

# **Perceiving emotions with a bilingual mind**

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## **Perceiving emotions with a bilingual mind**

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*À mes merveilleux parents adorés, Réjean et Claudette*



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## Abstract

The aim of this thesis was to investigate the perception of emotions in bilingual individuals. Constructionist theories of emotions state that an instance of an emotion is built out of our inner perceptions, of context and observations, as well as of our concept knowledge of a given emotion. Language plays a major role in the perception of emotions since it is the binding agent that holds together the building blocks of an instance of an emotion. Furthermore, language shapes the perception of, amongst other things, emotion, allowing us to interpret a panoply of cues and stimuli which without a specific word would not belong together. However, it is unknown whether having more than one language affects the perception of emotions.

This thesis is built on three empirical studies. In the first study, the perception of facial instances of emotions was investigated in a group of 4-year-olds. Before that age, children perceive emotions in others in terms of valence (good or bad) and arousal (low or high), but have difficulty perceiving specific instances of emotions (e.g., angry, sad, happy). At around the age of four years however, children's skills in perceiving specific instances of emotions in others improve quickly. Children with different linguistic backgrounds were thus investigated. The participants were either monolingual, dominant bilinguals or balanced bilinguals. Their task was to identify the instance of an emotion that was portrayed on different faces (happy, angry, sad, or scared). In this study, previous results showing that children gradually learn to identify specific instances of emotions were replicated. Namely, while happiness and anger were easily identified, children still struggled to identify sadness and fear accurately. No effect of linguistic group was found. It is still unclear however whether a child's linguistic environment may nonetheless have an effect on emotion perception since the task was simple and perhaps became too easy when the right labels were provided to the children.

In the second study, a semantic and a prosodic bias were investigated in a group of children aged 6-8 years. Until this age, children rely mainly on the semantics of an utterance to interpret the emotional state of an interlocutor, even when the emotional prosody is discrepant. While a previous study found that young bilinguals can identify the discrepant emotional prosody of an utterance at an earlier age than their monolingual peers, it was unclear why this effect was found and whether it may have been driven by a bias towards prosody for bilingual children. In this study, both the semantic and the prosodic bias were investigated. The children's level of bilingualism was

measured on a continuous scale ranging from monolingual to balanced bilingual in terms of exposure and use. Children were presented with spoken words which were either negative, positive or neutral, and were uttered with a negative, positive, or neutral tone of voice. The task was for some trials to identify the semantics of the word (and ignore the emotional prosody when it was discrepant), and for other trials to identify the emotional prosody of the word (and ignore the semantics when it was discrepant). While age predicted a decline of the semantic bias, as was found in previous studies, level of bilingualism did not. On the other hand, level of bilingualism predicted a larger prosodic bias. In other words, even when asked to identify the content of a word, the more bilingual children were, the more difficulty they had in ignoring a discrepant tone of voice. Thus, this study suggest that what was previously believed to be a bilingual advantage in prosody processing was in fact driven by a bias towards prosody.

Finally, in the third study, the relationship between bilingualism and social flexibility in adults was investigated. Social flexibility can be defined as the ability to detect social cues and to easily switch and adapt between different social environments. A previous study found that bilinguals showed better social flexibility. However, there were several conceptual and methodological concerns with the design. The relationship between bilingualism and social flexibility was thus investigated in the third study where several of the conceptual and methodological issues were addressed. The participants' frequency of using a second language, proficiency in that second language, frequency of code-switching, and level of education were used as predictors on accuracy, reaction times and switch-cost in an experimental task measuring social flexibility. Participants had to determine whether a face and a voice were congruent or discrepant based on one of two relevant social cues, gender or emotion, and to switch between those two criteria. The results of the third study could not support the idea that bilinguals are more socially flexible. In fact, in terms of cue acuity, level of education predicted better performance, while proficiency in a second language predicted lower accuracy. The results of this study suggest that when a caricatured instance of an emotion is presented out of context, having two languages does not facilitate perception and may perhaps create more uncertainty.

The results of the three studies are discussed from a constructionist theoretical point of view. However, since this research is amongst the first to investigate the relationship between the perception of emotions in others and bilingualism from a constructionist point of view, many questions remain

unanswered. Alternative explanations that go beyond a constructionist framework are considered to explain the results of the studies. Finally, suggestions on how the research presented in this thesis can be developed are also discussed.



## Summary in Swedish

Syftet med denna avhandling var att undersöka hur tvåspråkiga individer uppfattar emotioner. Konstruktionistiska emotionsteorier hävdar att en emotion består av våra inre perceptioner, av våra yttre observationer, samt av våra kunskaper om en viss emotion. Språk spelar en central roll i hur vi bildar emotioner eftersom det är komponenten som håller samman de olika byggstenarna som en emotion består av. Genom att hålla ihop en emotions olika delar skapar språk avgränsningen mellan de olika emotionerna. Språk formar inte endast emotionskategorier men guidar också vår perception av emotioner därefter. När perception sker grupperas disparata signaler ihop utifrån våra språkavgränsade emotionskategorier så att vi kan uppfatta dessa oförenliga signaler som en specifik emotion. Det är dock oklart om perceptionen av emotioner påverkas av att tala fler än ett språk.

Den här avhandlingen är byggd på tre empiriska studier. Den första studien undersökte hur 4-åringar upplevde emotioner i ansiktsuttryck. Innan barn når denna ålder uppfattar de emotioner i form av valens (bra eller dåligt) och arousal (hög eller låg), men har svårt att urskilja specifika emotioner (till exempel arg, ledsen, glad). Runt fyra år inträffar dock en snabb utveckling i ett barns förmåga att uppfatta emotioner hos andra. Barn med olika språkbakgrunder undersöktes därmed för att undersöka om deras utveckling påverkades av deras språkprofil. Deltagarna var antingen enspråkiga, dominant tvåspråkiga eller balanserade tvåspråkiga. Deras uppgift var att identifiera förekomsten av en emotion (glad, arg, ledsen eller rädd) som skildrades i olika ansikten. Tidigare resultat som visat på att barn successivt lär sig att identifiera specifika förekomster av emotion replikerades. Nämligen, medan barnen lätt kunde identifiera glädje och ilska, så hade de svårt att urskilja sorg och rädsla. Språkprofilen visade dock ingen effekt. Det är emellertid fortfarande oklart om barns språkmiljö ändå kan ha en effekt på hur de uppfattar emotioner. Nämligen, uppgiften som de fick göra var okomplicerad och kanske blev alltför enkel när barnen tillhandahölls de rätta namnen på emotionerna, vilket kan ha skapat en takeffekt.

I den andra studien undersöktes en semantisk och en prosodisk bias hos barn i åldrarna 6-8 år. Innan denna ålder använder sig barn främst av semantiken (själva ordet) hellre än av den emotionella prosodin (tonläget) när de tolkar det emotionella tillståndet hos en talare när den emotionella prosodin är inkonsekvent med semantiken. En tidigare studie har visat att tvåspråkiga barn tidigare lär sig att använda emotionell prosodi för att tolka andras emotionella tillstånd jämfört med jämnåriga enspråkiga barn. Det är

däremot oklart varför den effekten uppstod och huruvida den har orsakats av en prosodisk bias. I den här studien undersöktes därmed en semantisk såväl som en prosodisk bias. Barnens grad av tvåspråkighet mättes på en kontinuerlig skala som sträckte sig från enspråkig till balanserad tvåspråkig i relation till exponering och användning av ett andraspråk. Barnen fick lyssna på negativa, positiva samt neutrala ord som antingen uttrycktes i ett negativt, positivt eller neutralt tonläge. Uppgiften var att vid vissa tillfällen identifiera ordets semantik (och att ignorera den emotionella prosodin när den var inkonsekvent), och vid andra tillfällen identifiera ordets emotionella prosodi (och ignorera semantiken när den var inkonsekvent). Ålder, men inte graden av tvåspråkighet, kunde predicera en mindre semantisk bias. Å andra sidan predicerade graden av tvåspråkighet en större prosodisk bias. Med andra ord, ju mer tvåspråkig barnen var desto svårare var det för dem att ignorera ett inkonsekvent tonläge, även när de blev ombedda att identifiera ett ords semantik. Den här studien antyder sålunda att vad som tidigare antogs vara en tvåspråkig fördel när det gäller tolkning av emotionell prosodi var i själva verket drivet av en bias för prosodi.

Slutligen, i den tredje studien undersöktes förhållandet mellan tvåspråkighet och social flexibilitet hos vuxna. Social flexibilitet kan definieras som förmågan att upptäcka sociala signaler och att snabbt växla om och anpassa sig till olika sociala miljöer. En tidigare studie fann att tvåspråkiga personer hade högre social flexibilitet, men det förelåg dock flera konceptuella och metodologiska problem med den studien. Förhållandet mellan tvåspråkighet och social flexibilitet undersöktes därmed i den tredje studien, där flera av de konceptuella och metodologiska problemen åtgärdades. Frekvensen av användningen av ett andraspråk, deltagarnas kunskapsnivå i det andraspråket, hur ofta kodväxling skedde och deltagarens utbildningsnivå användes som prediktorer för olika variabler (träffsäkerhet, reaktionstider och switch-kostnad) i ett experiment där social flexibilitet mättes. Deltagarna ombads att avgöra om ett ansikte och en röst var förenliga eller inkonsekventa baserat på en av två sociala signaler (kön eller emotion) och att växla mellan dessa två kriterier. Resultatet av den tredje studien kunde inte stödja påståendet om att tvåspråkiga individer är mer socialt flexibla. När det gällde träffsäkerhet så var utbildningsnivå en signifikant prediktor, medan en högre kunskapsnivå i det andraspråket predicerade lägre träffsäkerhet. Resultaten av den här studien antyder att när en emotion presenteras i form av en karikatyr utanför något särskilt sammanhang underlättas inte perception av emotion av att vara tvåspråkig, utan kan snarare försvåras.



Resultaten av de tre studierna diskuteras utifrån ett konstruktionistiskt perspektiv. Däremot, då den här avhandlingen presenterar några av de första studierna som undersöker förhållandet mellan perceptionen av emotioner och tvåspråkighet utifrån ett konstruktionistiskt perspektiv så förblir fortfarande många frågor obesvarade. Alternativa förklaringar som går bortom ett konstruktionistiskt ramverk presenteras för att tolka resultaten som hittades. Förslag på hur forskningen som presenteras i denna avhandling kan utvecklas diskuteras även.



## List of papers

This thesis is mainly based on the following papers, herein referred to by their Roman numerals:

- Study I Champoux-Larsson, M.-F., Dylman, A. S., Örnkloo, H., & Esteves, F. (2018). Identification of facial expressions of emotion by 4-year-old children from different linguistic environments. *International Journal of Bilingualism*. Advance online publication. doi:10.1177/1367006918781069
- Study II Champoux-Larsson, M.-F., & Dylman, A. S. (2018). A prosodic bias, not an advantage, in bilinguals' interpretation of emotional prosody. *Bilingualism: Language and Cognition*. Advance online publication. doi:10.1017/S1366728918000640
- Study III Champoux-Larsson, M.-F., Dylman, A. S., & Esteves, F. (2018). *Empirical investigation of the relationship between social flexibility and bilingualism*. Manuscript submitted for publication.



## Preface

Ever since I was a little girl, bilingualism has fascinated me. I grew up in Québec, a francophone province in Canada, in the Eastern Townships, an area where Anglophones are relatively common compared to the rest of the province. Although I myself was a monolingual child, my best friend was bilingual. Her mother had immigrated from the United States of America and married a French-speaking Quebecker. My best friend and her siblings thus grew up in a bilingual environment, which baffled my monolingual mind whenever I went over to their home for a playdate. It is in this context that my first questions about bilinguals and bilingualism arose. Back then, my questions were at a more basic level such as “How can they do that?”, but I also recall asking myself questions that are not so different from research questions. For instance, I remember asking myself why my best friend’s little brother had used code-switching (although I did not call it code-switching back then, nor had I any idea of the scientific concept either) after he uttered “Wow! Il fait vraiment *dark* ici!” (“Wow! It’s really dark here”). Spending time with my bilingual best friend and her bilingual family filled me with the determination to one day become a bilingual myself. Little did I know that this environment I was in contact with during my childhood would also somehow influence not only my interest for languages, but my whole career altogether.

Bilinguals and bilingualism is a very gratifying area to study, but a challenging one too. People often find the subject interesting, if not fascinating, and can easily and intuitively relate to it. I often hear, when people ask me what my area of research is, that languages are so interesting, and that it is so captivating to see how young bilingual children can easily switch from one language to the other, and how they wish they were bilingual too. However, I discovered soon enough after I started my doctoral studies that the subject becomes complex quite early on. In fact, as soon as one tries to define and measure bilingualism, the issues begin to arise, something that even laypeople often notice quickly as well (“Do you have to be fluent to be bilingual?”, “Are only children growing up with more than one language bilinguals?”, “Wait, do you say I am a bilingual too? But I have such an accent when I speak English!”). These issues will be covered in the introduction of this thesis.

At the time when I wrote my research plan to apply for the doctoral studies program, a plethora of articles claiming to have found a bilingual advantage in cognitive functions were being published. Carried away by the excitement of this research, I decided that I would follow this train of thought to explore

another area where executive functions were involved: the perception of emotions. As I was gathering data and failing to find bilingual advantages, more and more articles where the concept of the bilingual advantage was being questioned were also being published. A failure to replicate results supporting a bilingual advantage led many to question at least the magnitude and extent of the bilingual advantage. I must admit that it was a bit disheartening, because quite frankly it would have been so much more spectacular to show how better bilinguals are at so many things beyond their linguistic skills. But bilinguals are no mystical animals with superhero powers, at least not according to my research. Instead, I found bilinguals to be different from monolinguals in some attributes, in certain contexts, and given specific features of bilingualism, at least when it comes to some aspects of emotion perception.

In short, my idea of bilingualism has changed tremendously since I first came into contact with it, and even more so since I began studying bilingualism and bilinguals. Like so many other PhD students before me, and numerous ones that will come after me, I have thought several times “Ugh, I wish I had known *that* back then when I designed that study!”. The studies that I will present in this thesis have no pretention of revolutionizing the field, but I believe that they raise a few central and relevant theoretical, conceptual and methodological issues that are related to research in this area. The evolution in how these issues are tackled from one study to the other reflect my own personal journey as a PhD student, which at times has been an arduous, but always enriching and exciting, experience. I hope that you also will enjoy the ride.

## Introduction

Bilingualism is a common and widespread phenomenon. According to a report by the European Commission (2012), more than half of Europeans in 2012 mastered one or more second language well enough to be considered bilingual or multilingual. On a global range, it is estimated that more than half of the world's population use more than one language and that a majority of countries in the world are bilingual (Grosjean, 1982; Harris & Nelson, 1992). Despite the fact that bilingualism is the rule rather than the exception, many studies in psychology, linguistics and psycholinguistics have studied populations where all or most participants were monolingual (Grosjean, 1998). Implicitly, the knowledge that we gain through these studies creates norms that may be true for monolingual populations, but not automatically for bilingual populations.

Consequently, the norms and milestones that we take for granted when talking about development throughout life may not necessarily suit all children, adolescents, younger and older adults, many of which are in fact bilinguals. When there are in actual fact no differences between how a monolingual and a bilingual person develop, this is obviously not an issue. However, there are situations when a bilingual should not be expected to perform as a monolingual. For instance, when measuring vocabulary in only one language in a bilingual child, s/he will most likely show a delay. In fact, it is only when taking into account all unique words that a child knows in both languages that we can see that their vocabulary is actually as large as the vocabulary of their monolingual peers (Bialystok, 2001; Pearson & Fernández, 1994; Poulin-Dubois, Bialystok, Blaye, Polonia & Yott, 2013). Without this knowledge, it would be reasonable to evaluate bilingual children in one language only, compare their performance to the norms that are established in a monolingual population, and conclude that the child shows a developmental delay. This, of course, would not reflect reality since the appropriate measurement of a bilingual child's vocabulary should take into account the unique words of both languages. There are situations where the contrary will be true. For instance, recent findings suggest that the first symptoms of dementia can be delayed by many years (some studies found a delay as large as four years) in the bilingual elderly (e.g., Abutalebi et al, 2015; Alladi et al., 2017; Chertkow et al., 2010; Craik, Bialystok & Freedman, 2010; Mortimer, 2014, but see Mukadam, Sommerland & Livingston, 2017, for a systematic review and meta-analysis where it was concluded that there is no compelling evidence for such an effect). If bilingualism can indeed slow down

the decline of cognitive functions, it would be erroneous to investigate dementia in a patient without considering whether this person is bilingual or not.

