated based on the ratio of looks to the exhaustive and non-exhaustive images as a function of time while the linguistic stimulus unfolded. As mentioned earlier, these measures were evaluated through a comparison with data from only-f sentences.

The predictions regarding eye-gaze patterns to the target images corresponding to an exhaustive scenario (target image) and a non-exhaustive scenario (alternative image) is as follows. The operator based view predicts that there should be no difference in the amount of looks to the target and alternative images between only-f and preVf: the presence of a silent [+exhaustive] operator makes it unnecessary to entertain non-exhaustive

alternatives. Perhaps, it may be speculated that processing a silent operator is cognitively more costly, which could be reflected by longer RTs. However, we can foreshadow that no such pattern was found in the RT data. As far as the conventional implicature view is concerned, it suggests similar trends: if the meaning of the preVf construction is exhaustive by convention, there is no reason why the processing system should dedicate extra effort to entertaining irrelevant non-exhaustive alternatives. Therefore, these two views predict that there should be no difference between the looks to the target and alternative images during the processing of preVf and only-f sentences. Also, it follows that context should have no effect. On the other hand, the scalar implicature view predicts that under certain conditions, the non-exhaustive alternative should also be considered during the process of interpretation. This follows from the view that preVf is underspecified for exhaustivity: in the lack of contextual support, like in the selection task used by **Study 4** or the in non-restrictive contexts used in **Study 5**, one has to actively calculate the exhaustive inference which includes the consideration and exclusion of non-exhaustive interpretational alternatives. If this is indeed the case, there should be a difference in the amount of looks to the target image between preVf and only-f when the selection task is employed or when these sentences are presented in non-restrictive contexts revealing that participants look at the alternative image more in the case of preVf sentences than in the case of only-f sentences.

The results of the two experiments in **Study 4** support the scalar implicature view. Looking patterns obtained in the experiment employing the forced choice task showed that looks to the target image converged at an equal rate in the case of the two sentence types. This result is predicted by all focus interpretation accounts. The results of the multiple choice experiment, however, showed a divergence as predicted by the scalar implicature view. While participants increasingly looked at the target image at the same rate during the sentences, the rate of looks only increased in the case of only-f sentences during the critical, post-sentence period, while the rate of looks to the target image remained at chance level during the same period in the case of preVf sentences, despite the fact that at the end of the trial the exhaustive image was chosen.

This pattern of looks obtained in the multiple choice task, namely that in the case of preVf participants constantly switched between the target and the alternative images before selecting the target image clearly indicates that the non-exhaustive alternative was considered to a greater extent than in the case of only-f sentences. This is exactly what the scalar implicature view predicts.

However, the fact that context was manipulated through task type in **Study 4** could raise concerns regarding the validity of our conclusions. Hence, **Study 5** manipulated the presence of contextual restriction through textual descriptions of scenarios as exemplified in (26). Analysis of eye tracking data, just as in **Study 4**, included exclusively those trials in which participants gave an exhaustive response.

**Study 5** used a different design: while in **Study 4** we compared two different sentence types within separate experiments using different contexts (i.e. task types), in **Study 5** we presented both sentence types in both context types (i.e. restrictive and non-restrictive) within each experiment. Thus, the difference within the sentence types between the two context types could be analyzed: preVf in the restrictive versus non-restrictive contexts, and likewise, only-f in these two contexts. This method of comparison was used to circumvent potential confounds resulting from the comparison of two different sentence types whose interpretation may involve different steps during processing. Thus, in this respect, **Study 5** is a methodological refinement to **Study 4** also in terms of design and in terms of how eye-tracking data is used to test our predictions.

Results revealed that in the case of only-f sentences, the percentage of looks to the target increased at a similar rate in both contexts suggesting that the presence of a contextual restriction did not have an effect on the extent to which participants considered the non-exhaustive interpretational alternative. On the other hand, context did have an effect on the processing of preVf sentences, as predicted by the scalar implicature view: in the restrictive context, looks converged quickly on the target image, whereas in the non-restrictive context this convergence was much slower reflecting a tendency that participants were considering the non-exhaustive interpretational alternative to a greater extent.

