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## Psycholinguistik

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### The Potsdam Research Institute for Multilingualism

Harald Clahsen & Claudia Felser

#### Abstract

A new research institute is introduced here which studies the representation and processing of language in multilingual individuals, focusing on morphological and syntactic phenomena. Projects within this research institute investigate grammatical processing in different kinds of multilingual populations, in comparison to monolinguals, using current psycholinguistic and neuro-cognitive experimental techniques. Our goal is to achieve a better understanding of the temporal dynamics of multilingual language processing and of how grammatical knowledge and processing mechanisms are related in development. In addition to our research activities, we will also provide advice to practitioners and educators concerned with multilingual individuals.

#### 1 Introduction

Today being monolingual is the exception, both amongst children and adults. People who have learned more than one language either from birth or later in life are in the majority worldwide. Several research centres across the world have been set up to investigate bilingualism and multilingualism, such as the 'Centre for Research on Bilingualism' at Stockholm University, the 'ESRC Centre for Research on Bilingualism' at Bangor University (UK) or the 'Childhood Bilingualism Research Centre' at the Chinese University of Hong Kong. In Germany, the University of Hamburg hosted a collaborative research centre on multilingualism funded by the German Research Council (DFG-SFB 538) from 1999 to 2011, initiated and led by Jürgen Meisel, the focus of which was on bilingual language acquisition and on corpus-based and historical research on multilingualism.

In this short note, we introduce a new research institute, the Potsdam Research Institute for Multilingualism (PRIM), which investigates how two or more languages are represented and processed in the mind/brain. PRIM opened in October 2011 and is the first research institute in Germany that employs current psycholinguistic and neuro-cognitive experimental techniques to investigate the representation and processing of multiple languages in an individual's mind/brain. The linguistic focus of the research at PRIM is on grammar, i.e. on syntax and morphology, and includes core areas of grammatical processing such as phrase-structure building, the computation of syntactic dependencies, and the production and comprehension of morphologically complex words. The research at PRIM studies people who have learnt or are learning more than one language, early and late multilinguals, language-unimpaired children and adults, as well as multilingual patients with acquired or developmental language impairments. Setting up and running the research institute at the University of Potsdam for the next five years is being funded by the Alexander-von-Humboldt Foundation ('International Award for Research in Germany' to HC).

## 2 Grammatical processing in multilinguals

Previous research on grammatical development in multilinguals has been largely corpus-based and has focused on the acquisition of grammatical *knowledge*. Yet, successful acquisition of linguistic knowledge presupposes the ability to *process* the linguistic input the language learner is exposed to. While much psycholinguistic and neurolinguistic research has been devoted to the study of real-time grammatical processing in monolinguals, relatively little is known about the mechanisms employed to process grammatical phenomena in two (native and/or non-native) languages, and even less when it comes to grammatical processing in more than two languages. There is currently no explicit and empirically founded model of multilingual grammatical processing, or of how grammatical processing mechanisms develop over time in multilingual individuals.

Previous psycholinguistic research indicates that the time course of grammatical processing of sentences and morphologically complex words in mature native speakers is influenced not only by purely grammatically-based parsing strategies, but also by other sources of information including semantic, contextual, probabilistic and prosodic cues, and that the adult native language processor is capable of rapidly integrating grammatical information with other sources of information during language processing (Gibson and Pearlmutter 1998). Child and adult language learners, on the other hand, have been argued to have difficulty integrating different types of information during real-time processing. Studies with monolingual children, for example, have reported a lack of sensitivity to certain types of lexical-semantic and pragmatic cues during children's real-time ambiguity resolution, indicating that the ability to use semantic information during sentence processing may be developmentally dissociated from the

ability to use phrase structure information (Felser, Marinis and Clahsen, 2003; Traxler, 2002; Trueswell, Sekerina, Hill and Logrip, 1999). For adult learners, i.e. late bilinguals who learnt their second after childhood, on the other hand, several studies have reported the opposite picture, suggesting that adult learners' ability to make use of grammatically-based parsing strategies is reduced relative to their sensitivity to lexical-semantic and contextual cues (e.g. Felser, Roberts, Marinis and Gross, 2003; Pan and Felser, 2011; Papadopoulou and Clahsen, 2003). However, the number of studies on this topic is still rather small, and the reported findings need to be tested on a larger scale. Furthermore, these earlier studies raise the question of whether early bilinguals, i.e. people who acquired more than one language during childhood, show the same limitations as late bilinguals in real-time grammatical processing.