Thus, by using norms established for monolingual populations when assessing bilinguals, there is a risk of misdiagnosing them, either by discovering a problem where there is none, or by missing a problem where there actually is one. Most of the time, when there are no actual differences between monolinguals and bilinguals, existing norms should be appropriate. But in order to know this, we need to gain more knowledge about the development of bilinguals. There already exists a large, albeit inconsistent, body of research regarding differences in executive functions between monolinguals and bilinguals. This disparate body of research has led to a lively debate on what is now known as the bilingual advantage in executive functions. While there are many studies indicating that bilinguals perform better than monolinguals on various tasks where executive functions are recruited, such as the Simon task, the flanker test, the attentional network task, and even various Stroop tasks (e.g., Bialystok, 1986a, 1986b, 1988; Bialystok, Craik, Klein & Viswanathan, 2004; Blom, Boerma, Bosma, Cornips & Everaert, 2017; Coderre & van Heuven, 2014; Costa, Hernández & Sebastián-Gallés, 2008; Damian, Ye, Oh & Yang, 2018; Martin-Rhee & Bialystok, 2008; Ong, Sewell, Weekes, McKaugue & Abutalebi, 2017; Poarch & Bialystok, 2015; Wang, Fan, Liu & Cai, 2016; Woumans, Ceuleers, Van der Linden, Szmalec & Duyck, 2015, see Barac, Bialystok, Castro & Sanchez, 2014, for a critical review of cognitive development of young bilinguals, Bialystok, 2007 for a summary of how bilingualism is believed to affect cognition throughout the lifespan, Bialystok, Craik & Luk, 2012, for a review of the effects of bilingualism on cognitive functions, and Kroll & Bialystok, 2013, for a suggestion of how language and cognition are linked together and can result in a bilingual advantage), other studies later emerged to put such findings into question (e.g., Costa, Hernández, Costa-Faidella & Sebastián-Gallés, 2009; Namazi & Thordardottir, 2010; Paap, Johnson & Sawi, 2014; Ross & Melinger, 2017, see Paap, Johnson & Sawi, 2015, for criticism on findings on bilingual advantage in executive functions)<sup>1</sup>. Indeed, numerous studies have failed to reproduce previous findings supporting a bilingual advantage in executive functions

<sup>1</sup> According to a study by de Bruin, Treccani and Della Sala (2015), one of the factors that led to many years of uncontested evidence in favor of a bilingual advantage in executive functions may in fact be a publication bias. The authors gathered an array of conference abstracts covering the topic of bilingualism and executive functions. Of those abstracts, those in favour of a bilingual advantage were much more likely to be published than those not supporting the bilingual advantage.



(e.g., Dick et al., 2018; Duñabeitia et al., 2014; Loe & Feldman, 2016; Ross & Melinger, 2017; von Bastian, Souza & Gade, 2016; for a meta-analytic review showing failing support, see Lehtonen et al., 2018 as well as Samuel, Roehr-Brackin, Pak & Kim, 2018 for a review), and there are even studies where a bilingual disadvantage in executive functions is found (e.g., Folke, Ouzia, Bright, De Martino & Filippi, 2016; Paap & Greenberg, 2013; Paap et al., 2017; Paap & Sawi, 2014). Although it is beyond the scope of this thesis to elaborate on the bilingual advantage debate, the body of research on bilingualism and executive functions raises an important point. Namely, in order to understand bilinguals properly, it is crucial to design well-considered studies and report all types of results in order to get the full picture of a phenomenon, especially when the population that is studied is as diverse and heterogeneous as it is here with bilinguals (Duñabeitia & Carreiras, 2015).

When it comes to the emotional development of bilinguals, research is much sparser compared to research on bilingualism and executive functions. However, based on constructionist theories of emotions, this is an area which deserves more attention (e.g., Lindquist, MacCormack & Shablack, 2015). Although constructionist theories of emotion do not propose that bilingualism may lead to an advantage or disadvantage in emotion processing, they suggest that using more than one language system may have an influence on how emotions are perceived (Lindquist, MacCormack & Shablack, 2015). Thus, based on this theoretical framework, the study of how bilinguals perceive emotions is a legitimate endeavour which deserves being looked into. The studies in this thesis attempted to achieve exactly this, namely to see if bilinguals perceive emotions differently compared to monolinguals. Observe that a different way of perceiving does not necessarily imply an advantage or disadvantage for any given group. Rather, differences can also denote alternative but equal ways of reaching a given goal. For instance, in the context of research on bilingualism and executive functions, Berroir, Ghazi-Saidi, Dash, Androver-Roig and Benali (2017) found clear distinct patterns in the brain activity of monolinguals and bilinguals when they solved a Simon task. Behaviourally, no advantage or disadvantage was found between the groups, but different neural networks were nonetheless recruited depending on the language profile of the participants. Similarly, in a study by Cachia et al. (2017), cognitive performance in terms of conflict monitoring correlated with different patterns of neurological activity based on the participant's language profile (monolinguals versus bilinguals). Hence, considering Berroir et al.'s (2017) and Cahica et al.'s (2017) results, it may be relevant to investigate differences even though they do not lead to enhanced

performance. In line with this notion, the studies in this thesis should not be taken as support for or against a bilingual advantage or disadvantage in the perception of emotions. Instead, they should be interpreted (with caution considering that the studies in this thesis only scratch the surface of a broad and complex area) as evidence for shared characteristics and distinctions as a function of bilingualism during emotion perception. However, before looking at the studies in more details, more information on the main subjects covered in all three studies will be presented in the sections below.

## **Bilingualism**

The first step when studying bilinguals and bilingualism is to understand what is meant by bilinguals and bilingualism exactly, and how it can be measured. Since these two questions are central to how the studies in this thesis were conducted, the first part of this section will briefly cover important aspects of defining and measuring bilingualism.

### **Defining bilingualism(s)**

Although defining bilingualism may seem like quite a simple and straightforward task at first, generating a clear definition of bilingualism becomes more complicated when taking a closer look at the concept. Simply put, bilinguals can be defined as people who can speak and understand more than one language (de Groot, 2011). Other definitions that have been suggested include “individuals or groups of people who obtain the knowledge and use of more than one language” (Butler & Hakuta, 2006, p. 114), “the use of two languages” (Ng & Wigglesworth, 2007, p. 3), “speakers who use two or more languages or dialects in their everyday lives, regardless of their levels of proficiency in the respective languages” (Pavlenko, 2014, pp. 20-21), and even “the native-like control of two or more languages” (Bloomfield, 1935, p. 56). However, these definitions are either too broad and unspecific to be useful or too restrictive and narrow to be pertinent in a variety of different contexts.

Still, they raise important issues that virtually every investigator faces when selecting bilingual participants for a scientific study. For instance, how much must one speak and understand more than one language to be considered bilingual? Must the usage of the second language(s) occur on a daily basis? Must the knowledge of the second language(s) be native-like? What is native-like knowledge of a language? Does it include pronunciation and accents? How proficient must one be before being considered bilingual?

Is proficiency necessary both in writing and oral skills? What about people who understand but do not speak a language?

In fact, there are no definite and absolute answers to these questions, and depending on the answer to these questions, the definition of a bilingual will differ. There is in other words no universal definition of bilingualism that suits all research questions in all the different academic fields where bilingualism is studied. Regardless, most of us still have an intuitive understanding of what bilingualism means, even if each individual definition is also likely to vary. Despite this, why are researchers unable to find and agree on a single definition? How cannot such a concept, which should be simple to define, result in a consensus? The main reason probably lies in the fact that bilingualism, as the questions above demonstrate, can and does take many forms. There are indeed many different facets to bilingualism, which have often been divided into different types of bilingualism. This also explains why different studies often investigate different types of bilinguals, and why a clear description of the type of bilingualism that was studied is particularly important whenever a study is presented.

When determining the bilingual population that will be recruited for a specific study, many factors can be considered and selection can be based on one or many of them<sup>2</sup>. Most of the time, the modalities that are used to classify participants as monolinguals or bilinguals are their written comprehension skills, and/or aural comprehension, and/or speech production, but very seldom are writing skills used (de Groot, 2011). Still, there is a plethora of characteristics that can differentiate bilinguals from each other and from monolinguals. To begin with, regarding the timing of language acquisition, a distinction can be made between simultaneous and sequential bilinguals (Genesee et al., 1978; Paradis, Genesee & Crago, 2011). Simultaneous bilinguals are children who are learning their first language<sup>3</sup> and second language at the same time from birth. For instance, a child growing up in a bilingual country where two languages are used on a daily basis at home and in the society would be referred to as a simultaneous bilingual. The same is

<sup>2</sup> To simplify this discussion, the factors will be presented in relation to bilinguals. However, the same factors can apply to multilinguals as well.

<sup>3</sup> Observe that the term first language is used rather than the outdated term mother language. First language is defined as a person's native language, which is not necessarily the same language as one's mother's language. Although one's native language generally used to be the same as one's mother's language back when women were mainly stay-at-home caregivers, this is far from true today. Thus, the term mother language has been gradually abolished in favor of the more modern and correct term first language, which better reflects and includes the different situations of current times.

true for a child growing up in a society where the main language is different from the language used at home. Furthermore, a distinction can also be made in terms of majority or minority language groups (Paradis, Genesee & Crago, 2011). In the first example, the child belongs to a majority group since both languages are widely spoken in the country. In the latter case, the child is classified as being part of a minority language group since the language at home is not widely used in the society in general. For some simultaneous bilinguals, it is even difficult to determine which language is the first language and which one is the second one. In such a case, a child can have two first languages. As for sequential bilinguals, they learn their second language after they have learned their first language (de Groot, 2011). As can be done for simultaneous bilinguals, one can distinguish between majority language and minority language sequential bilinguals based on the same logic.

Furthermore, another criterion that can be considered when studying bilinguals is the age of acquisition of the second language. The terminology that is used to define when in time a second language was learned is early and late bilingualism (Genesee et al., 1978; de Groot, 2011). Early bilingualism includes cases where someone has learned a first and second language before the age of around 7 years, be it simultaneously or sequentially (de Groot, 2011; Schaerlaekens, 1998). Late bilinguals are those who learned a second language during late childhood or afterwards (Schaerlaekens, 1998). Note however that there are examples where the terms “early” and “simultaneous” as well as “late” and “sequential” are used interchangeably (e.g., Gasquoine, 2016). The age at which one learns a second language will display itself even at a neurological level. For instance, levels of white matter fractional anisotropy increase as a function of learning a second language, and these fractional anisotropy values correlate with age of acquisition of the second language (Rossi, Cheng, Kroll, Diaz & Newman, 2017). There is also neurological evidence showing that the languages of early bilinguals are organized in a similar way in the brain (Dehaene et al, 1997; Mechelli et al., 2004; Perani et al., 1998). More precisely, both languages will tend to be more lateralized to the left hemisphere. For late bilinguals however, although the first language also tends to be lateralized mainly in the left hemisphere, the second language tends to be more widespread and at times even lateralized to the right hemisphere (Dehaene et al, 1997; Perani et al., 1998).

Another distinction that is often made is between balanced and dominant bilinguals. Balancedness can be based on exposure to languages, on usage of the languages and/or on proficiency (e.g., Butler & Hakuta, 2006; Peal & Lambert, 1962; Sawyer, 2016; Woumans, Ceuleers, Van der Linden, Szmalec

& Duyck, 2015; Yow & Li, 2015). When there is balanced bilingualism, the exposure to, usage of, or proficiency in both the first and second languages will be equal or practically the same. When it comes to dominant bilingualism, the exposure to, usage of, or proficiency in one of the languages is larger. However, balanced bilingualism based on proficiency for instance does not necessarily imply that a person is fully proficient in both languages, but only that they are equally proficient in both (de Groot, 2011). Thus, there is a difference between proficient bilinguals and non-proficient bilinguals as well, and both can be either balanced or dominant bilinguals.

Furthermore, absolutely balanced bilinguals, be it based on exposure, usage or proficiency, are quite rare. Indeed, absolute balancedness can be theoretically possible in cases where both languages are used fluently (pun intended) in the home and in the society as well. Nevertheless, in most cases, even if there may be quantitative balancedness, the two languages are often used in different contexts which do not or only moderately overlap. Not only can balancedness vary and shift across domains, but it can also fluctuate across different life periods (Grosjean, 2010).

To illustrate these two different types of balanced bilingualisms, take for example an English-French bilingual family living in the bilingual province of New-Brunswick in Canada versus a bilingual family that emigrated from Sweden to the francophone province of Québec in Canada. In the first case, both French and English are official languages that are practically used equally in the society and in the home of many of the province's inhabitants. In this case, balancedness of exposure, usage, and proficiency is more likely to occur since both languages are heard and used in a variety of situations that are not specific or unique to each language. In the second case however, balancedness will be less likely. Since the official language (French) is different from the home language (Swedish), it is unlikely that both will be used equally in different contexts. It is more probable that the former will be used in contexts such as work, school and social interactions, while the latter will probably be mainly used in family and home contexts. Since the contexts in which the two languages are used or heard do not overlap to the same extent, absolute balancedness is not as likely.

Nevertheless, although the above discussion about absolute balancedness is important, the distinction between balancedness that occurs in overlapping contexts or not is usually not made in scientific inquiries. Yet, when contexts where different languages are used largely overlap, code-switching is likely to occur. Code-switching, which is the use of more than one language within the same conversation or even utterance (Scotton & Ury, 1977) where the

speaker switches back and forth between the different language systems (Grosjean, 2010), has been found to correlate with other psychological aspects. For instance, it has been found to positively correlate with enhanced creativity and innovation (Kharkhurin & Wei, 2015) and it has even been suggested that code-switching may facilitate the creation of new memories (Antón, Thierry, Gaborov, Anasagasti & Duñabeitia, 2016). Hence, in some situations, the degree to which one code-switches may be of importance and the contexts where the different languages are used may also matter.

Although the dimensions presented above are relatively common within bilingualism research, there are additional ways to divide bilinguals. For instance, bilingualism can be classified in terms of how the languages are organized in a person's memory, in which case there is a distinction between compound, coordinate and subordinative bilingualism (Butler & Hakuta, 2006; de Groot, 2011; Weinreich, 1979). Bilingualism can even be classified as elite or folk bilingualism (e.g., Edwards, 2013; Fishman, 1977). Another example is how bilingualism can be classified based on the circumstances or environment where the languages were acquired, in which case bilingualism can be divided into circumstantial and elective bilingualism (e.g., Valdés & Figueroa, 1994). Bilingualism can even be defined in terms of the effect learning a second language has on the retention of the first language, namely additive and subtractive bilingualism (e.g., Edwards, 2013; Lambert 1974). Furthermore, the similarity of languages and/or of their scripts is also a factor that can be used (e.g., Pasquarella, Chen, Gottardo & Geva, 2015; Sunderman & Priya, 2012), and even the geography of bilingualism can be used to classify individuals (e.g., Edwards, 2013).

Hopefully, it is now clear that bilingualism can bear many different meanings and that it is probably more correct to speak of the different facets or types of bilingualism rather than studying bilingualism as one large homogenous and consistent concept<sup>4</sup>. In this thesis, the definition of bilingualism that is used varies based on the population that is studied. More information on the various definitions of bilinguals and bilingualism that were used in our studies will be provided under the section covering the empirical studies.

<sup>4</sup> Although it is not discussed in depth in this thesis, another relevant issue when defining bilingualism is to actually first establish what a language is since the distinction between what constitutes two different languages is not always clear-cut (Bialystok, 2001). For instance, the similarities between two different languages such as Dutch and Flemish may be smaller than the differences between two different versions of a language within that same language, such as different versions of Arabic (Fabbro, 1999; Spolsky, 1998).