Also, **Study 5** compared the processing of preVf and postVf sentences in the two contexts. With regard to this comparison, it was predicted that the mental processes associated with the interpretation of preVf and postVf will be affected similarly by the contextual manipulation. Namely, the looks to the target image should be superseded in the restrictive context in both sentence types. This prediction is borne out of theoretical considerations (Surányi 2011), empirical findings (Gerőcs et al. 2014; Tóth & Csatár 2017) together with the results of Experiment 3 of **Study 5** on the rates of interpretation in restrictive and non-restrictive contexts outlined in the above (Section 4.2.3).

The results of the experiment investigating the processing of preVf and postVf sentences (Experiment 3), were also in line with the predictions of the scalar implicature view. The comparison of looking patterns during the preVf sentences in the restrictive and non-restrictive contexts were replicated: the percentage of looks to the target in the restrictive context was higher than in the non-restrictive contexts suggesting that participants considered the non-exhaustive interpretational alternative in the latter context to a greater extent during the processing of the sentence. Gaze measurements during the processing of postVf sentences showed a similar pattern: looks to the target converged faster in the restrictive context than in the non-restrictive context. These results, just as in the case of preVf sentences, show that the interpretational process of entertaining non-exhaustive alternatives are affected by the presence of contextual restrictions. Since exhaustivity in the case of postVf is computed as a pragmatic inference (Surányi 2011, Gerőcs et al. 2014, Tóth & Csatár 2017), and looking patterns reflecting the interpretational processes of preVf and postVf patterned similarly as a function of our contextual manipulations, the conjecture that exhaustivity in the case of preVf is also associated with a pragmatic inference is further corroborated.

### 4.2.4 Thesis 9: The exhaustive interpretation of the pre-verbal focus is best seen as a scalar type implicature

We claim that the exhaustive interpretation associated with preVf should be analyzed as a scalar implicature, and we support this claim by a theoretical consideration outlined in Section 4.1.4 and by empirical findings provided by **Study 3, Study 4** and **Study 5**. As far as the theoretical aspect is concerned, we contend that preVf and only-f form a scale along the dimension of informativity or explicitness regarding exhaustivity. As far as the empirical aspect is concerned, the results of the three studies jointly support the scalar view of exhaustive interpretation. These results are the following: i) the availability of a contextual set is necessary for licensing preVf constructions, and that context has an effect on ii) the rate of exhaustive interpretation and iii) the mental processes associated with the calculation of exhaustive interpretation.

The finding that the presence of a contextually available set is a necessary condition for the use of preVf constructions corroborates the conjecture that exhaustivity which is tendentiously associated with it is an upper-bounded interpretation. Note, that the idea that focus interpretation is intimately tied to alternative sets is in line with the findings of **Study 2**, which showed that preVf generates a set of alternatives in the mind.

The results on the rates of exhaustive interpretation strongly suggest that exhaustivity is not coded by a syntactic or semantic operator, and also suggest that it is not a conventional meaning component of preVf. If either the semantic operator or the conventional implicature view were tenable, exhaustivity in preVf should be consistently computed as exhaustive at a rate comparable to only-f, and should not be affected by context. However, we found the opposite: if context does not directly support exhaustive interpretation, its relative rate in the case of preVf drops. The theory that best captures these results is the one that analyzes exhaustivity as a conversational implicature. The results on eye gaze measurements also confirm this conclusion and point to the direction that among conversational implicatures, exhaustivity in preVf is a scalar type implicature. Again, it has been found that contrary to the predictions derivable from the operator view and the conventional implicature view, the mental processes associated with the exhaustive interpretation of preVf are affected by contextual restrictions with respect to the number of potential referents for the focused element. If the context does not

include such a restriction, non-exhaustive interpretational alternatives are considered to a greater extent during the calculation of the exhaustive interpretation in preVf sentences.