Most current research on grammatical processing also lacks a developmental dimension. For monolingual children, previous studies using event-related brain potentials (ERPs) have demonstrated the remarkable developmental changes (as measured by ERPs) that occur between the ages of 0;2 and 3;0, from children identifying word and intonational boundaries to children processing lexical-semantic and phrase structure information; see Männel and Friederici (2008) for a review. On the other hand, there is evidence that even older school-aged monolingual children's processing of morphologically complex words and sentences is not yet adult-like (see e.g. Clahsen, Lück and Hahne, 2007). However, our understanding of the development of grammatical processing abilities in multilingual children is still extremely patchy. For late bilinguals, proficiency in the second language has been claimed to be a crucial predictor for grammatical processing abilities, but few studies have in fact systematically compared late learners at different stages of development in their non-native language(s) (see Steinhauer, White and Drury, 2009, for review and discussion). The question of whether grammatical processing in a non-native language can ever become fully native-like is also still unresolved.

### 3 PRIM: Aims and objectives

Against this background, the purpose of the research to be undertaken at PRIM is to develop a linguistically informed and precise model of the time course of grammatical processing in multilingual individuals. Building on our previous work on the acquisition of syntax and morphology in child and adult learners (e.g. Clahsen and Muysken 1986, 1989; Clahsen and Rothweiler, 1993, Clahsen, Avelado and Roca, 2002), and on the real-time processing of syntax and morphology (e.g. Clahsen 1999, 2006; Clahsen, Hadler and Weyerts, 2004; Clahsen et al., 2007; Clahsen, Felser, Neubauer, Sato and Silva, 2010; Felser and Clahsen, 2009; Felser and Cunnings, 2011, Felser, Cunnings, Batterham and Clahsen, in press), we specifically examine the temporal dynamics of multiple lan-

guage use, both at the micro-level (by investigating the moment-by-moment time course of language production and comprehension) and at the macro-level (by investigating multilingual individuals at different stages of language development). To investigate grammatical processing as it occurs in real time, PRIM relies on current psycholinguistic and neuro-cognitive experimental techniques which employ behavioural and physiological measures of moment-by-moment language comprehension and production, specifically reaction-time experiments, eye-movement monitoring (both during reading and listening), and electroencephalography (EEG).

The specific theoretical background for the research projects to be carried out at PRIM is the dual-pathways model of grammatical processing in language learners proposed by Clahsen and Felser (2006a, 2006b). Dual-pathways models of grammatical processing, which were originally developed to account for monolingual processing in adults, posit two different processing pathways that normally operate in parallel, a 'full parsing' route that involves a detailed grammatical analysis of a given input or output string, and a 'shallow processing' route which provides a primarily semantics-based, rough-and-ready analysis using probabilistic processing heuristics; see Ferreira and Patson (2007) for review and discussion. Regarding language learners, Clahsen and Felser (2006a, 2006b) argued that children's grammatical parser is essentially the same as that of mature native speakers, whereas the representations computed for processing a late-learned second language contain less grammatical detail than those of one's native language. Instead, late bilinguals are said to rely more on semantic, contextual and probabilistic cues to meaning. Even though Clahsen and Felser's (2006a, 2006b) proposal can account for a wide range of empirical findings, it currently is a static model in that lacks any specification of the time course of grammatical processing in language learners and of developmental changes of grammatical processing at different levels of language acquisition and proficiency. Furthermore, it contrasts child and adult native speakers with adult second language learners and is not sufficiently fine-tuned as regards potential differences between early and late bilinguals and other kinds of multilingualism.