### **Measuring bilingualism**

Given the plethora of characteristics that can distinguish different types of bilinguals and bilingualisms, accurately measuring bilingualism can be a challenge. Different types of measurements will be needed to determine how much bilingual participants are depending on the type of bilingualism that is studied. This of course also leads to an important methodological difficulty when trying to compare the results from different studies since bilingualism can not only be defined in different ways, but even the same type of bilingualism can be measured in different ways. For example, proficiency in a spoken first and second language can be measured with self-ratings, or ratings by a professional or by a parent. It can also be measured with objective language tests where the person's ability to produce language is evaluated based on various objective criteria (accent, grammar, vocabulary, etc.). As for exactly which measurement is appropriate to measure bilingualism, not only will it depend on which bilingualism criteria that are used in a given study, it will also depend on certain characteristics of the population such as the age of the participants and the languages that they speak.

Due to the simplicity, cost and practicality of using self-assessments, such measurements are frequently used in bilingualism research. There are clear advantages with tests that are based on self-reports or assessments from a respondent that is close to the participant. To begin with, they are quite affordable as they often require elementary resources (paper and pen, or a digitalized questionnaire) and no special training. They are easy to administer to the participants and can be easily modified to suit various needs. When it comes to estimations of one's own ability in a first and second language, it has also been found that these measurements correlate somewhat with more objective language measurements, albeit far from strongly (e.g., Gollan, Weissberger, Runnqvist, Montoya & Cera, 2011; Sheng, Lu & Gollan, 2014). However, like any other self-assessment procedures, language self-ratings have their limitations. For a concept such as bilingualism, there can be large individual variance in how the term is understood, and what standard people compare their own abilities to. Furthermore, given the panoply of different factors that are related to bilingualism, self-assessment questionnaires often fail to cover all of them. Ideally, the research community would benefit from having a well-designed and thoroughly validated self-assessment tool that covers all important aspects of bilingualism in several languages. But this is not an easy task given the nature of bilingualism and how much it varies.

On the other hand, objective tests can address issues of subjectivity by quantifying different aspects of language (be it for production or reception of

the language) and measure those aspects with validated reliable tests. Such an example for receptive vocabulary that is frequently used is the Peabody Picture Vocabulary Test (PPVT: Dunn & Dunn, 2007). Such an objective test, which in this case measures receptive vocabulary, offers several advantages. For instance, a participant's score can quantitatively be compared to established norms and the participant's own subjective interpretation of the questions does not affect the results as there are definite right or wrong answers. However, a given objective test will not necessarily measure a specific aspect of bilingualism that is interesting for a given study. For instance, while the Multilingual Naming Test (Gollan, Weissberger, Runnqvist, Montoya & Cera, 2011) is useful to measure dominance, it is not as suitable to measure receptive vocabulary as for example the PPVT is. Since such tests are often expensive, timely, and may require special training, using a battery of several objective tests in reality is often unfeasible. Especially within a bilingual context, it may be difficult to use objective tests in practice due to the plethora of second languages one can encounter. For instance, in a French-English society where all participants are French-English bilinguals, the use of an objective test available in both languages that measures language dominance (given that this is the factor that is interesting) to objectively measure the participants' bilingualism may be achievable. On the other hand, in a mainly monolingual society where the first language is the same for all participants, but where the second languages vary, it is practically nearly impossible to test all participants' knowledge of their second language objectively. This would not only require the test to be available in a variety of languages, it would also in some instances require that the person administering the test knows those languages as well. Furthermore, factors such as the participant's age, gender, intellectual quotient, attitude, memory, and even the context of testing can all affect how respondents will answer objective tests as well (Edwards, 2013). It is questionable whether the advantages of objective tests outweigh their limitations. Furthermore, even though self-ratings may not be as accurate as objective tests, they can still be accurate enough to be useful in research. Besides, one can wonder if a highly accurate instrument is that much better when in reality it can be applied in a very limited number of situations. I may well buy myself a flour specific kitchen scale with which I can weigh the flour to put in my cake down to the microgram, but if I need a team of engineers to run my scale, I will end up baking less often. A regular kitchen scale with which I can weight any ingredient at the press of a button will be much more convenient and will



therefore most likely result in many more culinary wonders than if I owned a high-precision microgram flour-only scale.

Finally, regardless of the type of test that has been used, there has been a tendency to categorize participants into monolinguals or bilinguals based on the scores obtained on the scale that was used. This can be problematic however. First, although there are a few cases of “pure” monolinguals and “pure” bilinguals, these are incredibly rare (Grosjean, 2010). Although a few individuals can be found at each end of the scale, the remaining people fall somewhere in-between. Only studying individuals on each end of the scale would be fruitless and would leave a large population of individuals, many of which are in fact monolingual or bilingual, outside of investigations. Thus, participants falling in-between the two extremes of the scale are nevertheless usually labeled as monolingual or bilingual. This method is much more inclusive, but unfortunately raises another issue. Namely that bilingualism is not a categorical variable (Bialystok, 2001) and dividing participants into fabricated groups may lead to as much variation within, if not more, as between the groups. For this reason, it is increasingly suggested that one should treat bilingualism as a continuous variable rather than a categorical variable (e.g. Kaushanskaya & Prior, 2015; Luk & Bialystok, 2013), which is more likely to reflect the language profile of the participant.

In short, as it is now, there is no ultimate and universal way to measure bilingualism. Regardless of the measurement that is used, there will be shortcomings which are important to take into account. Of course, depending on the type of question and methodology, some of those shortcomings will be more concerning than others. This is why each measurement’s strengths and limitations should be weighed against each other within the specific context of the study. Just as the definition of bilingualism will vary from study to study, which measurement one should choose to measure the concept with will depend heavily on the empirical question and obviously on the way bilinguals are defined.

## Emotions

Within research on emotion, there are several theories that attempt to explain how emotions are perceived and identified. Amongst these various theories, the constructionist theories of emotion argue that emotions are constructions that are built out of various basic psychological processes (e.g., Barrett, 2017; Barrett & Russell, 2015; Herschbach & Bechtel, 2015; Lindquist, 2013). Within the constructionist theories, some even argue that one of these building blocks of emotion is language, which not only contributes to the acquisition of

emotion concepts, but also shapes the perception of emotions (e.g., Barrett, Lindquist & Gendron, 2007; Lindquist, Barrett, Bliss-Moreau & Russell, 2006; Lindquist & Gendron, 2013; Lindquist, MacCormack & Shablack, 2015). Meanwhile, studies also show that there is much overlap between the neural networks of a bilingual's languages and that both languages can be activated simultaneously, even when only one language is used in a monolingual context, at least when full proficiency in the second language is not reached (e.g., Abutalebi & Green, 2007; Liu & Cao, 2016; Marian & Spivey, 2003; Marian, Spivey & Hirsch, 2003; Thierry & Wu, 2007, Zhang, van Heuven & Conklin, 2011, but see Costa, Pannunzi, Deco & Pickering, 2016 for an alternative explanation of some behavioural findings). Based on these premises, it is reasonable to inquire whether having more than one language, given that they share neural networks and can be activated simultaneously, may have an effect on how emotions are constructed during perception. There are indications that are in fact pointing into that direction. For instance, Alvarado and Jameson (2011) found that Vietnamese-English bilinguals perceived and categorised the words for anguish and shame differently depending on which language they performed the task in. When tested in English, participants categorised the words at different ends on an arousal scale, as monolingual English speakers also do. When tested in Vietnamese however, both words were categorised on the high end of an arousal scale, as monolingual Vietnamese speakers also do, suggesting that bilinguals may perceive emotions differently, at least when using their different languages. In order to understand better how language, and perhaps even bilingualism, forms the perception of emotion, constructionist concepts will be presented in the section below. The role that language plays in the construction, perception and identification of emotions will be also presented in more detail.

### **Emotions from a constructionist perspective**

Intuitively, it may be believed that facial expressions allow the expression of one's inner feelings and reading others' internal state, as if there was a one-to-one relationship between facial expressions and inner state. Some even claim that facial depictions of emotion are used very early on by infants both to express their own emotional state (e.g., Izard, 1971; Izard, Huebner, Risser, McGinnes & Dougherty, 1980; Izard & Malatesta, 1987, but see Camras & Shutter, 2010 for a different view), and also to understand other's emotional state (e.g., Hoehl & Striano, 2010; Montague & Walker-Andrews, 2001, but see Shutter & Camras, 2010 for a different view). According to nativist theories of emotion such as the Basic Emotion Theory (e.g. Ekman, 1992 & 1993; Ekman & Friesen, 1971) and the Differential Emotion Theory (Izard, 1971; Izard &

Malatesta, 1987), there are a limited number of discrete basic emotions that can be universally recognized from birth. For instance, the Basic Emotion Theory claims that across all cultures and languages, facial depictions of happiness, anger, sadness, disgust, surprise, and fear can be innately recognized (Ekman & Friesen, 1971). Furthermore, the Differential Emotion Theory claims that facial depictions of these six basic emotions along with contempt and interest, can even be produced from infancy (e.g., Izard et al., 1980). Although there seems to be a large body of research supporting these claims and theories, some studies have failed to support such statements (Camras & Shutter, 2010). For instance, in a review by Russell (1994), the author concluded that the early results supporting the Basic Emotion Theory may not be as robust as was believed. Russell raised a few critical methodological issues with the early studies, such as the problem of using forced-choice responses and caricatures of facial instances of emotion in these studies (caricatures being defined as pictures or representations of a facial instance of an emotion that is portrayed by actors or trained individuals with specific muscle movements and at its full intensity [Barrett, Lindquist & Gendron, 2007]). When these issues are considered, the results are not as robust and a larger degree of variation across cultures emerges. Alternative theories, such as the Dialect Theory of Emotions, which stem from nativist theories of emotions, have attempted to explain the cultural variation that is found without refuting the universality of emotions. According to the Dialect Theory of Emotions, the language of emotions is universal, but just like a language it may have several dialects as emotions are expressed with cultural differences (Elfenbein, 2013; Elfenbein & Ambady, 2002; Elfenbein & Ambady, 2003; Elfenbein, Beaupré, Lévesque & Hess, 2007; Hess, Thibault & Lévesque, 2013). To make an analogy with languages, English is a language that is understood by English-speakers around the world. However, there are several dialects of English (American, British, South-African, Indian, Canadian, Australian, Caribbean, etc.). While speakers of any of those English dialects will be likely to understand each other, understanding of their own dialect will be easier, and interpretation mistakes will be more likely when interacting with a speaker of another dialect. Similarly, according to the Dialect Theory of Emotions, emotions will quite accurately be inferred universally due to their similarities, but there will nonetheless be an in-group advantage within the own dialect due to the particularities of each culture (Elfenbein, 2013; Elfenbein & Ambady, 2002; Elfenbein & Ambady, 2003; Elfenbein, Beaupré, Lévesque & Hess, 2007; Hess, Thibault & Lévesque, 2013). Although this theory highlights the variation that is found across cultures, it

in part shares some of the limitations of the nativist theories of emotions (Elfenbein, 2013; Elfenbein & Ambady, 2002; Elfenbein & Ambady, 2003; Elfenbein, Beaupré, Lévesque & Hess, 2007; Hess, Thibault & Lévesque, 2008). Additionally, none of the theories described above give language a central place in the perception of emotions, as constructionist theories do. While the Dialect Theory would be appropriate for instance if the subject of this thesis had been the influence of culture and biculturalism on the perception of emotions, the aim here is to investigate how having more than one language potentially influences the perception of emotions. Hence, none of the theories described above provide a suitable theoretical framework since language is not a major element of any of them.

Meanwhile, the constructionist theories of emotion suggest that a specific instance of an emotion consists of bodily states and movements (affect), external sensations (exteroceptive sensations), and concept knowledge about emotions (e.g., Lindquist, 2013; Lindquist, Gendron, Barrett & Dickerson, 2014; Lindquist, MacCormack & Shablack, 2015; Wilson-Mendenhall, 2017). Consequently, the occurrence of an emotion cannot be boiled down to discrete universal basic emotions which we can innately perceive and that are hardwired into our brains. The constructionist perspective argues that facial cues and our own internal sensations will not be sufficient unless we also have what is termed as concept knowledge of that emotion (Barrett, Lindquist & Gendron, 2007). Specifically, a discrete emotion can be recognized when affect (e.g., feeling one's racing heart and sweaty palms, or feeling high arousal and positive valence), and exteroceptive sensations (e.g., seeing an oxygen mask drop in front of you from the compartment above your head when sitting on an airplane during a flight, or seeing someone smiling with raised eyebrows and wide-opened eyes at their surprise birthday party), are combined with concept knowledge about different emotional categories (e.g., about fear, or about surprise; Lindquist, MacCormack & Shablack, 2015). The perception of discrete instances of emotion is created out of these three building blocks, all of which are necessary, and none of which is sufficient on its own (Lindquist, MacCormack & Shablack, 2015). Emotions, like other experiences, are context-specific and there is increasing evidence that the neural systems that interact when an emotional phenomenon is experienced are not specific to emotions (Wilson-Mendenhall, 2017). Since instances of emotions tend to occur in similar situations both within and across individuals however, we tend to group them as "basic emotions", which in fact are categories that we create rather than objective emotions per se (Wilson-Mendenhall, 2017). However, because emotions vary with each individual and situation, it is important

according to this view to study variation in emotional repertoires (Wilson-Mendenhall, 2017). Indeed, people differ in how well they can experience or discriminate between different instances of emotions, which is tokened as emotion granularity or emotion differentiation within the constructionist framework (e.g., Barrett, Gross, Christensen & Benvenuto, 2001; Kashdan, Barrett & McKnight, 2015; Nook, Sasse, Lambert, McLaughlin & Sommerville, 2018; Wilson-Mendenhall, 2017).

When it comes to affect, what is meant is the levels of arousal and valence that we experience from our own body (e.g., Barrett, 2017; Lindquist, 2013; Lindquist, MacCormack & Shablack, 2015). Affect changes and varies to help us compare various instances and understand the world around us as good or bad, and as something that we should want to approach or avoid (e.g., Barrett, 2017; Lindquist, MacCormack & Shablack, 2015). As for exteroceptive sensations, they come from the external world and they are perceived via our senses (vision, audition, taste, olfaction, and proprioception; Barrett, 2009). Exteroceptive sensations can relate to perception of physiological states in others such as a smiling face, or they can also be about the environment or context of a given situation, for instance sitting on an airplane while it is in the air (Lindquist, MacCormack & Shablack, 2015). Finally, concept knowledge is our gathered knowledge about a given category, which can be an emotion or not (Lindquist, MacCormack & Shablack, 2015). It consists of disparate and numerous instances that belong to a given category, such as a discrete emotion. They are acquired through first-hand experience of the category and via instrumental learning from other people (Lindquist, MacCormack & Shablack, 2015).

Importantly, concept knowledge is relative and culturally formed (Lindquist, MacCormack & Shablack, 2015). For instance, before moving to Sweden many years ago, my concept knowledge of the category “a delicious breakfast” included instances of bacon and eggs, pancakes with maple syrup, French toast, and donuts (all oh so healthy and good for you). After moving to Sweden, my concept knowledge of the category “a delicious breakfast” has been influenced by my new culture and experiences, and my concept knowledge of the category “a delicious breakfast” has changed to include crispbread with boiled eggs and Kalles Kaviar, but to exclude the (still delicious) Tim Horton’s maple dip donut from that category. An important point raised by some constructionist theories is that this concept knowledge will guide and form perception of the world, and, even in the case of emotions, will shape how affect and exteroceptive sensations are interpreted, (a notion called situated conceptualization: Lindquist, MacCormack & Shablack, 2015).

So emotions, just like breakfast food, do not exist out there as discrete emotions (or absolute and intrinsic breakfast-worthy food) independently of our constructions. Rather, they are what constructionists refer to as nominal kind categories that exist within the context of a culture that agrees upon which features the elements of a category share (Lindquist, MacCormack & Shablack, 2015). In other words, facial muscular movements which are commonly called facial expressions of emotion for instance, are more likely to be some sort of cultural symbols that are agreed upon within a given culture and used for communication, than being a representation of one's inner state and emotions (Lindquist & Gendron, 2013). This is why a smiling face in a cooperative context will be interpreted differently from the same smiling face in a competitive context (e.g., de Melo, Carnevale, Read & Gratch, 2013).