**Study 5** also compared the rate of exhaustive interpretation and associated mental processes of preVf and postVf sentences. It was observed that both the rate of exhaustivity and the mental process of excluding non-exhaustive alternatives are modulated by context in the two constructions similarly. Hence, the question presents itself: is there a difference in source between the exhaustive interpretation of preVf and postVf? In other words, how can we account for the intuition that the tendency to interpret focus containing sentences is stronger in the case of preVf than postVf? This intuition has been confirmed by experimental work (cf. Gerőcs et al. 2014). We tentatively suggest that a refinement of methodology could reveal more subtle differences between the two construction types. Regarding rates of exhaustivity, it is possible that certain properties of the contexts used in our experiments were such that they also encouraged participants to calculate an exhaustive interpretation and thus the exhaustivity rates in the restrictive and non-restrictive contexts were the same for the two focus types. More specifically, it is highly likely that the two construction types do not differ in their role of expressing exhaustivity (only-f serves this purpose perfectly), and consequently certain contexts, like the ones used by the studies above, may modulate tendencies of exhaustive interpretation associated with preVf and postVf alike. Consider the example in (17) (repeated as (27) for convenience): in the context of ordering in a café, the most relevant interpretation is exhaustive in the case of both (27a) and (27b), i.e. both in the case of preVf and postVf respectively.

(27)    a.    Egy KÁVÉT kérek!
              a coffee.ACC ask.PRES1SG
              A coffee, please!
        b.    Kérek egy kávét.
              ask.PRES1SG a coffee.ACC
              A coffee, please!

As far as the differences in processing of the preVf and postVf is concerned, it was also found that context had a similar effect on both construction types. Since the aim of our research was to investigate the extent to which non-exhaustive alternatives are considered during processing, our conclusions cannot go beyond stating that exhaustivity emerges as conversational implicature in both preVf and postVf. However, a visual inspection of the looking patterns associated with the processing of preVf sentences (Figure 14 in **Study 5**) and those associated with the processing of postVf sentences (Figure 15 in **Study 5**) suggests that the exhaustive identification of the referent occurs later in the case of postVf sentences. (Note that critical nouns were aligned, and consequently the more sluggish identification of the exhaustive image could not have been caused by differences in word order.) This observation suggests that the exhaustive interpretation is calculated later in postVf and is also in line with the claim that it is even less informative than preVf with respect to exhaustivity. We suggest that future work should address these questions, possibly testing the conjecture that postVf occupies the lowest position on the scale of informativity: <only-f, preVf, postVf>.

Finally, let us entertain an alternative analysis to the scalar account proposed above. Based on the consideration that i) the scale <only-f, preVf> does not form a classical entailment scale (Section 4.1.3), and that ii) context plays a crucial role in the exhaustivity inference of preVf one may suggest that this inference should be analyzed as an ad hoc implicature. In the case of ad hoc implicatures, a set of alternatives is also created and excluded as part of the inference. As the name suggests, these alternatives are generated ad hoc, i.e. they are determined by the specific context of the utterance (on ad hoc scales see e.g. Hirschberg 1985; Levinson 2000). Consider example (28) borrowed from Levinson (2000), in which a friend is asking about Fred, who is making an attempt to cycle from the West Coast to New York City.

(28)     A: How is Fred doing?
         B: He's got to Salt Lake City.
         inference: Fred has not reached New York
         nonce scale: <New York, Chicago, Salt Lake City, Reno>

The friend's response gives rise to the inference that Fred has not made it to New York yet. For this interpretation a scale needs to be generated, in which Salt Lake City occupies a lower position with respect to New York. Note that this scale is generated strictly with respect to the context of the utterance, and can only be generated if one is familiar with the location of cities in the USA and the itinerary of the cyclist. Given the response and the ad hoc scale in (28), the inference is calculable: had Fred reached New York, speaker A would not have made a more informative statement. Therefore Fred has not reached his final destination.