The new research at PRIM focuses on two fundamental questions that require further investigation: Firstly, we ask how individuals who learn more than one language integrate different sources of information during the processing of sentences and morphologically complex words. Earlier findings suggest that child and adult language learners may each selectively under-use different types of information during processing. One reason for this could be that language learners process these types of information more slowly than mature native speakers. Consequently, one would expect to find both child/adult and native/non-native differences in the relative timing of, structure-based versus, for example, semantics-based effects. Monolingual (as well as any type of multilingual) children may need more time to employ and integrate semantic and pragmatic information with grammatical information during sentence and morpho-

logical processing than mature speakers. Late bilinguals, on the other hand, might be slower in using morphological and syntactic information during processing in their second (non-native) language, relative to mature native speakers. It is also conceivable that learners are globally insensitive to certain types of information during real-time processing, particularly at less advanced stages of language development, which would lead us to expect that some of the effects present in mature native speakers' processing records are absent in the data from late learners. While typically developing (monolingual as well as multilingual) children should overcome any such limitation during the course of language development, global insensitivity to one or more information sources during parsing could prove a serious obstacle for late bilinguals to acquiring native-like processing abilities. To establish whether and when during language processing different types of information become available, it is necessary to chart the moment-by-moment time course of processing using suitably sensitive, but learner-friendly, behavioural and physiological measures (Frenck-Mestre 2005; Mueller 2005; Sekerina, Fernandez and Clahsen 2008).

The second major question that guides the research at PRIM concerns changes of language learners' grammatical processing abilities over time. Previous studies suggest that both child and adult language learners' processing of sentences and morphologically complex words differs from that of mature native speakers, which raises the question of how and when they might become more like adult native speakers and what causes these changes. One possibility would be that the processing system itself is subject to developmental changes in that new processing mechanisms emerge over time (*discontinuity hypothesis*). For example, it is conceivable that language learners initially store inflected or derived words as wholes and that the mechanisms required for automatic morphological segmentation during processing emerge later in development. An alternative possibility is that the processing mechanisms themselves do not change over time, and that any observed developmental changes in processing result from other factors, such as the language learners' developing lexicon and grammar, or from more efficient storage and faster access/retrieval of linguistic information (*continuity of parsing hypothesis*). It is possible, for example, that even though late bilinguals have at their disposal the same processing mechanisms as native speakers in principle, they can only make limited use of structure-based parsing strategies during processing of their non-native language because the grammar of a late-learned language does not provide the kind of detailed grammatical representations that the parser needs in order to operate in native-like ways.

#### 4 PRIM's organisational structure

Three different groups of multilinguals will be studied (in comparison to monolinguals): (i) early bilinguals and multilinguals (both school-age children at

different age levels and adults) who acquired more than one language from birth; (ii) late bilinguals and multilinguals, adults who acquired one or more non-native languages after childhood, from different language backgrounds and at different proficiency levels; and (iii) multilingual children and adults who were diagnosed with developmental or acquired language impairments. The institute consists of three major research units defined in terms of the populations under study, namely children, adults, and patients. PRIM comprises four main laboratories for carrying out reaction-time (RT), eye-movement-during reading, EEG and listening-based ‘Visual World’ (VisWorld) eyetracking experiments. Our research will focus on two core linguistic domains: word-level grammatical phenomena (morphology), and sentence-level phenomena. PRIM also comprises a knowledge transfer centre that bundles the three knowledge transfer services (KT Units) associated with each of the research units for dissemination of research on multilingualism to individuals interested in multilingualism via an on-line contact form, as well as to kindergartens and schools in the form of workshops and other public activities. The institute’s organisational structure is represented schematically in Figure 1 below.