Furthermore, some constructionist perspectives even suggest that language plays a central role both in the construction of concept knowledge and in the perception of instances of emotions as it acts as the "glue" that holds together an emotion's elements (Lindquist, MacCormack & Shablack, 2015). Language is central in the development of concept knowledge about emotions as shown by studies on emotional communication between caregivers and children. Caregivers' emotional vocabulary and use of emotional words correlates with their child's emotional vocabulary (e.g., Cervantes & Callanan, 1998; Dunn, Bretherton & Munn, 1987; Dunn, Brown, Slomkowski, Tesla & Youngblade, 1991; Saarni, 1999; Yehuda, 2005). Even caregivers' attitude towards emotion, which most likely mediates how much they talk about emotions with their child, correlates with the child's emotional vocabulary (e.g., Castro, Halberstadt, Lozada & Craig, 2014; Dunsmore & Halberstadt, 1997; Gottman, Katz & Hooven, 1996; Hakim-Larson, Parker, Lee, Goodwin & Voelker, 2006). Furthermore, children of parents with alexithymia (a subclinical condition where an individual has difficulty identifying, expressing, and understanding feelings and even find it difficult to tease apart feelings from their somatic components [Parker, Taylor & Bagby, 1989]), also show an impoverished emotional vocabulary which consequently makes them more likely to have alexithymia as young adults (e.g. Fukunishi & Paris, 2001). Thus, language appears to play a role in the formation of emotional categories during childhood, and most likely in the constant development of concept knowledge about emotion throughout adulthood as well (Lindquist, MacCormack & Shablack, 2015).

Furthermore, language also plays an essential part when children learn to identify instances of emotion. As mentioned earlier, constructionist perspectives stipulate that when only a bottom-up processing occurs (e.g.,

looking at a face displaying what is commonly named a facial expression), the stimulus will remain ambiguous unless a top-down processing, (which is necessary to perceive, or construct, discrete instances of emotions) also occurs (Gendron, Lindquist, Barsalou & Barrett, 2012). The perspective suggests that language is one of these top-down processes. Language acts as the binding compound that holds together the panoply of disparate signals and cues into a single emotion category that we recognize as a discrete emotion (Barrett, Lindquist & Gendron, 2007), just like cement is the binding compound that holds together aggregates and water (which otherwise do not have much in common) that form concrete (which only aggregates and water on their own cannot create). In short, without language, we can experience valence and arousal but not a discrete emotion as such (Lindquist, MacCormack & Shablack, 2015). In other words, according to a constructionist perspective, language first helps us to make sense out of all of the inputs and sort them into neat and distinct categories, and afterwards guides our perception of our surroundings based on these labels that are assigned to each and every one of the categories (Lindquist, MacCormack & Shablack, 2015). Our concept knowledge and the words associated with it help us perceive the world in a way that makes it fit into our categories. There is indeed a large body of research emerging from different areas that supports the idea that language guides perception, which is what we will now turn to.

### **Language and perception of emotions**

Language shapes perception in many ways. For instance, colour perception (e.g., Davidoff, 2001; Davies & Corbett, 1997; Mo, Xu, Kay & Tan, 2011; Roberson, Davies & Davidoff, 2000; Roberson, Pak & Hanley, 2008), visualization of spatial location (Levinson, 1996; Levinson, Kita, Huan & Rasch, 2002; Pederson et al., 1998), time perception (e.g., Bylund & Athanasopoulos, 2017; Casasanto & Boroditsky, 2008; Li, Jones & Thierry, 2018), perception of motion and speed (e.g., Bylund & Jarvis, 2010; Meteyard, Bahrami & Vigliocco, 2007), categorization of objects (e.g., Ji, Zhang & Nisbett, 2004), olfactory perception (e.g., Cain, 1979; Majid & Kruspe, 2018; Olofsson & Wilson, 2018) and visual search for abstract objects (e.g., Lupyan & Spivey, 2010; Lupyan & Ward, 2013) are influenced by the perceiver's language and language cues. When it comes to perception of emotions in particular, there is neurological evidence showing that several language networks are activated during perception of emotions as well (Barrett, Lindquist & Gendron, 2007). Although not conclusive on its own, this neurological evidence is also supported by studies investigating emotion perception in patients with semantic dementia. Semantic dementia is associated with a loss of

understanding of semantics even though the patient does not show other language impairments in vocabulary. When asked to sort pictures depicting traditional caricatures of facial instances of emotions, these patients are unable to sort the pictures into emotional categories, but their ability to perceive affect remains intact so that they are instead able to sort the pictures based on affect (i.e., valence and arousal: Lindquist, Gendron, Barrett & Dickerson, 2014). In other words, without the semantic meaning of labels for discrete instances of emotions, patients with semantic dementia can still perceive affect, but cannot tease apart discrete instances of emotions within the same valence. This is probably because they have no concept knowledge about various instances of emotions due to the lack of semantics which is needed to bond and hold the categories together, in fact in a quite similar manner as younger children who have not yet learned emotional labels (see below).

More evidence in favour of the notion that language shapes the perception of discrete instances of emotions can be found in studies where the semantic satiation paradigm is used with emotional words (e.g., Gendron, Lindquist, Barsalou & Barrett, 2012; Lindquist, Barrett, Bliss-Moreau & Russell, 2006). In the semantic satiation paradigm (for reviews on semantic satiation, see Black, 2004 and Esposito & Pelton, 1971), a participant has to repeat a word out loud for either three or 30 times. While repeating a word three times leads to priming, repeating a word 30 times leads to semantic satiation, meaning that the repeated word momentarily loses its semantic meaning. When shown a word or object that belongs to the same category as the repeated word, the performance of the participants who repeated the word 30 times is impaired. When the semantic satiation paradigm is used with emotion words along with facial depictions of emotions, a satiation effect is observed (e.g., Gendron, Lindquist, Barsalou & Barrett, 2012). For instance, when a participant is asked to repeat the word "anger" 30 times and is then tasked to determine whether a displayed facial depiction of emotion matches the word that was repeated, response latencies increase (e.g., Lindquist, Barrett, Bliss-Moreau & Russell, 2006). This effect still holds even when the participants are not required to refer to the satiated word, which could otherwise lay behind the increased response latencies. For instance, in a task where participants are asked to determine whether or not the same emotion is depicted by two different faces after an emotion word has been satiated, larger response latencies are found (e.g., Lindquist, Barrett, Bliss-Moreau & Russell, 2006). Furthermore, even accuracy is impaired by semantic satiation when participants are forced to make a decision as quickly as possible when asked to determine whether two



different faces depict the same instance of an emotion after semantic satiation (e.g., Lindquist, Barrett, Bliss-Moreau & Russell, 2006). The fact that temporarily impaired access to the semantics of a relevant emotion word impedes emotion perception suggests that language is a key factor in the perception of emotions and that facial information alone is not sufficient.

Another example of how language shapes the perception of emotion is found in studies where morphed faces of caricatures of emotions displaying two emotions equally (e.g., a morphed face displaying 50% anger and 50% happiness) are presented with an emotion word (e.g., Halberstadt & Niedenthal, 2001). For instance, when a morphed face displaying anger and happiness equally is presented along with the word “anger”, people will be more likely to perceive the face as angry (Halberstadt & Niedenthal, 2001). This effect has also been found when a neutral face was presented along with an emotion label, leading participants to perceive emotion in an otherwise emotionally neutral face. If indeed emotions were natural kinds with a unique and distinct facial representation with specific muscular activation, the morphed picture, which equally represents two typical instances of a facial depiction of an emotion or a neutral depiction, should not be affected by which label is attached to it.

As mentioned above, there is also a large body of research showing that young children can perceive affect and valence, but that they do not perceive discrete instances of emotions per se until they develop concept knowledge of discrete instances of emotions. The acquisition of concept knowledge about emotions coincides with the acquisition of emotional vocabulary, which in fact may help children to perceive discrete instances of emotions. Until children have the appropriate emotional labels in their vocabulary, they perceive emotions in terms of valence, namely, as more or less good or bad, and in relation to the level of arousal (Castro, Halberstadt & Garrett-Peters, 2016; Gross & Ballif, 1991; Morton & Trehub, 2001; Widen, 2013; Widen & Russell, 2002, 2003, 2008, 2010; Zieber, Kangas, Hock & Bhatt, 2013). When asked to sort picture displaying faces of different caricatures of instances of emotions (e.g., angry, happy, sad, disgusted, scared faces), children around 2 years of age will manage to sort the pictures based on valence (i.e., all negative pictures together, and all positive pictures together), but not according to discrete instances of emotions (e.g., Castro, Halberstadt & Garrett-Peters, 2016; Gross & Ballif, 1991; Morton & Trehub, 2001; Widen, 2013; Zieber, Kangas, Hock & Bhatt, 2013). Gradually however, they learn to distinguish between different emotions based on the categories that are built in the specific cultural context that they grow up in (Barrett, Lindquist & Gendron, 2007; Gendron,

Lindquist, Barsalou & Barrett, 2012; Lindquist, Barrett, Bliss-Moreau & Russell, 2006; Lindquist, Gendron, Barrett & Dickerson, 2014). It is only then that they can sort pictures displaying faces of different caricatures of instances of emotions (e.g., angry, happy, sad, etc.) into different piles, which occurs during a child's third or fourth year (e.g., Gross & Ballif, 1991, Székely et al., 2011; Wang, Lü, Zhang & Surina, 2014; Widen & Russell, 2002, 2003, 2008, 2010). Also, children have more difficulty matching different faces displaying caricatures of facial instances of emotions together than matching the same type of stimuli to a word, suggesting that words are helpful to make sense of otherwise ambiguous stimuli (Russell & Widen, 2002).

To conclude, based on such a constructionist view, language plays a major role in the perception of instances of emotions. It is central both when concept knowledge about emotions is being developed, and also when we form what we perceive in others and in the world around us. However, it is still unclear whether having more than one language will affect the emotion perception process, and if so, how. There are indications to suggest that it could since perception of for instance time (e.g. Bylund & Athanasopoulos, 2017) and motion (e.g. Meteyard, Bahrami & Vigliocco, 2007) varies as a function of the language that is used.

## Aim

The aim of this thesis is to investigate how emotions are perceived and identified by individuals as a function of their level of bilingualism. Bilingualism is and has been the norm rather than the exception on a global scale. Furthermore, language is known to be intertwined with cognition and emotion. Yet, most psychological studies on the perception and identification of emotion do not take language, and even less so bilingualism, into account. Based on a constructionist theory of emotion, bilingualism and the effect it may have on the perception and identification of emotions is an area that should be investigated further. However, little is known on the relationship between emotion and bilingualism. Thus, the aim of this thesis is to fill this knowledge gap by clarifying how some aspects of bilingualism could relate to the perception and identification of emotions.

This was achieved with three experimental studies. In the first study, the aim was to investigate whether the perception of emotion of visual stimuli would vary across young participants (4-year-olds) with different linguistic profiles (monolinguals, dominant bilinguals, balanced bilinguals). In the second study, the aim was to investigate the perception of emotion in speech (semantics and emotional prosody) as a function of the level of bilingualism in children aged 6-8 years. Finally, in the third study, the aim was to investigate the perception of visual and auditory stimuli within a social flexibility context in adult participants based on their level of bilingualism.

## **The empirical studies**

This thesis is built around three studies which can be found at the end of this work but will be explained and summarized in this section. Although all studies have used different designs and populations, they share a few common elements that were used differently across the studies to suit each of their purpose. These elements will be discussed in the General methods section before going into more details for each individual study in the Summary of studies section.

### **General methods**

Although the three studies differed from each other in many ways, they all shared the study of bilingual participants. Thus, how the participants were defined, selected and how bilingualism was measured will be presented in this section. Furthermore, although the designs and the tasks varied across the studies, they all had in common the use of emotional stimuli and the measurement of behavioural responses. This will also be presented in this section.

#### **Definition and selection of participants**

As was lifted in the introduction, there is no universal definition of a bilingual or bilingualism. I wrote that the definition varies in part to suit a specific study purposes, and this is essentially how the bilinguals in this thesis' studies were defined. The definition of our participants was largely based on how we chose to measure their bilingualism, which in turn was largely determined by which instrument we used to measure bilingualism. Each scale and how it was used will be described in more detail below, but I will first turn to the definitions and selection of participants.

In the first study, participants were divided into three groups: monolinguals, dominant bilinguals, and balanced bilinguals. Since our participants were relatively young (4 years old), we chose to use the degree of exposure to a second language to determine their linguistic profile. There were two main reasons why exposure, rather than use or proficiency, was used as our main criteria. First, we did not expect to find many bilingual children who were capable of producing both languages at that age in a northern Swedish context, which would have made it practically impossible to find enough balanced bilinguals in terms of use or proficiency. Secondly, it has also been shown that exposure to another language in and of itself can be sufficient to affect a child's development (e.g., Fan, Lieberman, Keysar &

Kinzler, 2016). Determining cut-off lines between groups can be a delicate and problematic undertaking. In this study, we thus chose to use the same cut-offs as were used in previous studies (Namazi & Thordardottir, 2010; Thordardottir, 2011), where bilingualism was also operationalised in terms of exposure to languages. More specifically, monolinguals were children who were exposed to their first language 95% of the time. In many countries, including Sweden, exposure to only one language is almost impossible due to media, traveling, immigration, etc. However, it is unrealistic to expect that a child who hears a song or a television program in another language should be considered bilingual. This 5% margin allowed for the categorization of these children as monolinguals nonetheless. As for the dominant bilinguals, they were children that were exposed to their first language at a rate between 61% and 94% of the time. Finally, balanced bilinguals were exposed to their first language at a rate between 40% and 60% of the time. All participants in the study understood Swedish, but Swedish was not the first nor necessarily their dominant language for all participants. None of the participants included in this study however had difficulties communicating in Swedish. The bilingualism score in the first study was based on some of the questions included in the Language Experience and Proficiency Questionnaire (LEAP-Q) developed by Marian, Blumenfeld and Kaushanskaya (2007), which is described in the section below.

In the second study, both exposure to languages and use of languages were used to operationalise bilingualism. The participants in this study were a bit older (they were between six and eight years old), by which time their linguistic skills had improved compared to 4-year-olds. Furthermore, the scale that we used provided more detailed information on both usage of and exposure to languages, allowing us to calculate a more fine-grained language score for each participant. However, instead of dividing participants into groups, we chose to treat bilingualism as a continuous variable. A main conceptual gain in analysing bilingualism as a continuous variable is its improved ecological validity. Bilinguals do not tend to fall into distinct and clear categories in the real world, and creating post-hoc categories may distort the participants' true language profile. Section C of the Language and Social Background Questionnaire for children (LSBQ-children, version 2.0) by Luk and Bialystok (2013) was used to compile the bilingualism score in this study. A more detailed presentation of this scale can also be found in the section below.

In the third study, bilingualism was also operationalised as a continuous variable. The population that was studied consisted of adults between the

ages of 18 and 68 years. Their bilingualism score was calculated by using the template developed for the revised version of the Language and Social Background Questionnaire (LSBQ: Anderson, Mak, Chahi & Bialystok, 2017). More information on the scale and the template can be found below. Because we wanted to replicate the results found in a previous study, we used the same criteria that were used in that study (i.e., Ikizer & Ramírez-Esparza, 2017). More specifically, the frequency of use of a second language and the proficiency in that second language were used to classify participants into a monolingual and bilingual group in the original study. Although we also used the frequency of use of a second language and the proficiency in a second language as variables, we left them on a continuous scale because of the conceptual gains it provides. Furthermore, in the study by Ikizer and Ramírez-Esparza (2017), a factor that they believed was important, but that they did not measure, was the frequency of code-switching. In order to investigate this rationale, we also used this criterion for our population. Thus, the bilinguals in the third study were defined based on three criteria that we treated as individual continuous variables: frequency of use of a second language, proficiency in the second language, and frequency of code-switching.

The age of the participants that were recruited in the different studies varies greatly and is based on the age at which the studied emotional phenomenon is substantially changing or particularly relevant. Thus, for the first study where the perception of facial depictions of emotions was the phenomenon of interest, we chose to study children that were 4 years old. It is around this age that children begin to tell apart and accurately identify facial depictions of emotion into discrete emotions (e.g., Gross & Ballif, 1991, Székely et al., 2011; Wang, Lü, Zhang & Surina, 2014; Widen & Russell, 2002, 2003, 2008, 2010). In the second study, we wanted to understand how bilinguals deal with the emotional prosody of words, and we thus chose to study children between the ages of 6 and 8 years. Before that age, children find it difficult to rely on the emotional prosody of an utterance in order to identify an interlocutor's emotional state. However, they gradually learn to use emotional prosody to understand the meaning that is communicated by their interlocutor and by the age of 10, most children can efficiently use emotional prosody to identify the emotionality of an utterance (e.g., Friend, 2000; Friend & Bryant, 2000; Solomon & Ali, 1972). In order to capture any potential developmental differences between monolinguals and bilinguals, we recruited participants that were going through this developmental stage. Finally, in the third study, we wanted to understand the perception of facial

and auditory emotional cues in terms of social flexibility. Social life is an important part of life throughout the lifespan, and since the concept has not been researched extensively, we chose to recruit adult participants as previously done in related studies.