Let us now present two reasons why we think that the ad hoc analysis for preVf exhaustivity is problematic. First, note that without the context above, the sentence *He's got to Salt Lake City* does not license the inference that the person about which the statement is made has not reached New York yet. Ad hoc inferences can only be made strictly with reference to specific contexts. However, this is not the case for preVf: there is ample empirical evidence that out of context preVf sentences give rise to the exhaustivity inference. The second reason is that the type of alternatives that focus generates is always predictable. Hence, there is a strict restriction regarding the alternatives the focus, i.e. the inference triggering construction can generate. Again, this is not characteristic of ad hoc implicatures. Consider examples in (29).

(29)    a.     ALÍZ aludt a padlón (és nem Benedek).
               ALICE slept on the floor (and not Benedek).
               alternatives:     {Benedek, Cili, a szomszéd, Géza kutyája}
                                 {Benedek, Cili, the neighbor, Géza's dog}
        b.     'Alíz aludt a 'padlón (és Benedek kint cigarettázott az erkélyen). (Accent marked by '.)
               Alice slept on the floor (and Benedek smoked on the balcony).
               alternatives:     {Benedek cigarettázott az erkélyen, Cili verset olvasott a másik szobában}
                                 {Benedek smoked on the balcony, Cili read poems in the other room}

In (29a) the focused element is Alíz. Therefore, this sentence generates a set of alternatives containing individuals (denoted by names or definite NPs). On the other hand, in (29b) the whole sentence is focused (broad focus), therefore it gives rise to a set of alternatives containing potential events (denoted by clauses). Based on the literature on different focus types in Germanic languages, and the results of **Study 2**, it seems reasonable to claim it is not only a theoretical claim that the type of alternatives focus generates is predictable. Albeit, the alternatives themselves are contextually determined. For these two reasons, we contend that the ad hoc analysis of preVf exhaustivity is not tenable.

Apart from their relevance in contributing to the refinement of the theory of focus interpretation, the results presented in **Study 4** and **Study 5** are significant for two further reasons. First, these are the first studies to directly address the question of how the interpretation of Hungarian focus and context interact. This is an especially interesting question, since focus is defined as an information packaging device (see e.g. Krifka 2008), and as such, its definition and description inevitably includes claims regarding what role it fulfills in discourse, and vice versa, how discourse context may affect its interpretation. Still, earlier experimental studies had addressed the question of focus interpretation using paradigms in which participants were asked to interpret preVf sentences without prior discourse context. Hence, even if the theoretical interpretation of the data may be debated, the data themselves are interesting and novel. Second, these two studies were the first to investigate the mental processes of exhaustive interpretation associated with the Hungarian focus construction. We believe that these are important first steps in the study of how Hungarian sentences are processed. The question is especially interesting considering that Hungarian is a discourse configurational language in which the different discourse roles such as topic and focus are expressed through dedicated syntactic positions (É. Kiss 1995). Thus,

research may be continued to study other types of Hungarian focus, or different types of topics (such as presentation and contrastive topic), and a number of other word order phenomena (and perhaps prosody related aspects) that are pertinent to discourse configurational languages. Also, we hope that the paradigms used in the experiments can inspire and inform future studies using online methods in the investigation of the processing of Hungarian sentences.

In sum, although the results pertaining to the availability of sets, to the rates of exhaustivity and to the mental processes associated with calculating exhaustivity may be interesting in their own terms, they are to be interpreted collectively. The role of sets suggests that exhaustivity is an upper-bounded interpretation. Additionally, the variability of exhaustive interpretation and the observation that non-exhaustive interpretational alternatives are also considered in non-restrictive contexts during processing jointly support the claim that the exhaustive interpretation of preVf is best seen as a conversational, scalar type implicature. Adding to this: the theoretical consideration that preVf and only-f form a scale of informativity point towards the idea that preVf exhaustivity should indeed be seen as a scalar implicature.