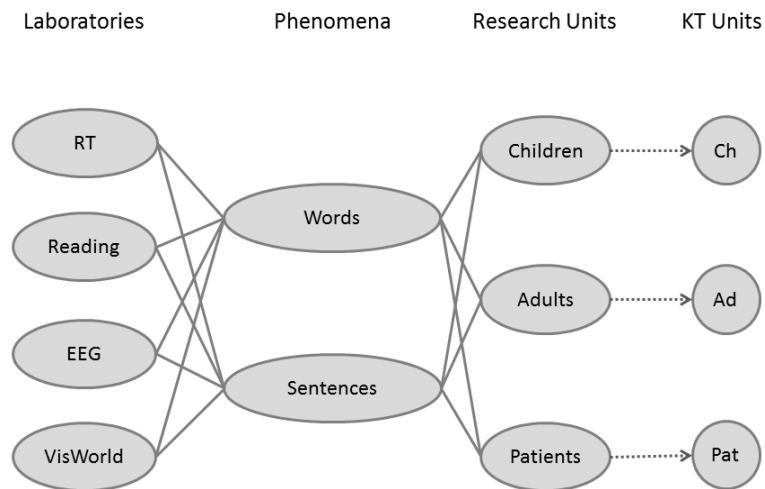


Figure 1. The structure of PRIM

The project team combines expertise in linguistics, experience in working with language learners (including children) and patients, and expertise in the use of experimental psycholinguistic methods. Comparing results from various subprojects will allow for meaningful and empirically well-founded generalizations about grammatical processing in multilingual individuals. The target languages for our experiments will mainly be German and English, which our participants have acquired as either a first or a second language (L2) as children or adults, together with other languages. PRIM belongs to the University of Potsdam's Cognitive Science programme, collaborates with the University's knowledge transfer centre ('Zentrum für Psycho- und Patholinguistik'), and is part of an interdisciplinary network for multilingualism ('Berliner Interdisziplinärer Verbund für Mehrsprachigkeit') initiated by the ZAS ('Zentrum für Allgemeine Sprachwissenschaft').

## 5 PRIM's research programme

The overall focus of our research will be on the mechanisms and information sources multilingual individuals employ during real-time language processing, and on developmental changes of grammatical processing in multilingual children and adults. The research programme consists of six closely related subprojects, three of which investigate morphological processing and three examining sentence-level processing. Proven time-sensitive experimental paradigms will be adapted to the study of child and adult language learners, by designing new experimental materials and improving existing procedures. For each of the six subprojects, a series of experiments using different online processing measures will be carried out. We will initially focus on a comparison of early and late bilinguals, comparing individuals who grew up with two languages from birth to those who learned a new language later in life. Data from these two groups will be compared to monolingual controls. Studies on multilingual individuals with language impairments will be postponed to the second phase of PRIM (see e.g. Rinker and Sachse, 2009, Rothweiler, Chilla and Clahsen, 2012).

The subprojects are designed to allow the same participants to take part in an RT, an eye movement, and/or an ERP experiment on a given phenomenon, so that convergent evidence will be available from different techniques. Experiments that require participants to read complex material will only be administered to older children and adults. Morphological processing will be investigated in three subprojects (M1 to M3) covering the main morphological systems (inflection, derivation, compounding) and different kinds of morphological forms. The experiments will focus on regular morphological processes, as these are likely to recruit grammatically-based processing mechanisms. In addition, irregular morphological processes will be examined for phenomena for which this is feasible. The three subprojects on sentence processing (S1 to S3) will be devoted to investigating children's and adults' processing of structural ambiguities,

and of grammatical and referential dependencies. Taken together, the various subprojects will provide a comprehensive picture of grammatical processing in multilinguals and how this compares to monolingual processing. The six subprojects are described briefly below.

### 5.1 Subproject M1: Inflection

This subproject will investigate how multilinguals process inflected words, for example, past-tense forms in English and participle forms in German. An ongoing debate in the psycholinguistic literature concerns the question of whether (and what kind of) inflected forms are morphologically decomposed, or mentally stored as whole word units. Test instruments will include, among others, RT experiments tapping into morphological processing during language production. Here we will adopt the speeded production task (e.g. Prado and Ullman 2009), in which a verb or noun stem is presented either alone or in the context of a sentence, with a second sentence containing a blank to elicit the inflected form, e.g., *Everyday I play football. Just like everyday, yesterday I \_\_\_\_ football*; see also Clahsen et al. (2004). Participants will be instructed to produce the missing form as quickly and accurately as possible. Whole-word versus stem-based frequency effects on participants' production latencies provide the crucial diagnostic for determining the role of morphological composition and lexical storage of inflected word forms during production. We hypothesize that in contrast to (child and mature) native speakers, late bilinguals rely more on non-structural than on grammar-informed processing in their non-native language. Consequently, we expect their performance to exhibit whole-word frequency effects, even in conditions in which this is not the case for early bilinguals and monolingual native speakers. Developmental changes will be detected by comparing performance across different age groups of children and different proficiency groups of late bilinguals. It has been proposed, for example, that morphological composition of inflected word forms is developmentally delayed relative to lexical storage (Bybee, 1999: 1017). If this is correct, then whole-word frequency effects should be more widespread at early compared to more advanced developmental levels.