### **Measurement of bilingualism**

As mentioned in the introduction, bilingualism has traditionally been used as a categorical variable. Participants often fall into the monolingual category or the bilingual category. At best, the bilingual category can have subdivisions such as low and high proficiency (e.g., Carlson & Meltzoff, 2008; Yow & Li, 2015), frequent and non-frequent code-switchers (e.g., Verreyt, Woumans, Vandelandotte, Szmalec & Duyck, 2016; Yim & Bialystok, 2012), early and late bilinguals (e.g., Blanco, Bannard & Smiljanic, 2016; Kapa & Colombo, 2013), dominant and balanced bilinguals (e.g., Hsu, 2017; Rosselli, Ardila, Lalwani & Vélez-Urbe, 2016; Woumans, Ceuleers, Van der Linden, Szmalec & Duyck, W., 2015; Yow & Li, 2015), which is what we used in the first study (although based on exposure). However, such categories are often arbitrary and there may be as much, if not more, variation within the groups as between the groups. This is of course problematic methodologically and conceptually as well since bilingualism is not a categorical variable in real life (Bialystok, 2001). Few people can be categorised as either monolingual or bilingual. Instead, most people fall somewhere on a range from more or less monolingual to more or less bilingual. Bilingualism within a given individual varies not only across situations, but also over time (Grosjean, 2010). People do not suddenly wake up bilingual, and unless one suffers a traumatic event, people do not tend to forget a language overnight.

In order to capture the continuous nature of bilingualism better, we chose to measure bilingualism in our participants as a continuous variable in the second and third studies. So instead of referring to our participants as monolinguals or bilinguals, we referred to their level of bilingualism. Level of bilingualism was in turn based on both exposure to languages and use. Although this measurement cannot capture all the variation found in bilingualism, it provides a more refined representation of the participants' bilingual status. The scales that we employed for the studies, and how they were used, are described below. All original scales were in English and our own translation to Swedish was used.

Different questionnaires were used in the three studies and will be presented below. In the first study, we were interested in exposure to a second language, which the LEAP-Q covered relatively well. However, in the second study, we aimed to gather more detailed information about our participants'

use of and exposure to languages. Since the LSBQ (Luk & Bialystok, 2013) is more comprehensive, and also because a version for children is available, this questionnaire was chosen. Finally, in the third study, we also wanted information about several aspects of our participants' language profile. Furthermore, the new version of the LSBQ (Anderson et al., 2017) was built so that a continuous score of bilingualism could be calculated. This also suited our purposes well, which is why this questionnaire was chosen for the third study.

### *LEAP-Q*

The LEAP-Q was developed by Marina, Blumenfeld and Kaushanskaya (2007) and has been validated in two different American adult populations with 52 and 50 participants respectively. It consists of self-report questions asking participants to provide the languages that they know in order of dominance as well as in order of acquisition, the percentage of the time that they are exposed to each language, to what percentage each of the languages are used for reading, communicating orally with others, and which cultures the participant identifies with. Furthermore, there are questions covering the age at which the participant began acquiring each language, at which age they became fluent, at which age they began reading in each language, and finally at which age they became fluent readers of each language. Moreover, participants are asked about longer periods of time (in terms of years and months) spent in different language environments (country, family, school/working environment), about their level of proficiency for each language, about the factors that contributed to their learning of the respective languages (interaction with friends, interaction with family, reading, self instruction, television, radio), and to what extent the participant is still exposed to each of those contributing factors. Finally, there are questions about how much of an accent the participant perceives having in each respective language, and how often s/he is identified as a non-native speaker based on the accent.

For our purposes, the questionnaire was adapted so that the questions about the child could be answered by a parent or legal guardian. Questions that were not relevant for 4-year-olds, for instance questions about reading, were not included. Since we were mainly interested in the exposure to the languages, exposure questions were primarily included in our adaptation of the LEAP-Q. Our version thus consisted of questions on which languages the child knew in order of dominance and in order of acquisition, the percentage of time the child was exposed to each language, the percentage of time each



language was used during playtime, the percentage of time the child chose a language to begin a conversation, how old the child was when s/he first listened to or started being exposed to the languages, in which environments languages were presented to the child, which factors had contributed to language learning (interaction with friends, with family and other relatives, later during early childhood with kindergarten staff, and also with different medias such as television, movies, etc.). The classification of our participants was subsequently based on the question regarding the percentage of time the child was exposed to each language (please refer to Study I for more details about the scale).

### *LSBQ-children*

The LSBQ children version is derived from the LSBQ for adults, which was developed by Luk and Bialystok (2013). The LSBQ was validated in an adult bilingual population of North Americans in a sample of 110 participants. All participants understood English but the other language that they spoke varied.

The questionnaire for the children's version consists of three parts and is designed to be filled out by a parent or legal guardian. In the first part, questions about the parents' country of birth and, if relevant, year and month of immigration to Canada, as well as language questions (which language(s) each parent spoke when growing up, as well as all the languages each parent knows in order of fluency) are asked along with a standard question on highest level of education achieved along with current occupation.

The second part of the questionnaire covers questions on the child's language experience. Namely, if the child understands a language (or other languages) other than English, parents are asked to list which language(s) the child understands along with the degree to which the child understands each language (from "poor" to "excellent" on a five steps scale). There is a distinction that is made in a subsequent question about the language(s) other than English that the child can speak. Here as well, languages are listed along with a rating of how well the child speaks each language (from "poor" to "excellent" on a five steps scale). This section ends with questions on whether the child attends any extracurricular language program (and if so how often), on which language(s) the child first spoke (English, other language, or both English and another language), and whether another relative such as a grandparent lives in the home (and if so, which language(s) this person speaks).

The third section of the questionnaire, part C, covers questions on language use by the child and the family. All questions in this section are

answered on a scale from 1 to 7 where 1 means that only English is used, 4 that English and another language are equally used, and 7 that only another language than English is used. The first block of questions covers the language(s) that the child uses to speak to different people (mother, father, siblings, maternal grandparents, paternal grandparents, other relatives, friends). The second block covers the language(s) used by the child for different activities (reading, listening to the radio or music, watching television or videos, using the internet). The third block consists of two general questions asking which language(s) the child uses overall to communicate at home, and within the community or local environment. The following blocks of questions cover the language(s) that are used in the child's environment mostly at home. First, questions about which language(s) is used by different persons (mother, father, siblings, maternal grandparents, paternal grandparents, other relatives, neighbours/friends/other caregivers) to address the child are presented. The following block of questions asks which language(s) are used between different people around the child (parents, siblings, maternal grandparents, paternal grandparents, other relatives, neighbours/friends). Finally, a block of questions regarding which language(s) is used in the home for various activities is asked (reading, listening to the radio or music, watching television or videos, using the internet, reading stories to the child).

This questionnaire was used in the second study. For our purposes, questions were translated to Swedish, the name of the first language was changed from English to Swedish, and the name of the country was changed from Canada to Sweden when they appeared in questions. Otherwise, the questionnaire was used as in its original version. More information on the scale can be found in Study II.

#### *Revised LSBQ*

The revised version of the LSBQ was developed and validated by Anderson, Mak, Chahi and Bialystok (2017). As the previous version of the LSBQ (Luk & Bialystok, 2013), it is a self-report questionnaire that is meant to be answered by participants themselves. It was validated in an adult population of North Americans in a sample of 605 participants. Of those participants, 147 could only speak English, and 458 had some knowledge of a language other than English (of which 241 were born outside of Canada or outside of a non-English speaking country). All participants understood English but the other language that bilingual participants spoke varied. A major addition to the revised LSBQ is the possibility to calculate a bilingualism score (named

Composite Factor Score) that can be either on a continuous scale, or that can be transformed into categories. The Composite Factor Score can be calculated automatically in an available spreadsheet where the participants' answers on each individual question is entered and then calculated with different weights based on the factor analysis that was performed during the validation of the questionnaire.

The questionnaire consists of a first part where various background questions are asked (occupation, handedness, whether the participant plays first-person shooting video games, hearing impairments, visual impairments, neurological impairments, parents' education and occupation, whether the participant was born in Canada, whether the participant has lived abroad in a non-English speaking country, etc.). The language background section of the questionnaire consists first of a question on the language(s) and dialect(s) that the participant can speak and understand, including English. These languages are to be listed in order of fluency, and for each language, the participant has to indicate where the language was learned (home, school, community, other), at what age it was learned, and whether there were periods of time in their life when they did not use each language. Then, participants are asked to rate their proficiency in English for speaking, understanding, reading and writing on a scale from 0 to 10 (no proficiency to high proficiency). The following question asks how often English is used to speak, listen, read, and write individually on a five step scale (from none of the time to all the time). The two following questions ask the same proficiency and frequency of use questions that were just described for questions about English, but concern the participant's second language.

The final section of the questionnaire covers community language use behaviour. All questions (except for the last block) are answered on a five step scale from "all English" to "only the other language" where the middle choice represents "English and the other language equally". The first block covers questions on the language that was heard or used during various life stages (infancy, preschool, primary school, high school). The second block covers questions on which language the participant generally uses when speaking to various people (parents, siblings, grandparents, other relatives, partner, roommates, neighbours, friends). The following block covers the language(s) that is used in various situations (at home, school, work, social activities, religious activities, extracurricular activities, shopping/restaurant, health care/government or public offices/banks). Finally, another block covers the language(s) that is used for various activities (reading, emailing, texting, social media, writing lists and notes, watching television or listening to the

radio, watching movies, internet browsing, praying). A last block covers the frequency to which the participant code-switches with different people (parents and family, friends, on social media) on a five step scale ranging from never to always.

This questionnaire was used in the third study. For our purposes, the questionnaire was translated to Swedish and the first language was changed from English to Swedish. The country of residence was also changed from Canada to Sweden. Furthermore, in a European context, it is not infrequent that people speak more than one second language. Therefore, for the second language questions, participants were instructed to rate or think of their strongest or most frequently used second language. Otherwise, we used the questionnaire as originally designed (except for the background questions, where we excluded questions that were not relevant to our study, such as questions on medication and head injury). Furthermore, since we were interested in three specific aspects of bilingualism (frequency of use of the second language, proficiency in the second language, frequency of code-switching), we used the questions that measured those specific aspects only rather than using the Composite Factor Score.

### **Emotional stimuli**

Throughout the three studies, a common feature of the stimuli was that it depicted instances of emotions, either visually, aurally, or both simultaneously. In emotion research, the use of what has been called caricatures is widespread. As mentioned earlier, a caricature is a picture or representation of a facial depiction of an emotion that is portrayed by an actor or trained individual with specific muscle movements and at its full intensity (Barrett, Lindquist & Gendron, 2007; Lindquist & Gendron, 2013). Similarly, a suggestion for a caricature of a vocal depiction of emotion could be a spoken utterance or sound representing an oral representation of an emotion that is performed by an actor or trained individual with specific sound modulations and at its full intensity. Based on these definitions, this is the type of stimuli that was used in studies of this theses. In study I, only visual stimuli were used, and in study II, only auditory stimuli were used. In study III, both visual and auditory stimuli were used. The databases that were used or, when the stimuli were created by us, how the stimuli were developed, are presented in this section.

#### *Visual stimuli*

In studies I and III, visual stimuli were selected from the Radboud Faces Database (RaFD; Langner, Dotsch, Bijlstra, Wigboldus, Hawk & van

Knippenberg, 2010). The RaFD consists of 8040 pictures portrayed by 67 different models (20 Caucasian male adults, 19 Caucasian female adults, 4 Caucasian male children, 6 Caucasian female children, 18 Moroccan male adults). Each actor portrays seven instances of emotion: happiness, anger, sadness, contemptuousness, disgust, fear, surprise, and also neutral. Each emotion is portrayed with different gaze directions: looking left, right and frontally. Finally, each picture is taken from five different angles: frontally, at 45 degrees on the left and right, and at 90 degrees on the left and right. Only the frontal view pictures were validated by 276 adult participants (each participant rated a subset of the pictures) on the following attributes: attractiveness of the model, the depiction that was portrayed, the intensity of the depiction, its clarity, its genuineness and finally its valence.

In study I, we selected a subset of 32 pictures for the experimental trials. They were portrayed by four different male and four different female adults. The emotions that were included were happiness, anger, sadness, and fear. Each picture was displayed only once during the trials. In study III, we selected pictures from the same database, but based our selection on genuineness of the emotion. Since caricatures of facial depictions of emotions have the disadvantage of being less frequent in everyday life (Barrett, Lindquist & Gendron, 2007), we attempted to increase the ecological validity of the stimuli by basing our selection on genuineness. A total of 8 pictures were selected. They were portrayed by two male and two female adults each displaying two emotions (happiness and anger). The stimuli pictures were presented several times, but always at the same frequency.

#### *Auditory stimuli*

Although auditory stimuli were used in both study II and study III, they were not selected from the same sources. For study II, the stimuli were produced by us in several steps. Since the material that was required for our design had to be semantically positive, negative or neutral in the mind of a child, and since there are no existing databases containing such words that were validated in a population of children in Swedish, we asked children to produce words based on several emotional categories (for the exact procedure, see Champoux-Larsson, Fjällborg & Dylman, submitted). Children aged 8 to 11 years produced words based on the design that was developed by Neshat-Doost, Moradi, Taghavi, Yule and Dalglish (1999). There were two important advantages in asking children to produce words of different valences rather than asking them to validate words from existing databases designed to be primarily used in adult populations. An issue with existing word databases is

that they are built by scanning various sources such as stimuli words used in previous studies, words found in books, newspapers, and/or on the Internet (e.g., ANEW: Bradley & Lang, 1999; DAL: Whissell, 1989; EMOTE: Grünh, 2016). However, such words will not necessarily be part of children's vocabulary. Furthermore, although some of databases have been validated on valence, they are validated by an adult population. A positive, neutral or negative word for a child is not necessarily the same for an adult. Thus, by asking children to themselves produce words that, for instance, made them happy or sad, or described satisfaction or fear, we could both make sure that the children understood the words and that the words had the right connotation valence-wise. Finally, although the database developed by Neshat-Doost et al. (1999) was available, it was in English and relatively outdated. A direct translation of words will not necessarily carry the same valence throughout languages, cultures and, in this case, generations. Thus, the method that we used had the final advantage of preventing differences in perceived valence due to linguistic, cultural and/or generational differences as well.

In a second step, we selected words from this bank of data based on the frequency at which they were produced (20 words for each type of valence were selected for a total of 60 words). The words' valence and arousal were rated by 26 independent raters using the Self-Assessment Manikin Scale (SAM; Bradley & Lang, 1994). Adult raters were selected for this task since the words that were being rated had already been produced by children and were all highly frequent in this age group. The 18 words (six from each of the categories positive, negative, and neutral) were then selected based on valence, and were matched on arousal, frequency, and number of letters.

In a third step, all 18 words were recorded by a male and a female native Swedish speaker in a positive (happy), negative (angry) and neutral manner. The valence of the recordings were then rated by independent raters until an inter-rater agreement of .8 was reached (recordings were re-recorded when non-satisfactory). Thus, the set of stimuli for study II consisted of 108 utterances, half of them with a female voice, and the other half with a male voice. A third of the utterances had a positive emotional prosody, another third had a negative emotional prosody, and the last third had a neutral emotional prosody.