### 4.2.5 Thesis 10. Exhaustivity associated with focus is derivable from its attention capturing properties

As a final point, we formulate the tentative proposal that the exhaustive interpretation associated with preVf is derivable from its attention capturing properties. Before discussing the details, let us summarize the findings pertinent to our proposal. Part 3 established that attention related processes operative during the encoding and refreshing of the linguistic elements are modulated by focus. The focused element is allocated more attention during encoding and it is refreshed according to task demands: if the task allows the focused element to be foregrounded, the focused element receives more refreshing, whereas if a focused and a non-focused element are both task-relevant, the non-focused item receives priority for refreshing. In the latter case, this strategy is likely to be employed since the focused element is already in a more elevated state of activation due to its stronger encoding. We have also shown that focus marking amounts to marking prominence linguistically: items marked for prominence in a non-grammatical way (i.e. multi modally presented items) activate the same task-dependent refreshing schedules as focus. Part 4 asked the question of what is the source of the exhaustive interpretation of preVf observed throughout the theoretical and experimental domain. Our findings demonstrated that exhaustivity is not a syntactically or semantically coded feature, but most probably it is calculated as a pragmatic inference. Together with theoretical considerations we proposed that the source of exhaustivity is best seen as a scalar implicature.

The conjecture regarding the source of exhaustivity above was formulated within the domain of pragmatics, which, being a subfield of communication theory, attempts to capture linguistic phenomena related to conditions of use and interpretation in terms of communicative goals and values. Although by setting up a taxonomy of different interpretational relationships in the study of meaning (such as entailment, presupposition, conventional- and conversational implicature etc.) and positing a semantics-pragmatics interface a lot can be accounted for, we contend that the explanatory power of meaning related accounts can be further increased if psychological mechanisms not intimately related to language itself are also considered. We believe that our findings related to the psychological mechanisms operating on the representations of focused elements allow for such considerations: the observation that the focused element receives extra attention by virtue of being the most prominent one in a sentence or utterance explains the strong tendency that this element is interpreted exhaustively. To introduce the idea, let us quote Birch & Rayner (1997, p. 653):

> Given the limitations of human information-processing capabilities, an important aspect of successful language comprehension involves selectivity in what is encoded and retained from sentence to sentence. Some information becomes more available for use in interpreting subsequent sentences, while other information becomes less available. Typically, *selectivity* [emphasis added] in what is attended to and retained is based on salience: concepts that are perceived as important are attended to more closely than other information, since these concepts seem likely to be *the ones that will be needed for understanding*

*forthcoming information* [emphasis added]. One factor that affects perceived importance or salience of information within sentences is linguistic focus.

Although Birch & Rayner (1997) do not make any reference to exhaustivity, their consideration is directly applicable to it. A central notion in the above passage is selectivity. The selective nature of attention is observable when salient linguistic elements (such as linguistically focused elements) are processed: salient information is attended, while the non-focal information remains unattended. This claim is in line with our findings that focus modulates attention-based WM processes. The role of attention in tasks that WM is involved in is crucial: "the focus of attention allows a coherent organization and interpretation of the information it contains, but that information is limited to a few, separate known items at a time" (Adams et al. 2018 p. 345). In the case of focus interpretation, one task of the processing system is to integrate the focused element and the rest of the predicate to generate the interpretation of the whole focus containing expression. During this process, the representation of the focused element is allocated extra attention, and as a consequence of the selective nature of attention others are excluded. Thus, it follows that the predicate will be considered to hold for this element and not some other, less attended items. Hence, the whole focus containing expression will be assigned exhaustive interpretation.