A second set of RT experiments will examine morphological priming effects in word recognition. By varying the stimulus onset asynchronies (SOA), i.e. the delay between the onset of the prime (e.g. *played*) and the onset of the target word (e.g. *play*), we can precisely determine at which point in time the language processor accesses different information sources. This technique allows us to test the hypothesis that in a late-learned language, grammar-based information is considered at a later point in time during processing than in a language that has been acquired early (Silva and Clahsen, 2008; Neubauer and Clahsen, 2009). If this is correct, we should see delayed morphological priming effects in late



bilinguals relative to early bilinguals, but no corresponding contrast for semantic or orthographic priming effects.

## 5.2 Subproject M2: Derivation

Here we will test whether the processing mechanisms for inflection are also used for derivational word forms. One important linguistic difference between derivational and inflectional morphology is that derived word forms can be fed into further derivational processes (e.g. *kindness* → *unkindness*), whereas forms such as *walks* or *walked* cannot undergo any further word formation. Linguists (e.g. Anderson, 1992; Stump, 2001) have argued that this is due to a difference in the outputs of derivational and inflectional rules in that derivation (but not inflection) creates new lexemes which are listed in the lexicon and may provide the input for further derivational rules or the base for inflectional rules. Building on this work, we hypothesize that productive derivational processes yield ‘combinatorial entries’ (Clahsen, Sonnenstuhl and Blevins, 2003) in a mature native speaker’s lexicon, i.e., stored forms that maintain their morphological structure. Subproject M2 examines how the linguistic properties of derived word forms influence the way they are processed, and the extent to which the experimental findings on inflected words from subproject M1 generalise to derivational morphology.

To investigate derived word forms during word recognition, we will, for example, test deadjectival word forms with *-ness* in English or *-ung* in German in masked priming experiments (Rastle and Davis, 2008) in which primes are shown too briefly for participants to recognise them consciously. In addition to morphologically-related prime-target pairs (e.g. *happiness* – *happy*), we will include both orthographically (e.g. *brother* – *broth*) and semantically-related pairs (*doctor* – *nurse*). Priming effects will be calculated by comparing target RTs in these conditions to those of unrelated controls. We expect morphological (but not semantic or orthographic) priming effects for their non-native language to be delayed in late bilinguals relative to early bilinguals (Clahsen and Neubauer, 2010).

Another set of experiments will employ the eye-movement monitoring technique to examine derived word forms during reading. This technique allows us to investigate the recognition of derived words in sentence contexts, rather than as isolated words (see e.g. Clahsen and Ikemoto, 2011). As in the masked priming experiments, additional control conditions will be used to partial out the contribution of the semantic and the orthographic overlap between the bare adjective and the derived word form. Eye-movement measures provide a rich source of data for determining how different cues from the preceding context affect the processing of the critical derived word. For early bilinguals, the relative patterning of morphological vs. semantic/orthographic effects should be the same as for monolinguals. Given previous eye-movement experiments on the

time-course of morphological processing in adult monolinguals (Cunnings and Clahsen, 2007, 2008), we thus expect early reading-time measures to be affected by morphological relatedness and less so by purely semantic or orthographic overlap in early bilinguals. Non-native processing in late bilinguals, on the other hand, is hypothesized to be less influenced by morphological information. Hence, effects of morphological relatedness in the non-native language of late bilinguals should be absent or delayed relative to early bilinguals and monolinguals, even for participants whose reading times are native-like for the semantic and orthographic overlap conditions.

### 5.3 Subproject M3: Constraints on compound formation

This project examines the processing of complex word forms that combine inflectional and other morphological processes. Our focus will be on different kinds of inflected and non-inflected forms occurring inside compounds and derived word forms, which is subject to a number of morphological, semantic and (possibly) phonological constraints. Investigating these constraints will provide a window into the information sources language learners employ during the processing of morphologically complex words. To take an example, compounds in English offer a strong contrast between singulars (which are preferred), irregular plurals (which are permitted), and regular plurals (which are disallowed) as compound-internal modifiers (e.g. *owl/ox breeder* vs. *\*owls/oxen breeder*) (compare e.g. Cunnings and Clahsen, 2007). This asymmetry has been attributed to three constraints, a semantic one against non-heads with plural number semantics (Haskell, MacDonald and Seidenberg, 2003), a morphological one against regularly inflected, grammatically-computed, compound modifiers (Berent and Pinker, 2007), and a phonological one against non-heads with codas ending in *s/z* (Seidenberg, MacDonald and Haskell, 2007). Several studies have shown that children as young as three are sensitive to the constraint against *-s* plurals inside compounds (Gordon, 1985, and much subsequent work). By investigating the role and the time course of these constraints in on-line processing experiments, subproject M3 will provide insight into how and when language learners make use of different information sources during processing.