For the purposes of study III, only the prosody could be emotional while the semantics had to remain neutral. Auditory stimuli were thus selected from the Juslin & Laukka 2001 database (Juslin & Laukka, 2001; Laukka, Juslin & Bresin, 2005). In this database, recordings of a neutral utterance (both as an

affirmation and as a question, namely “It is 11 o’clock.” and “Is it 11 o’clock?” respectively) are produced by eight actors, half of which utters the sentence in their native British English, and the other half in their native Swedish. Five different emotional prosodies are available in the database (happiness, sadness, anger, fear, disgust), all with low and high arousal. For our purposes, only the stimuli in Swedish for happiness and anger were selected, resulting in eight different audio clips from four different actors (two males and two females). The affirmative version of the recordings was used in the experimental trials. The recordings with low intensity were selected since they had been rated higher on their level of naturalness. To follow the same premises as for the selection of the visual stimuli, the criterion that was given most weight when choosing the stimuli was its ecological validity in order to reduce the methodological issues that the use of caricatures poses.

Importantly, for both study II and study III, a central criterion for the stimuli was that it should be produced by native Swedish speakers in Swedish. Although people are generally skilled at identifying the emotional prosody of utterances in a foreign language, or in a language that they do not understand, there is an in-group advantage (e.g., Paulmann & Uskul, 2014; Pell, Monetta; Paulmann & Kotz, 2009; Pell & Skorup, 2008). Furthermore, even when an utterance is altered so that the semantics are no longer perceptible, the in-group advantage remains (Pell, Monetta, Paulmann & Kotz, 2009; Pell & Skorup, 2008). Thus, there seems to be an important linguistic or cultural aspect in the correct identification of emotional prosody. Based on this knowledge, we chose to use only stimuli that were in the participants’ first language, which was Swedish for both study II and study III.

### **Measuring emotion perception**

In all three studies, behavioural data were used as dependent variables to measure emotion perception. The premise that behaviour (in the form of reaction times and accuracy for instance) can reflect various psychological processes has been used in psychology and other fields for decades (Heitz, 2014). When it comes to inferring an emotion from a visual and/or auditory stimulus, the rationale is that the faster an emotion is interpreted, the faster the reaction times will be. When using caricatures of instances of emotions, the “correctness” of the answer, namely accuracy, can also be measured.

Although we gathered reaction times and accuracy in all studies, we chose to analyse only accuracy (as opposed to both accuracy and reaction times) in the first two studies. There were large variations in reaction times between subjects in the child populations, and those differences were most likely caused by factors such as developmental differences and/or computer use

acquaintanceship. Furthermore, using reaction times as a measurement with children is problematic for other reasons. For instance, children tend to have a shorter attention span compared to adults and do not necessarily comply with instructions very well. Thus there was no time limit to provide a response in the children studies in order to gain more flexibility during the data collection. This has proven to be a good strategy since there were quite a few trials where reaction times were abnormally slow due to participants taking a toilet break, needing to blow their nose or starting a conversation on an unrelated subject with the experimenter, amongst other things. Although those types of trials could be removed from the analysis, in the first two studies this could have led to other problems. Since trials with relatively long response latencies were quite frequent, and because the studies with the children did not contain a large number of trials, the proportion of trials that would have been removed would have been large. Not having enough trials to compute mean values with would have resulted in the scores being less representative. Here it was judged more appropriate to investigate accuracy only, which was a more reliable behavioural measurement than reaction times.

For the third study however, all participants were adults and although there is also variation in computer use acquaintanceship, attention span and compliance with instructions, the variation is smaller. Furthermore, in the study with adults, more trials could be used. Thus, having to remove a few problematical trials out of a large number of total trials affects the total result considerably less. This allowed us to investigate both accuracy and reaction times in the third study. Also, in order to motivate participants to respond at the maximum of their capacity speed-wise, they were instructed to answer as quickly and accurately as possible. There was also a time limit of three seconds to provide an answer, after which it was too late to respond. Although such conditions may create a speed-accuracy trade-off, meaning that the faster the participants answer, the lower the accuracy is likely to be (e.g., Diederich, 1997; Förster, Higgings & Bianco, 2003; Wickelgren, 1977), this was not a major concern with our design. Accuracy rates in our study were high and similar to the accuracy rates found in other similar tasks with emotional stimuli. Finally, since an ability to switch between tasks was investigated in study III, we also used reaction times to create a switch-cost measure, which is the difference between the mean reaction time for trials that are preceded by a trial with the same task and the mean reaction time for trials that are preceded by a trial with a different task. This type of switch-cost measurement (called n-1 shift) has been shown to be the most reliable measure of switch-cost (Timmer, Calabria, Branzi, Baus & Costa, 2018).



## Ethical considerations

As with all research involving human beings, ethical issues must be taken into consideration. The studies presented below did not fall under the Swedish law which deals with ethical vetting of research involving humans. Regardless, an application was sent to the regional ethical review board for the first two studies to receive an official approval since our participants were children. Because research with young participants can raise concerns in their parents or caregivers, we wanted to take all possible precautions and measures to create a relationship characterised by trust. Furthermore, informed consent was obtained from participants in all studies. In the first two studies, written informed consent was obtained from the legal guardians and oral informed consent was obtained from the child. Naturally, the information provided to the children was adapted to their level of comprehension. In the third study, written informed consent was obtained from the participants. All data that were gathered were administered meticulously and in accordance with legislations.

Furthermore, aside from the actual legal aspects of ethics, participants were treated with care and respect. Especially when participants were children, great caution was taken to make sure that the participants themselves wanted to be part of the study and that they understood that it was voluntary. In some instances, children refused to participate, even though their caregiver had approved their participation in the study, and in other instances, participation was terminated when the child showed discomfort during participation. Although the experiments were presented to children as games, they were perhaps experienced as tedious by some of them. Great encouragement was therefore given to the participants in order to make their participation as enjoyable as possible. Furthermore, all participants were praised for their participation regardless of their performance, and were also rewarded with a small gift, even though they did not complete the whole experiment or refused to participate altogether. An age-appropriate debriefing was conducted with all participants to make sure that they did not have unanswered concerns. The third study included adults and did not contain any element that was likely to create distress. However, participants were clearly informed of their rights and compensated for their time with a movie ticket.

In all three studies, participants (or their parents or legal guardians) had the opportunity to leave their contact information (e-mail address) in order to be contacted with the results of the study at the group level. This allowed the participants and their children to receive more information and gain more

meaning for their contribution. The contact information was also administered meticulously and in accordance with legislations.

## Summary of studies

In this section, the most relevant elements of each study will be presented along with the key analysis and results.

### Study I

Champoux-Larsson, M.-F., Dylman, A. S., Örnkloo, H., & Esteves, F. (2018). Identification of facial expressions of emotion by 4-year-old children from different linguistic environments. *International Journal of Bilingualism*. Advance online publication. doi:10.1177/1367006918781069

#### *Background and aim*

At an early age, emotions are perceived based on their valence (positive or negative) and on their arousal (low or high; Castro, Halberstadt & Garrett-Peters, 2016; Gross & Ballif, 1991; Morton & Trehub, 2001; Widen, 2013; Zieber, Kangas, Hock & Bhatt, 2013). It is only later during childhood that children begin to classify facial depictions of emotions into distinct categories with a specific label attached to them (e.g., Gross & Ballif, 1991, Székely et al., 2011; Wang, Lü, Zhang & Surina, 2014; Widen & Russell, 2002, 2003, 2008, 2010). This part of development coincides with language development. More specifically, during this period of development, children's emotional vocabulary increases. Although it may be intuitive to claim that language allows children to express what they perceive, an alternative explanation based on empirical findings is that language provides children with the necessary tools to distinguish between discrete emotions (e.g., Barrett, Lindquist & Gendron, 2007; Lindquist, MacCormack & Shablack, 2015; Roberson, Damjanovic & Kikutani, 2010; Russell, 1994; Russell & Bullock, 1986). In other words, the emotional vocabulary may guide and shape perception to turn ambiguous facial depictions that are either positive or negative, and high or low in arousal, into discrete emotional categories.

As for children growing up with two languages, it has been suggested that they tend to outperform their monolingual peers on various tasks recruiting executive functions (see Barac, Bialystok, Castro, & Sanchez, 2014, for a review of the effects of bilingualism on the cognitive development of young children). However, it is not known if and how growing up with two language systems will affect their emotional development as well. Since the development of executive functions and emotion understanding correlate strongly (e.g.,

Blankson, O'Brien, Leerkes, Marcoitch & Calkins, 2012; Hughes & Ensor; 2009; Leerkes, Paradise, O'Brien, Calkins & Lange, 2008; Martins, Osório, Veríssimo & Martins, 2016), it is possible that the emotional development of bilingual children may differ on some aspects. In line with this idea, other studies show that children exposed to a bilingual environment tend to outperform peers growing up in a monolingual environment on various social-cognitive tasks. For instance, bilingual children have been found to be better at using paralinguistic cues such as direction of gaze to understand the intent of another person (e.g. Yow et al., 2017). Although they are better at social perception tasks, it is not known if they also will be better at distinguishing facial depictions of emotions, which also recruits executive functions, perception, and social skills. The aim of this study was thus to investigate if children coming from different linguistic environments would differ in the development of their ability to identify facial depictions of emotions.

#### *Method and analysis*

In order to do so, we asked 84 4-year-olds to identify the emotion portrayed on still pictures of facial depictions of emotions (happiness, anger, sadness, fear). This age group was chosen based on the fact that previous research has shown that it is at around this age that children can identify happiness and anger quite well and begin to categorise sadness and fear into discrete emotions (e.g., e.g., Gross & Ballif, 1991, Székely et al., 2011; Wang, Lü, Zhang & Surina, 2014; Widen & Russell, 2002, 2003, 2008, 2010). The participants came from different linguistic environments based on exposure to languages and could be either monolingual, dominant bilingual or balanced bilingual. Monolinguals were exposed to a first language only, or only marginally exposed to a second language (at a rate of maximum 5% of the time). Dominant bilinguals were exposed to their first language significantly more than to their second language (between 61 and 94% of the time), while balanced bilinguals were exposed to both their languages virtually equally (between 40 and 60% of the time).

The children were presented with 32 pictures of males and females expressing caricatured facial depictions of happiness, anger, sadness and fear and had to identify the emotion that was displayed by clicking one of the four answer icons where each facial emotion was represented by a cartoonish illustration. Each correct answer was given a score of 1, and each erroneous answer was given a score of 0. Those scores were analysed with a mixed-design ANOVA with group (monolinguals, dominant bilinguals, balanced bilinguals) and emotion (happy, angry, sad, scared) as independent variables.

Furthermore, in order to better understand the mistakes that were made, we analysed them based on their valence. More specifically, we analysed how many of the answers on the erroneous trials were within the same valence (e.g., answering “angry” when the correct answer was “sad” or “scared”), and how many were cross-valence (e.g., answering “happy” when the correct answer was “angry” or “sad” or “scared”). A one-way between-group MANOVA was performed with group (monolinguals, dominant bilinguals, balanced bilinguals) as the independent variable and type of mistake (within-valence, cross-valence) as dependent variables.

### *Results and conclusions*

We found a main effect of emotion that replicated earlier findings, namely that happiness was the easiest to identify for a 4-year-old, followed by anger, and by sadness and fear equally. However, we did not find any difference between the groups. In other words, the linguistic profile of the participants had no effect on their performance. As for the analysis of mistakes, the results were not statistically different between the groups, even if the balanced bilinguals made only 1.58% of cross-valence mistakes, compared to 3.38% and 3.5% for monolinguals and dominant bilinguals respectively. Thus, based on our results, we cannot claim that the linguistic environment a child grows up in will affect the development of identification of facial depictions of emotions.

However, our result cannot rule out this possibility altogether. Indeed, it may be so that the task that the children performed was too simple. To begin with, when given labels to identify discrete emotions, participants’ accuracy is much higher than when they have to name an emotion by choosing labels of their own (e.g., Lupyan & Spivey, 2010). In other words, in a task such as ours, providing participants with labels is likely to boost their performance (Lindquist & Gendron, 2013). In this study, as in many other studies investigating instances of emotions in faces, the appropriate emotion labels are provided to the participants and may thus create a context where the participant’s perception is formed by these labels (Lindquist & Gendron, 2013). This naturally contributes to higher accuracy compared to when free labeling is used. However, free labeling may not be appropriate in this population since 4-year-olds are in the process of gaining vocabulary, and also because bilinguals tend to have a smaller vocabulary in each of their individual language separately (Bialystok, 2001; Pearson & Fernández, 1994; Poulin-Dubois, Bialystok, Blaye, Polonia & Yott, 2013), which would put them at a disadvantage. Asking 4-years-old to freely label facial depictions of emotions would thus probably not reveal the children’s true understanding

and perception of emotions. On the other hand, a task where children are asked to sort different depictions of emotions, or even a task where they are simply asked to determine whether two depictions of emotions are the same or different, even when using caricatures, would allow investigating whether the language profile of a child affects his or her perception of emotions.

This study could also be modified by testing the participants with a different task that requires solving conflict. Bilingual children tend to perform similarly to monolinguals in tasks that are simple and where there is no conflict of information (like in our task). However, when tasks become more difficult and when an element of conflict is introduced, a bilingual difference is often found (e.g., Costa, Hernández, Costa-Faidella & Sebastián-Gallés, 2009; Yow & Li, 2015; Yow et al., 2017; Yow & Markman, 2011a). A way to achieve this with this study would be for example by asking children to interpret facial depictions of emotions in a conflicting environment (e.g. a happy person in a scary environment). This would allow us to gain a more detailed understanding of bilinguals' perception of emotions visually within a given context.

Furthermore, a different choice of stimuli where caricatures of instances of emotion would not be used could also lead to a more fine-grained understanding of children's perception and understanding. It is possible that the caricatures that were used were too representative of culturally determined facial depictions of discrete emotions, and that differences could be found if less caricatured stimuli were used. Indeed, when categorizing prototypes and caricatures, there is a clear categorization advantage for caricatures compared to prototypes, meaning that caricatures are more easily categorized than prototypes, even though a prototype should by definition be more common than a caricature (Goldstone, Setyvers & Rogosky, 2003). Another alternative would be to use caricatures but of different cultures (i.e., out-group caricatures). Since out-group caricatures are representative for other cultures' norms, their use may limit the in-group advantage (and hence ceiling effect) that is caused by using caricatures based on the perceiver's own culture.

Moreover, the categorization advantage is enhanced when a label is attached to a caricature (Goldstone, Setyvers & Rogosky, 2003), which is what we did in study I, and which is what many studies within emotion research have done as well (which has often been taken as support for the notion of universal basic emotions). To sum up, although our results cannot support the idea that the linguistic environment of a child will affect the development

of the perception and identification of facial depictions, more research should be conducted before this can be completely ruled out.

## **Study II**

Champoux-Larsson, M.-F., & Dylman, A. S. (2018). A prosodic bias, not an advantage, in bilinguals' interpretation of emotional prosody. *Bilingualism: Language and Cognition*. Advance online publication. doi:10.1017/S1366728918000640

### *Background and aim*

Emotions can be expressed in many different ways, be it visually with facial depictions of emotion, tactilely with a hug, a push or a caress, as well as orally with words or noises (e.g., a laughter, a grunt or a gasp). When it comes to speech, not only semantics (the words that are uttered) can be used to express an emotional state, but emotional prosody (that is the tone of voice used to utter the words) can be used to convey the message (e.g., Hall & Schmid Mast, 2007; Kruger, Epley, Parker & Ng, 2005). Although the semantics and emotional prosody can be congruent (e.g., saying "I am so scared!" with a scared tone of voice), they can at times also be discrepant (e.g., saying "I am so scared!" with a playful tone of voice). If the semantics and emotional prosody do not match, the listener's task becomes more difficult when trying to understand the speaker's emotional state. Nonetheless, to efficiently interpret and understand paralinguistic cues such as emotional prosody is an important social skill (e.g., Schroeder, Kardas & Epley, 2017) which allows us to, amongst other things, detect lies, appreciate jokes, and understand sarcasm.

However, this skill is not innate but has to be learned. Until the ages of 8-10 years, children tend to rely mainly on the semantics of utterances in order to understand the emotional message, even when the emotional prosody is discrepant, a phenomenon called the semantic bias (e.g., Friend, 2000; Friend & Bryant, 2000; Solomon & Ali, 1972). On the other hand, a study by Yow and Markman (2011b) found that bilinguals as young as 4 years do not show a semantic bias and can identify the emotional prosody of spoken discrepant utterances at the same accuracy level as adults. However, in the Yow and Markman (2011b) study, participants were not asked to identify either the semantics of utterances or their emotional prosody specifically, but could freely choose what to base their judgement on. Thus, it is possible that bilingual children did not show an advantage per se, but rather showed a bias towards the tone of voice, what we called a prosodic bias. Such a bias would give the impression that bilinguals' decline of their semantic bias occurred

quicker than for monolinguals. In order to understand the bilingual participants' superior performance in the study by Yow and Markman (2011b), we conducted a study where we asked participants with different levels of bilingualism to identify either the semantics *or* the emotional prosody of utterances where words and tone of voice were either congruent or discrepant. This design allowed us to investigate not only the semantic bias, but also an eventual prosodic bias.