One might object, however, that the activation of focus alternatives (see Thesis 3, Section 3.5.3) poses a problem for this proposal. If alternatives are also activated, these elements could easily be considered as possible candidates to which the focus containing predicate also holds. Hence, the rate of exhaustive readings should not be as high as generally observed. Note, however, that a distinction is to be made between activated and attended WM items. Findings in the retro-cue literature have demonstrated the importance of such a distinction. For example, in an experiment by Loaiza and Souza (2018), participants were shown five dots of different to-be-remembered colors on a screen at a particular location, one of which was later tested on a color ring. Between the presentation of the colors and the test phase, a brief interval was inserted during which participants were cued with one cue (single cue-condition) or two cues (double cue-condition) regarding which color would be tested. Trials with no cue were also presented as a control-condition. In the single cue-condition, the cue was always valid with respect to the location of the tested color, whereas in the double cue-condition only the second cue was valid. Hence, in the double-cue condition the first cue lost its relevance. Since trials in the different conditions were presented in a random order, upon seeing the first cue, participants could not anticipate whether the color corresponding to this particular cue would be tested or not. Thus, the experimental task required participants to shift their attention depending on the cue presentation during refreshing and maintain the activation of both items. The results indicated that the probability of recalling information was increased in both single- and double cue-conditions relative to the control-condition demonstrating that the retro-cue benefit was present even when the first cue was irrelevant. Thus, the findings of Loaiza and Souza (2018) show that representations in WM may have different states: until the second cue was presented, the color corresponding to that cue must have been upheld somehow even if it was not attended, else, the retro cue benefit would not have been observed in the double cue-condition. Such observations in the retro cue literature led researchers to differentiate between attended memory items and unattended memory items. The latter, although not attended to, may still be active, else, they could not be used efficiently in a WM task. In light of these findings, we argue that WM content during the processing of focus containing expressions may also be divided into attended items, such as the representation of the focused element, and unattended but highly available items, such as focus alternatives.

The proposal to derive the exhaustive interpretation of focus from its attention controlling properties accommodates the observation that task or context modulates the rate of exhaustivity and the inferential processes associated with exhaustive interpretation (Part 4). Note that the results of Loaiza and Souza (2018) outlined above not only demonstrate that unattended memory items may still be available, but also that attention during WM retention can switch dynamically according to task demands: when the second cue was presented, participants shifted their attention to the corresponding WM item. This effect was also manifest in Experiment

3 in **Study 1:** when the task required participants to respond to both visual probes, their attention was allocated to the non-focused element to a greater extent. Similarly, the task imposing no restrictions on the choice of images in Experiment 3 of **Study 4** and the non-restrictive contexts used in **Study 5** may have modulated the attention system in a way that not only the representation of the focused element was allocated extra attention, but also other, non-focused elements. The lower rate of exhaustive readings and the observed inferential processes whereby non-exhaustive alternatives were also considered may have been the result of this sharing of attention among multiple possible interpretational candidates during processing.

In order to further elaborate our point, let us demonstrate the parallelism between how linguistic focus and attention have been grasped within their respective domains of linguistics and psychology. Within the linguistic domain, focus has been generally shown to be the linguistic device that "foregrounds" or "highlights" important information. At the same time, it has also been shown that elements falling outside the scope of linguistic focus are "excluded" from the interpretation in the sense that the predicate of focus expression is not considered to hold for them. This amounts to exhaustive interpretation. Parallelly, within the domain of psychology, attention has been defined from the very beginning as "taking possession of the mind, in clear and vivid form, of one out of what seems several simultaneously possible objects or trains of thought. Focalization, concentration of consciousness are of its essence. It implies a withdrawal from some things in order to deal effectively with others" (James 1890, pp. 403-404). Both linguistic focus and attention have two essential components: one is the concentration on some specific element and the other is the exclusion of other elements. We strongly believe that such characteristics of linguistic focus are the consequence of the psychological characteristics of attention. The parallelism is not accidental: linguistic focus acts as a spotlight; it sheds light on particular elements, while others are excluded by necessity.

## 5 Summary and conclusion

The present Thesis addressed questions regarding the representation and interpretation of the Hungarian pre-verbal focus construction.