One set of experiments will use eye-movement monitoring, both during reading and during listening. The reading experiment will be taken from Cunnings and Clahsen's (2007) study of adult native speakers of English and will be administered to multilingual children and adults at advanced age/proficiency levels. To investigate compounds in spoken word recognition, we will use the visual world technique (Trueswell, 2008) which monitors participants' eye movements to visual displays while they listen to sentences. Again, we predict that early bilinguals' eye-movement patterns are parallel to those of monolinguals. For late bilinguals, in contrast, effects of the morphological constraint on

reading/looking times in their non-native language are expected to be delayed or absent, relative to effects of the semantic constraint.

#### 5.4 Subproject S1: Ambiguity resolution

In this project we examine the role of structural and semantic constraints in early and late bilinguals' processing of locally ambiguous sentences such as *While the child was chasing the butterfly disappeared through the window*. Examining how the processing system deals with structurally ambiguous input helps reveal what processing strategies and information sources determine comprehenders' initial analyses and their ability to recover from misanalyses. Local subject/object ambiguities in so-called 'garden path' sentences often cause measurable processing disruption in mature native speakers at the point at which a parsing error becomes evident. While late bilinguals also show garden path effects when processing sentences of the above type (e.g. Juffs and Harrington, 1996), they seem to be more strongly guided than native speakers by semantic plausibility and have more difficulty recovering from an initial misanalysis (such as mistaking *the butterfly* for the direct object of the verb *chase*) if the initial interpretation is highly plausible (Roberts and Felser, 2011). Monolingual children, in contrast, appear to be less sensitive to plausibility information than adults when processing garden path sentences, and seem to prefer the structurally simplest analysis regardless of plausibility or semantic fit (Traxler, 2002). Young children have also been found to have difficulty abandoning their initially preferred interpretation of locally ambiguous sentences (Trueswell et al., 1999). The picture has recently become more complex when findings from adult monolingual processing studies revealed that even native speakers often misinterpret garden path sentences, however, which indicates that they sometimes compute only incomplete or 'good enough' representations of the input rather than performing a full parse, as long as the resulting interpretation is plausible (e.g. Christianson, Hollingworth, Halliwell and Ferreira, 2001; Ferreira, Christianson and Hollingworth, 2001). Moreover, older adults have been found to rely more on 'good enough' representations than younger adults, a difference that has been attributed to age-related differences in working memory capacity (Christianson, Williams, Zacks and Ferreira, 2006). The ability to recover from misanalysis may also be affected by syntactic complexity, with longer or structurally more complex ambiguous regions (e.g. *the butterfly that was very beautiful*) reducing comprehenders' ability to revise an incorrect interpretation (Christianson et al., 2001; Van Gompel, Pickering, Pearson and Jacob, 2006).

To investigate and compare the processing and interpretation of garden path sentences across different multilingual populations and to obtain a fine-grained record of the time course of processing, we will, for example, carry out eye-movement-monitoring-during-reading experiments. We expect early bilinguals and adult native speakers to pattern essentially alike in that they should be sensi-

tive to semantic incongruence (as in *#While the child was chasing the milk...*), with the possibility that the timing of plausibility effects is temporally delayed in children compared to adults. Late bilinguals, on the other hand, might show effects of implausible direct objects immediately (i.e. in early processing measures; compare Felser et al., in press) but may take longer than native speakers to recover from an initially plausible misanalysis (Roberts and Felser, 2011). Their processing patterns might become more native-like at the highest proficiency level, and the proportion of wrong interpretations should decrease with increasing proficiency. Late bilinguals (as well as bilingual and monolingual children) may also have more difficulty inhibiting incorrect interpretations compared to adult native speakers. The role of executive control abilities in multilingual sentence processing is as yet poorly understood (compare e.g. Festman, 2011; Wattendorf, Festman, Westermann, et al. 2011), a research gap which we hope to begin to fill. To this end, comprehension-based experiments will be supplemented by, for example, production priming tasks (Van Gompel et al., 2006).