### *Method and analysis*

We asked 74 children aged 6 to 8 years to perform a task where they identified the emotional valence of 18 different spoken words. The words were either positive, negative or neutral and were uttered with a positive (happy), negative (angry) or neutral tone of voice. This resulted in 108 utterances based on the 18 words that were selected. In our task, we asked the children to identify the emotional valence of the words regardless of tone of voice for half of the trials, and to identify the emotional valence of the tone of voice regardless of the word content for the other half of the trials by pressing one of the cartoonish illustrations of each alternative. Since a bias occurs when a distractor cannot be ignored and interferes with the response, we could study biases both in terms of semantics as a distractor (as in a semantic bias) and in terms of emotional prosody as a distractor (as in a prosodic bias).

Importantly, children in this study had different levels of bilingualism. At one end of the scale, children were exposed to and used only one language, while at the other end of the scale, there was a virtually equal exposure to and use of another language. We treated the bilingualism variable as a continuous variable in order to not create post-hoc categories which reflect the reality of bilingualism poorly.

Multiple regression analyses with age and bilingual experience as predictors were performed in order to understand the participants' general performance better and investigate whether we could replicate the findings in Yow and Markman (2011b). The outcome variables that we analysed were accuracy for the tone of voice trials, accuracy for the consistent tone of voice trials, accuracy for the discrepant tone of voice trials. However, in order to explore the occurrence of biases specifically, age and bilingual experience were used as predictors in multiple regression analysis where the percentage of only the biased mistakes were used as outcome variables for each type of bias. For instance, when the task was to identify the emotional prosody, a mistake was considered to be biased if the answer that was provided was consistent with the word itself (e.g., if the answer that was provided was

“positive” for the utterance “love” expressed with an angry tone of voice in a prosody trial). However, mistakes where the provided answer did not correspond to the distractor (e.g., if the answer that was provided was “neutral” for the utterance “love” expressed with an angry tone of voice in a prosody trial) were not included in the analysis since they did not represent a bias in such, but rather a mere mistake.

### *Results and conclusions*

We replicated the findings of Yow and Markman (2011b) by showing that age and bilingual experience predicted better performance on tone of voice trials in general and for discrepant tone of voice trials. As for consistent tone of voice trials, only age predicted a higher accuracy. As for the biases analysis, when both types of biased mistakes were analysed together, only age predicted a lower occurrence of biased mistakes. When the semantic bias was analysed separately, a combination of age and bilingual experience predicted better performance, but only when considered together. In other words, each predictor on its own could not significantly predict better performance, but could only reach significance when combined together. Finally, as for the prosodic bias, while bilingual experience predicted a larger bias, age did not.

Put together, our results suggest that bilingual children do perform better on tasks where they have to identify tones of voice that are discrepant with the uttered words’ content, but that this advantage may in fact be driven by a bias towards prosody. Indeed, when asked to ignore the tone of voice and identify the word content, bilingual participants performed more poorly. However, the performance of participants was in general similar to the other types of trials, even when it came to their tendency to show a semantic bias if age was not added as a factor. Of course, having a bias towards prosody is not necessarily negative since misunderstandings are more likely to occur when emotional prosody is missed or misinterpreted. The message to take home should therefore be that bilinguals develop in a different manner when it comes to processing emotional prosody. Finally, our results are also in line with other studies showing that bilingual children perform better on various social tasks such as perspective taking (e.g., Fan, Lieberman, Keysar & Kinzler, 2016; Genesee, Tucker & Lambert, 1975; Greenberg, Bellana & Bialystok, 2013; Hsin & Snow, 2017) and theory of mind (e.g., Goetz, 2003; Kovács, 2009; Nguyen & Astington, 2014; Rubio-Fernández & Glucksberg, 2012), which contributes to the literature on bilinguals’ social skills.

It is unclear why bilingual children show a prosodic bias. A tentative explanation could be that prosody, compared to semantics, shows less



variation across languages and could thus be a more reliable cue for a bilingual child when communicating with speakers in different languages. However, this is an idea that must be explored further in order to be established. Also, we cannot determine with this study how adult bilinguals would perform on the task. A study by Misono, Mazuka, Kondo and Kiritani (1997) found that when semantics and prosody are discrepant, adult monolinguals choose to base their judgement on prosody in less than 35% of the trials. It is unclear whether bilingual children's prosodic bias will also gradually disappear, and if so, when. Another interesting question is whether adults who became bilingual later in life, namely late bilinguals, would also demonstrate a similar bias or not. Further research will be needed in order to understand the evolution of the prosodic bias better, and the mechanisms behind it.

### **Study III**

Champoux-Larsson, M.-F., Dylman, A. S., & Esteves, F. (2018). *Empirical investigation of the relationship between social flexibility and bilingualism*. Manuscript submitted for publication.

#### *Background and aim*

Perception of emotions in others is an important social task that we all need to learn to perform at least at a functional level in order to interact skillfully in society. Based in part on the idea that bilinguals, at least when it comes to children, outperform their peers on some social tasks such as theory of mind (e.g., Goetz, 2003; Kovács, 2009; Nguyen & Astington, 2014; Rubio-Fernández & Glucksberg, 2012), perspective taking (e.g., Fan, Liberman, Keysar & Kinzler, 2016; Genesee, Tucker & Lambert, 1975; Greenberg, Bellana & Bialystok, 2013; Hsin & Snow, 2017), and other types of social tasks (e.g., Verhagen, Grassmann & Küntay, 2017; Yow, 2015; Yow & Markman, 2011a; Yow, Li, Lam, Gliga, Chong, Kwek & Broekman, 2017), Ikizer and Ramírez-Esparza (2017) have suggested that adult bilinguals may also show greater social flexibility. According to the above mentioned authors, social flexibility consists of two important elements. First, it is "the ability to switch with ease and adapt between different social environments", and second, to "accurately read social cues in the environment" (Ikizer & Ramírez-Esparza, 2017, p. 2). In order to support this idea, the authors conducted a correlational study where 671 participants (465 monolinguals, 206 bilinguals) responded to an online survey where a social flexibility scale and a frequency of social interactions scale were used. The social flexibility scale was developed by Ikizer & Ramírez-Esparza (2017) themselves, based on the Trait Emotional

Intelligence Questionnaire (TEIQue: Petrides, 2009a; Petrides, 2009b). The frequency of social interactions scale was taken from Ybarra and colleagues (2008). The authors found that the bilingual group scored higher on the social flexibility scale, that they also had more frequent social interactions, and that the relationship between bilingualism and the frequency of social interactions was significantly mediated by the score on the social flexibility scale. However, there are several methodological limitations in this study, some of which the authors themselves point out, while other issues are lifted in Vives, Repke and Costa (2018).

Aside from issues with the type of empirical findings that they used to base their rationale on, a major concern regarded their sample. In fact, there were other differences between the group of monolinguals and the group of bilinguals beyond language. For instance, the bilingual group was both more educated and bicultural. These two factors may have contributed to the differences that were found. Another limitation was that the study was correlational only. Thus, it cannot be claimed that bilingualism leads to higher social flexibility scores on the scales used by Ikizer and Ramírez-Esparza (2017). In order to investigate the relationship between social flexibility and bilingualism more stringently, we carefully selected a population of native Swedish speakers while controlling for important possible confound variables and conducted an experimental study where we tested social flexibility in terms of switching and cue sensitivity as a function of the participants' level of bilingualism.

### *Method and analysis*

Eighty-five adult participants (18-68 years) with Swedish as their first language and varying levels of use of and proficiency in a second language participated in this study. These two criteria were selected to replicate the method in Ikizer and Ramírez-Esparza (2017). Furthermore, we also used measurements of self-reported frequency of code-switching since it was suggested by Ikizer and Ramírez-Esparza (2017) themselves that this element could be a contributing factor behind enhanced social flexibility (however code-switching was not measured in the original study). Furthermore, because there were differences in the original study on the level of education between the two groups, we also used this factor as one of our predicting variables. Importantly, although Ikizer and Ramírez-Esparza divided their participants into two groups (monolinguals and bilinguals), we chose to continue treating the level of bilingualism as a continuous variable because of the conceptual benefits this method provides.

As for the task, participants were asked to determine whether a voice (a pre-recorded semantically neutral utterance said by either a man or a woman with various emotional prosodies) that was presented along with a face (a picture of a man or of a woman displaying various facial depictions of emotions) were congruent or discrepant based on either gender (male/female) or emotion (happy/angry), which are both relevant social cues. Naturally, some of the trials were congruent (e.g., a male voice with a male face, or a happy voice with a happy face) while others were discrepant (e.g., a male voice with a female face, or a happy voice with an angry face). In the first part of the experiment, participants had to base their judgement on gender only in one block, and on emotion only in another block (the blocks were presented in a counterbalanced order). This part of the experiment was meant to measure how accurately participants could identify social cues (the second element of social flexibility). In the second part of the experiment, participants had to switch between which cues they should base their judgement on, at times responding based on gender, and at times based on emotion. This block allowed us to investigate the first element of social flexibility, namely the capacity to switch between different environments.

Finally, in order to compare our results to those of Ikizer and Ramírez-Esparza (2017), we also measured social flexibility with the social flexibility scale and frequency of social interactions scale that the authors used in their study. By also using these two scales, we could determine whether a difference between the results of our experiment and the results of their study was due to the use of different designs and measurements, or if they were due to differences in our populations. In the case where only the results of the experiment would differ, the difference would most likely be due to the instrument. However, in the case where both the results of the experiment and the scales would differ, the difference would most likely be due to fundamental differences between our populations.

Frequency of use of a second language, proficiency in that second language, frequency of code-switching, and level of education were used as predictors in multiple regression analyses where reaction times and accuracy on non-switch trials, as well as on the switch-cost, were the outcome variables. Additionally, the same four predictors were used in multiple regression analyses with the scores of each of the two scales used by Ikizer and Ramírez-Esparza (2017) as outcome variables.

### *Results and conclusions*

Our analysis showed that proficiency in the second language predicted lower accuracy in non-switch trials, and that level of education predicted higher accuracy. The other two factors did not significantly predict performance. As for reaction times in the non-switch blocks, none of the factors significantly predicted performance. In the switch-block, the switch-cost was not significantly predicted by our predictors (comparably to results found by Hernández, Martín, Barceló & Costa, 2013). Thus, our results support the suggestion that level of education rather than bilingualism was behind the effect found in Ikizer and Ramírez-Esparza (2017). However, it may have been that our task measured another construct that was different from the social flexibility that Ikizer and Ramírez-Esparza measured with their scales. The results of our analyses do not support this premise however. Indeed, the regression model that predicted the social flexibility score was not significant. Interestingly however, when examining the predictors individually, level of education predicted the social flexibility score significantly, and so did the frequency of code-switching. This suggests that once again level of education may have been a contributing factor. It also suggests that the rationale presented by Ikizer and Ramírez-Esparza (2017), namely that code-switching could be a contributing factor behind social flexibility as they measured it, may have some support. As for the frequency of the social interactions however, none of the predictors were significant.

All in all, our results suggest that the findings in the original study may be driven by something other than bilingualism, such as level of education. Interestingly, a major difference between our population and the population in the original study is the cultural background of our participants. While our participants all had Swedish as their first language and had various second languages that varied in term of context and culture, the monolingual and bilingual participants in Ikizer and Ramírez-Esparza stemmed from a more homogenous population. Namely, their monolingual participants were English speaking North Americans from a purely North American culture (bicultural monolinguals were excluded from their analysis). A large proportion of their bilingual participants on the other hand were Hispanic North Americans who spoke English and Spanish. Although it is beyond the scope of this study to determine whether biculturalism may have better predicted social flexibility, it is a possibility that should be explored further, which was also an issue raised by Ikizer and Ramírez-Esparza (2017).

It is also possible that the rationale behind Ikizer and Ramírez-Esparza's (2017) idea may have lacked robust empirical support. As pointed out by

Vives et al. (2018), the idea that bilinguals performed better than monolinguals on social tasks was based on studies made with child populations. Indeed, within the field of cognitive research and bilingualism, differences that are found between monolinguals and bilinguals during childhood do not always carry on into adult populations (e.g., Bialystok, Martin & Viswanathan, 2005, see Bialystok, Craik & Luk, 2012 for a review and Bialystok, 2009 for a summary of the effects of bilingualism across the lifespan). Although there are no studies on social flexibility specifically in children in particular to which Ikizer and Ramírez-Esparza's (2017) and our results can be compared, it is nonetheless a possibility that an effect could be found in a younger Swedish population. Of course, more research should be conducted in order to determine whether this is the case.

## General discussion

From a constructionist point of view, language plays a major role in the perception of emotions both when it comes to the formation of discrete categories of emotions, and also when those language-driven categories guide and form perception (Barrett, 2017; Barrett, Lindquist & Gendron, 2007; Lindquist, Barrett, Bliss-Moreau & Russell, 2006; Lindquist & Gendron, 2013; Lindquist, MacCormack & Shablack, 2015). However, whether having more than one language affects the perception of emotions or not has not been investigated extensively. The aim of this thesis was thus to explore the perception of emotions as a function of bilingualism. In order to accomplish this, three experimental studies were conducted where the performance of participants with varying levels of bilingualism was investigated through emotional tasks. All studies explored the perception and identification of instances of emotions, but each was directed at a different age group. In each one of the studies, the identification and perception task corresponded to a pertinent emotional task for each specific population in particular.

### Perception of emotions as a function of bilingualism

In the first study, the perception of facial depictions of emotions, which develops quickly in pre-school aged children, was studied in 4-year-olds with a simple emotion matching task. No differences in performance were found in our task between monolinguals and different types of bilinguals. However, we replicated the results from previous studies showing that children learn to identify different instances of emotions gradually and that accuracy on some emotions is higher for happiness and anger in that age group (e.g., Gross & Ballif, 1991, Székely et al., 2011; Wang, Lü, Zhang & Surina, 2014; Widen & Russell, 2002, 2003, 2008, 2010). It is still unclear however whether bilingualism may have had an effect on the perception of emotion due to the simplicity of the assignment. Providing participants with the appropriate labels for each emotion may have facilitated the task for all participants and inflated the accuracy rate.

In relation to a constructionist viewpoint, the first study supports the notion that discrete instances of emotions are learned rather than being innate in that we also found that 4-year-olds quite skillfully identified instances of happiness and anger, but still struggled to distinguish sadness from fear. It is interesting to note that when it comes to caricatures of sadness and fear, even though they share the same valence, they do not share the same level of arousal nor similar facial movements. In fact, the caricatures are quite distant

from each other with the exception of valence, which is negative for both. Namely, while the pictures of sadness were lower in arousal, showing a face with a closed mouth, the corners of the mouth pointing downwards and narrowed eyes, the pictures of fear were higher in arousal, showing a face with an opened and rounded mouth, wide-opened eyes and high eyebrows. Clearly, those two depictions of facial instances of emotion do not share many characteristics in common, which should make them easy to differentiate from each other. Yet, as in other studies, our participants could not tell those two depictions apart, even when they had been provided with the appropriate labels, and even though the task should have been simplified since it was a simple matching task. If recognition and identification of emotions was in fact as innate as some theories claim (e.g., Izard, 1971; Izard, Huebner, Risser, McGinnes & Dougherty, 1980; Izard & Malatesta, 1987), and considering that our participants were well beyond infancy, they should not have performed significantly worse on two of the basic emotions. Yet, they did. What is still unclear however is whether the bilingual participants were helped by their two languages in the perception of emotions. Clearly, our results cannot support the idea that they were since we did not find differences between our groups. However, there were indications that bilingual participants, at least those who were exposed to their languages equally, may have had a different behavioural pattern. Indeed, when looking at the type of mistakes that the children made, only 1.58% of the balanced bilinguals' mistakes were cross-valence (e.g., answering "happy" when the expected answer was "angry"). For monolinguals and dominant bilinguals, the rate was 3.38% and 3.5% respectively. Those differences were not statistically significant. Still, they may suggest that valence distinctions are made or develop differently as a function of a child's language profile.