In the first major part, we proposed that the function of focus is to guide the attention of the addressee. To test this claim, attention allocation during the encoding, and refreshing of focused elements were examined. The results showed that during encoding, more attention is allocated to the focused element than to its non-focused counterpart, while during refreshing attention is allocated to the focused element depending on task demands: if, in sentences with a topic and a focus constituent, the foreground-background distinction is relevant, the focused element is refreshed at a higher rate than its non-focused counterpart. If, however both the topic and the focus are equally relevant for the given task, the topic receives more refreshing than its focused counterpart. In line with the international literature, we also claimed that the focused element is more accessible in Working Memory, and that focus alternatives are generated. Evidence for this claim was provided via the results of a probe recognition experiment. Additionally, we tested the claim formulated by Stevens & Roberts (2019) that focus should be seen as a grammaticalized means of applying prominence selectively within utterances. We provided evidence for this claim in an experiment in which the redundancy of verbal stimuli was manipulated and their refreshing rate was measured. Results showed that redundantly presented verbal stimuli gave rise to the same refreshing patterns as focus suggesting that the above claim is tenable.

In the second part of the Thesis we investigated the exhaustive interpretation of the pre-verbal focus construction, and conjectured that it should be analyzed as a scalar type pragmatic inference. We aimed to support our claim by theoretical considerations and empirical results. Regarding theory, we showed that exhaustivity can be seen as a conversational implicature (as opposed to a conventional implicature), and demonstrated that the pre-verbal focus and the lexically marked focus construction form a scale of informativity, or explicitness in terms of exhaustivity. Regarding experimental findings, we showed that the use of the focus construction is motivated by contexts that contain a set of relevant alternatives, and that the rate of exhaustive

interpretation and the mental processes associated with the calculation of exhaustivity are affected by contextual factors: in the absence of contextual support on exhaustivity, non-exhaustive interpretational alternatives are also considered. Taken together, we concluded that our conjecture regarding the scalar nature of the exhaustive inference in the pre-verbal focus is tenable.

Finally, we made the tentative proposal that the exhaustive interpretation of focus is derivable from its attention controlling properties. We suggested that there is a strong analogue between the selective nature of attention and exhaustivity: relevant items are attended, while others are excluded. Nevertheless, we admit that this account is more of a hypothesis than an explanation, and that further experimental investigation is needed to test it.

Experimental work summarized in the present Thesis is novel for a number of reasons. First, the studies have introduced methodological novelties in the examination of linguistic focus, such as pupillometry and the blank-screen paradigm in the research on attention allocation during the encoding and refreshing of the representation of focused elements. Also, the visual world paradigm was first used to study the interaction of contextual factors and the much studied exhaustive interpretation in the pre-verbal focus. With regards to the production study, no experimental work had endeavored before to identify contextual factors that contribute to the use of the pre-verbal construction. Additionally, all investigations were carried out on a discourse configurational language, such as Hungarian. As the questions addressed here have mainly been investigated in configurational languages, hopefully, the results presented in the current work may help gain a more complete picture on focus.

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## 7 Appendix

**Study 1:**
Káldi, T., & Babarczy, A. (2021). Linguistic focus guides attention during the encoding and refreshing of working memory content. *Journal of Memory and Language,* 24.

**Study 2:**
Káldi, T., Szőllősi, Á. & Babarczy, A. (to appear in *Frontiers in Psychology*). Hungarian structural focus: accessibility to focused elements and their alternatives in Working Memory and delayed recognition memory

**Study 3:**
Káldi, T., Madarász, L., & Babarczy, A. (2020). Contextual triggers of the Hungarian pre-verbal focus structure – A guided production study. In V. Hegedűs & I. Vogel (Eds.), *Approaches to Hungarian,* 16:73–96.

**Study 4:**
Káldi, T., Babarczy, A., & Bende-Farkas, Á. (2016). Hungarian Focus: Presuppositional Content and Exhaustivity Revisited. In J. Emonds & M. Janebová (Eds.), *Language Use and Linguistic Structure, Proceedings of the Olomouc Linguistics Colloquium 2016,* 245-262. Palacký University Press.

**Study 5:**
Káldi, Tamás, and Anna Babarczy. 2018. "Linguistic Exhaustivity Inference Is Context Dependent: A Visual-World Eye-Tracking Study on Hungarian Focus." *Acta Linguistica Academica,* 65(4):547–95.