### 5.5 Subproject S2: Filler-gap dependencies

The second sentence processing project focuses on the role of syntactic versus semantic information and on complexity effects in the processing of filler-gap dependencies (FGDs) as in *Which book were you reading \_\_\_ last night?* Linking syntactically displaced elements (or ‘fillers’) to their corresponding ‘gaps’ during processing requires both sufficient memory resources for maintaining the filler in working memory and the ability to integrate the filler with its lexical licenser when this is encountered (Gibson, 1998). In line with theoretical linguists’ distinction between subcategorisation and semantic selection, the filler integration process itself may involve two qualitatively subprocesses, structural gap-filling and lexical-semantics based ‘goodness-of-fit’ evaluation. There is evidence from the adult monolingual processing literature to suggest that in the processing of ‘unbounded’ dependencies such as *Which book were you reading \_\_\_ last night?*, the filler is linked to a structural gap (see e.g. Nakano, Felser and Clahsen, 2002; Nicol and Swinney, 1989) rather than being associated directly with its lexical licenser (Pickering and Barry, 1991). While children have been found to pattern with adults in making use of structural gaps (Roberts, Marinis, Felser and Clahsen, 2007), little is known about their ability to evaluate the filler’s semantic fit during the processing of filler-gap dependencies. In contrast, results from previous L2 processing studies suggest that real-time filler integration in non-native comprehension may not be mediated by purely structurally defined gaps (Felser and Roberts, 2007; Marinis, Roberts, Felser and Clahsen, 2005), even though late bilinguals are able to establish a semantic link between a filler and its lexical licenser as soon as the latter is encountered (Felser et al., in press; William, Möbius and Kim, 2001).

To examine the time course of filler-gap processing in multilingual individuals, we will, for example, carry out an ERP study on the processing of indirect object gaps in sentences such as *Peter teased the horse for which Susan bought some carrots \_\_ after the show* (compare Felser and Roberts, 2007; Roberts et al., 2007). For early bilinguals, we expect to find effects of memory storage and filler integration (i.e. a LAN/P600 effect around the point of the gap). Following earlier findings from Felser and Roberts (2007) using cross-modal priming, we may expect this effect to be absent or delayed in late bilinguals.

A further set of experiments will investigate syntactic and pragmatic complexity effects in multilinguals's processing of unbounded dependencies. There is evidence indicating that late bilinguals have more difficulty than native speakers resolving *wh*-dependencies that span multiple clauses in their non-native language (Cunnings, Batterham, Felser and Clahsen, 2010; Marinis et al., 2005). We will carry out a series of eye-movement monitoring experiments to examine effects of syntactic and pragmatic complexity on early and late bilinguals' processing of *wh*-dependencies. Building on previous work (Cunnings et al., 2010; Felser et al., in press) we will further investigate the processing of sentences containing extraction islands. If the hypothesis that island constraints reflect processing capacity limitations (e.g. Kluender, 2004) is correct, then given that processing a non-native language is generally slower and more resource-demanding than processing one's native language, we might expect less proficient late bilinguals to show greater sensitivity to islands in their non-native language, compared to native speakers and highly proficient learners. Conversely, if island constraints are purely grammar-based (e.g. Chomsky, 1973) and presuppose the ability to build detailed, abstract hierarchical phrase-structure representations, we might expect less proficient late bilinguals to show reduced sensitivity to islands during processing instead.

## 5.6 Subproject S3: Pronoun resolution

This project examines how different types of information affect the way multilinguals interpret ambiguous pronouns, including the question of whether syntactic binding is preferred over discourse-based coreference assignment, or vice versa. Linguistic theory assumes that pronominal reference resolution can, in principle, be accomplished either via syntactic binding or discourse-based coreference assignment (Reuland 2001). In sentences containing two potential referents for an ambiguous pronoun such as *Jeder Schüler, der bemerkte, daß der Lehrer ins Klassenzimmer kam, glaubte, daß er gleich ein Gedicht vortragen würde* ('Every pupil who noticed that the teacher was entering the classroom believed that he would soon recite a poem.'). the quantified noun phrase *jeder Schüler* can only be linked to the pronoun *er* via syntactic binding, whereas the (non c-commanding) definite noun phrase *der Lehrer* can only be linked to it via coreference.