In the second study, the perception of emotion in emotional prosody, which develops during late childhood, was investigated in a group of 6- to 8-year-olds. Until this age, a semantic bias is usually found in children (e.g., Friend, 2000; Friend & Bryant, 2000; Solomon & Ali, 1972). Namely, when a spoken word is uttered with a tone of voice that has a discrepant valence, children tend to rely more heavily on the semantics of the word rather than on its prosody to identify the speaker's emotional state. Here, we found that a child's level of bilingualism did not lead to a better or worse performance on a task where participants had to identify the emotional valence of spoken words based on either their semantics or on their emotional prosody. That is, bilingualism did not lead to a faster decline of the semantic bias on its own. However, we found that the higher the level of bilingualism was, the better

participants were at identifying the emotional prosody of utterances, but simultaneously, the more likely they also were to show a prosodic bias. More specifically, children with a higher level of bilingualism performed better in the condition where they had to identify the prosody of the word while ignoring its semantics, but probably because it was driven by their difficulty to ignore the emotional prosody of the utterances even when the task was to identify the words' semantics.

Seen from a constructionist point of view, our results may suggest that having more than one language helps children to perceive emotions in the tone of voice of an interlocutor, perhaps by providing them with more categories and more detailed concept knowledge. It could for example be the case that differences found in emotional prosody across languages enriches the children's concept knowledge about different emotions and thus enhances their emotional granularity. Furthermore, as bilinguals' total vocabulary when both languages are considered is equivalent to their monolingual peers' vocabulary (Bialystok, 2001; Pearson & Fernández, 1994; Poulin-Dubois, Bialystok, Blaye, Polonia & Yott, 2013), it could be so that their concept knowledge about different emotions do not contain more words per se, but still contain a more diversified set of experiences and occurrences of each category such as different ways to express an instance of an emotion with the tone of voice.

In the final study, the social flexibility of bilinguals was explored in an adult population. In this study, social flexibility consisted of both the ability to detect relevant social cues and to switch between different social settings. Although a previous study (Ikizer & Ramírez-Esparza, 2017) has suggested that adult bilinguals are more socially flexible, we could not replicate these results in our population. While the original study was correlational only, ours was based on an experimental task where participants were asked to determine whether a facial emotional cue and an utterance expressed with different emotional valences were congruent or discrepant. Here, bilingualism in terms of frequency of use of a second language, proficiency in a second language, and frequency of code-switching did not lead to better social flexibility. In fact, second language proficiency actually led to lower accuracy in the non-switch trials. Interestingly, when performing additional analyses (which are not reported in the study itself) for emotion trials and gender trials separately, we found that lower accuracy rates were predicted by higher second language proficiency for emotional stimuli only. From a constructionist point of view, this is in fact very interesting. As the theory suggests, an instance of an emotion is built in part from all the experiences



and concept knowledge that we have about this emotion. This suggests that having more than one word to hold categories of emotions together does not necessarily lead to better accuracy when an instance of an emotion is presented in a situation devoid of context. Indeed, none of the elements that are the building blocks of an emotion are sufficient on their own to perceive an emotion “correctly”. If bilingualism results in more diversity in terms of words and experiences related to emotions, it may be that there is more overlap between bilinguals’ emotion categories compared to monolinguals. With more overlap comes more uncertainty and more room for different interpretations is available. This could explain why more proficient bilinguals in our sample were less accurate. Parallels could be drawn with the disadvantage in speech production found in bilinguals (e.g., Li, Goldrick & Gollan, 2017; Pelham & Abrams, 2014; Runnqvist, Gollan, Costa & Ferreira, 2013; Sadat, Martin, Alario & Costa, 2012; Sadat, Martin, Magnuson, Alario & Costa, 2016; Sandoval, Gollan, Ferreira & Salomon, 2010). For a monolingual, a given object or subject can be labeled with one or very few words. For bilinguals however, there are more possible and valid labels available to them. This is reflected by a slower retrieval of vocabulary in naming tasks. Similarly, it could be that for the same emotion, there is a larger variety of labels and language-related experiences for bilinguals. If so, bilinguals may not have the same type of one-to-one relationship between emotional cues and emotional categories as monolinguals do. In order to understand this disadvantage better however, studies investigating emotion perception within context would be needed.

Furthermore, it could have been that our task did not reflect social flexibility at all. If so, our study would not be evidence against a bilingual advantage in social flexibility. However, even when we measured social flexibility in our population with the same two scales that were used by Ikizer and Ramírez-Esparza (2017), we found no correlation between the scales and bilingualism, with the exception of code-switching on the social flexibility scale (remember however that the regression model itself was not statistically significant). This could mean that there is some evidence for the suggestion by Ikizer and Ramírez-Esparza (2017) that frequent code-switching contributes to enhanced social flexibility. On the other hand, here again, level of education seemed to have an impact on the social flexibility score (again, note that the regression model itself was not statistically significant however), which supports the idea that level of education was behind the results found by Ikizer and Ramírez-Esparza (2017). Indeed, code-switching per se was not measured in this study, and it is therefore not possible to know how their

sample's code-switching would have correlated with their measurements of social flexibility.

The constructionist perspective does not make clear predictions when it comes to how having more than one language may affect the perception of emotions however. Rather, it only raises the idea that since language is so central in the perception of emotion, it is a pertinent line of research to investigate. A possibility is that having more than one language contributes to the concept knowledge about different emotions by providing a larger array of varied experiences. With richer categories, it may be that the emotional granularity is enhanced. In such a case, the detection and identification of instances of emotions should also be improved. However, we found the opposite in a context where a limited amount of exteroceptive sensations were available. Presented without a social or situational context, an identical combination of facial movements can be interpreted in completely different ways. This may explain the effect that we found in our sample. Namely, it may have been so that the more bilingual a participant was, the more heterogeneous their concept knowledge was in a situation that was free of context. This would in turn lead to more overlap between categories in such a situation. Thus, the more bilingual a participant was, the more context would have been necessary. However, since our task provided no context, the more bilingual a participant, the more challenging the task probably was. Consequently, the more bilingual was, the lower their accuracy was. Of course, our results could also be interpreted in several different ways in relation to the constructionist perspective. It could be that bilingualism does not lead to better emotional granularity, that emotional granularity does not facilitate performance in a task like ours, or even that having more than one language does not affect perception of emotions at all, at least in adults.

### **Other possible mechanisms**

Although it is beyond the scope of this thesis to establish specifically and with certainty which bilingualism-related mechanisms affect the perception of emotion, it is nevertheless possible to speculate and discuss the question even beyond a constructionist framework. The results of this thesis' three studies can tentatively be explained in the light of the relationship between bilingualism and cognitive as well as sociolinguistic aspects. For instance, it has been suggested that bilinguals are required more monitoring of their environment in order to know which language they should choose to interact in (e.g., Yow & Markman, 2011a). This heightened attention could lead them to also be more sensitive to social and emotional cues. This idea is supported

by studies showing that bilingual children have an advantage in theory of mind (e.g., Goetz, 2003; Kovács, 2009; Nguyen & Astington, 2014; Rubio-Fernández & Glucksberg, 2012) and perspective taking (e.g., Fan, Lieberman, Keysar & Kinzler, 2016; Genesee, Tucker & Lambert, 1975; Greenberg, Bellana & Bialystok, 2013; Hsin & Snow, 2017) for instance. However, full-blown and caricatured instances of emotions were used in our studies. If enhanced monitoring indeed has the potential of improving performance in tasks such as the one that was used in the first study, due to the nature of the stimuli that we chose, there was no room for enhanced attention to improve performance in our task. Thus, although monitoring is a possible mechanism, it could not have shown in our task unless more realistic and typical facial instances of emotions had been used. Using such a type of stimuli would have created room for enhanced attention and monitoring to show an effect.

Another mechanism that may lay behind the perception of emotions in relation to bilingualism is related to the linguistic ambiguity faced by bilinguals. Bilinguals are exposed to more ambivalent environments compared to their monolinguals. While monolinguals interact in an unambiguous linguistic environment where only one language is spoken, bilinguals have to face linguistic ambiguity on a regular basis when interacting in several languages. This may lead bilinguals to be better at handling ambiguity and uncertainty compared to their monolingual peers. However, here again, full-blown and caricatured instances of emotion do not generate much ambivalence. Thus, if the ability to deal with ambiguity could have explained a difference in performance as a function of bilingualism, the choice of caricatured stimuli would not have allowed our design to tap into this skill. The lack of differences would therefore not be surprising, but rather expected.

## **Resolution of methodological issues and future studies**

As suggested earlier, there are many modifications that could be brought to the studies based on our results in order to shed more light on the perception of emotions with a bilingual mind. While some modifications should be made to resolve some methodological weaknesses, others can be made to develop existing designs further.

An important change that could be brought to all studies would be to conduct the studies in the participants' second language. Here, they were only tested in their first language, with the exception of a few participants in the first study who did not speak Swedish as their first language, but still were early, albeit sequential, bilinguals. It may be that the perception of emotion in

one's first language is not affected by the degree of bilingualism, but that perception is different when tasks are carried in a second language. For instance, semantics satiation could be used in the participants' first and/or second language to explore whether their other language can act as a backup. Moreover, by testing participants in both their first and second language, a within-group design could be used, eliminating the issues that between-group designs bring regarding background variables that can be confound variables. For instance, even though we measured socio-economic status of our participants in terms of highest completed education (for the parents in the first two studies and for the participant in the third one), other important variables such as intelligence or vocabulary size were not controlled for. It could be that these variables correlated with the results in any of the studies and may have influenced the results somehow.

Moreover, in the first and third studies in particular, modifying the tasks in order to avoid the use of predetermined emotion labels, which enhances performance on emotion identification tasks, could lead to more informative results. A simple modification in the first study could be to ask children to determine whether two faces express the same or different emotions. Although caricatures of facial instances of emotions are still used in such a design, the use of labels can be avoided, thus resolving the labeling issue. Also, since there were indications that the language profile may affect how valence is judged, perhaps more representative results could be obtained in a task where children must interpret other's internal state based on their facial movements in a more naturalistic setting. The same is true for the third study where it is a possibility that bilingualism leads to more uncertainty when context is not available. So, a task where a face must be interpreted within various social contexts for instance could help us understand whether having two languages affects how the cues are integrated together. The detection of relevant emotional cues in diverse environments could also be investigated by using varying levels of noise (both visually and aurally) and/or with more or less salient cues. Using facial depictions of emotion within different social situations, with different cues (e.g., posture, voice, scene), and surrounded by other faces displaying various instances of emotions, could even increase the investigations' ecological validity (Barrett, Lindquist & Gendron, 2007).

Furthermore, in order to detect the contribution of different possible bilingualism-related mechanisms in the identification of facial depictions of emotions, using stimuli that do not represent caricatures would leave more room for the effect of factors such as enhanced monitoring and ability to handle ambiguity to reveal itself. Using morphed pictures of facial depictions

of emotions where the stimuli go from being completely neutral and gradually increasing in emotionality until the full-blown emotion is shown could be a change in the stimuli that would improve the design and allow us to test monitoring skills. Morphing two different depictions of facial instances of emotion in different proportions (e.g., morphing anger and happiness together first at a proportion of 50% each, and then at a proportion of 60% anger and 40% happiness, then 70% anger, 30% happiness, etc.) would allow us to better understand how bilinguals' practice in dealing with ambiguity contributes to the perception of emotion.

Also, based on the nature of bilingualism and how it is measured, a significant improvement would be to use bilingualism as a continuous variable, which is what we did in the second and third studies, rather than dividing participants into language groups. This would reduce some of the issues related to the measurement and classification of bilingualism. However, given the scales that exist today, available measurements are far from perfect. For instance, even though the revised version of the LSBQ (Anderson et al., 2017) has addressed many of the issues related to the complexity of measuring bilingualism, it is best suited for bilinguals speaking only two languages. Although bilingualism is frequent compared to multilingualism in Canada, where the scale was developed, it is not as well suited for a European context for instance, where multilingualism is not as uncommon. Clearly, there is a need for a better scale to measure bilingualism in different contexts and cultures.

Furthermore, it would be interesting to develop the second study to understand first if the prosodic bias can be found in younger bilingual populations, and if it continues throughout adulthood. A similar design with age-appropriate words could help to determine this. It is unclear however why our participants showed a prosodic bias. As suggested above, it could be caused by a better emotional granularity which each language's emotional prosody contributed to. However, this remains to be tested. It could also be that emotional prosody varies less across languages compared to semantics. Although there are differences in emotional prosody between different languages, those differences are arguably smaller than semantic differences between languages (depending on the language pairs obviously), which could make emotional prosody a more stable and reliable cue to base one's judgement on when determining the inner state of others. This should be investigated in further studies.

Finally, the third study could be modified to investigate whether an individual's level of bilingualism affects social flexibility by testing the

concept in a more ecologically valid context. In the third study, switching between social environments was operationalised with a switch-task. However, the actual switch was made on the cues that were to be used, which does not perfectly reflect a change of environment per se. Thus, an experimental task where cues are presented within a context and where the context itself changes would be a more ecologically valid representation of a switch between social environments. Furthermore, this would allow us to investigate how bilingualism affects the perception of emotions when a context, and consequently a larger amount of information, is available. Perhaps the potential uncertainty that the context-less cues potentially create would be diminished if they were presented within a context. This would probably give a more ecologically valid representation of how the perception of emotion could be affected by bilingualism.

### **Concluding remarks**

The three studies presented in this thesis have only begun to scratch the surface when it comes to the investigation of bilingualism in relation to the perception of emotions. Although they do not cover the area exhaustively, the studies in this thesis nonetheless provide an actual ground on which to build further studies to pursue the exploration of this area. When it comes to the older children, we found that having more than one language changes the way emotion in speech is processed. As for adults, bilingualism also affected the perception of emotions, but negatively. The exact mechanisms behind these effects is beyond the scope of our designs to determine, but should be studied further. While no effects of bilingualism were found in the youngest child population, this could be due to methodological issues which should be resolved before certain conclusions can be drawn.

One aim that was not part of this thesis was to prove or disprove a bilingual advantage or disadvantage in emotion perception. Due to the ongoing debate surrounding the bilingual advantage in executive functions, it is tempting to draw parallels between this thesis' area of research and research on bilingualism and executive functions. Executive functions and emotion perception are deeply intertwined (e.g., Langenecker et al., 2005; Mathersul et al., 2009), and logically one could deduce that if there is an advantage in executive functions in bilinguals, this could also be reflected in the perception of emotions. However, as mentioned in the introduction, bilingualism and bilinguals are concepts that are difficult to define and measure. This is a major issue both when attempting to categorize participants into distinct groups, especially in this case where there are no clear and

distinct groups in reality, and when attempting to compare results from different studies together. This important point, which is a challenge for virtually all research on bilingualism, should remind us of the caution with which conclusions on bilinguals as a distinct group should be drawn. Here, the aim was not to compare the performance of distinct groups of people with each other, but rather to investigate whether being an individual in a bilingual context may have any effect on other psychological processes. With the second study, we clearly showed that what has earlier been interpreted as an advantage in the processing of emotional prosody in bilinguals was in fact driven by a bias towards prosodic information. When taking a look at the other side of the coin, better understanding of emotional prosody was not the same as a faster decline of a semantic bias. In fact, the second study made an important point, namely that solving tasks in a different manner may indicate the use of different strategies, but it may not automatically or necessarily be an advantage. Rather than focusing on black and white, dichotomous questions separating monolinguals and bilinguals, a better way to look at bilingualism research may be to investigate how individuals with a unique language background may solve other psychological tasks in a different way as a function of their own context with their own challenges and strengths.

Finally, although the contribution of this thesis may seem modest, it presents amongst the first studies to explore how having more than one language can have an effect on the perception of emotions. Although a constructionist framework was chosen, further research does not necessarily need to be limited to this theory and can extend beyond it in order to encompass other useful theoretical frameworks. I hope that the results presented in this thesis will lead to more studies investigating the perception of emotions in relation to bilingualism from different points of view in order to gain a wide-ranging and nuanced knowledge on this specific area.

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