To investigate which antecedent multilingual individuals (both children and adults) might prefer to link the pronoun to during real-time processing, we will, for example, use the cross-modal picture priming technique, which has been shown to be suitable also for younger children (McKee, Nicol and McDaniel, 1993; Roberts, Marinis, Felser and Clahsen, 2007). Pictures showing the preferred antecedent should elicit shorter reaction times at the pronoun compared to those showing the dispreferred antecedent, and in comparison to unrelated control pictures. Given that syntactic binding relationships (unlike coreference assignment) are defined over hierarchical phrase structure representations, we might expect late bilinguals to have more difficulty computing these in their non-native language compared to native speakers.

Multilinguals' sensitivity to structural versus discourse-level constraints in pronoun resolution will be examined using eye-movement monitoring during listening and during reading. One set of eye-movement experiments will use the visual world technique to record participants' gaze directions and durations while they are listening to the spoken stimuli (compare Clackson, Felser and Clahsen, 2011). While the proportion of participants' initial looks to either one of the two potential antecedents after hearing the pronoun will provide an indication of their initial interpretation preference, their responses to end-of trial comprehension question will help reveal their ultimate interpretations. In the corresponding reading-based experiments, manipulating gender congruence between a pronoun and its potential antecedents will be used as a diagnostic for dependency formation (compare e.g. Sturt, 2003; Felser and Cunnings, 2011; Felser, Sato and Bertenshaw, 2009). Longer reading times are expected in the pronoun region in those conditions that force a referential dependency to be established between the pronoun and its dispreferred antecedent. Given earlier findings from ambiguity resolution studies (e.g. Trueswell et al., 1999), we expect younger children's interpretation preferences to remain largely unaffected by the extra-sentential discourse context, whereas older children and adults should show sensitivity to contextual biases. In addition, late bilinguals might show particularly strong effects of the preceding discourse context in their non-native language (compare Pan and Felser, 2011), with the possibility of context effects becoming weaker at more advanced proficiency levels.

## 6 Outlook

The new research centre introduced here will examine multilingual children and adults at different stages of language development/proficiency with respect to both morphological and sentence processing. The research planned for the next five years should provide detailed evidence on both similarities and differences between monolinguals and multilinguals, as well as between early and late bilinguals and multilinguals, in the domain of grammatical processing. The research at PRIM should help us understand better why normally developing chil-

dren are generally successful at acquiring one or more languages during childhood, whereas people who acquire a second language as adults usually fail to attain fully native-like performance abilities. Comparisons of early and late language learners will also be informative for better understanding the nature of grammatical processing, for instance by shedding more light on the role of different processing pathways in native vs. non-native language comprehension and production.

Findings from the project should be of interest to theoretical and applied linguists, cognitive psychologists, and developmental psychologists. The experimental results will lead to detailed and novel insights into a largely unexplored area of research, namely the temporal dynamics of grammatical processing in multilingual individuals, and will provide evidence of how grammatical processing mechanisms change during development. At a more general level, our research will contribute to the understanding of how complex aspects of language, particularly grammar, are represented and processed, a core issue in current research on language processing. Finally, we hope that our research will help provide criteria for identifying more precisely what kind of grammatical phenomena may cause processing problems for different kinds of multilingual populations. These criteria should ultimately lead to improved practice in language teaching and language therapy settings as it will enable the language practitioner to specifically target the particular domains of grammatical processing that restrict a multilingual person's achievements in his/her non-native or (in the case of language disorders) the impaired language.

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Potsdam

Harald Clahsen and Claudia Felser

University of Potsdam, Potsdam Research Institute for Multilingualism, Karl-Liebknecht-Str. 24-25, D-14476 Potsdam. URL: <http://www.uni-potsdam.de/prim/>

Email: clahsen@uni-potsdam.de, felser@uni-potsdam.de