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Processing of Emotional Words by Czech-German Bilinguals

Zpracování emočních slov u česko-německých bilingvních mluvčích

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Vojtěch Kocourek

Abstract

The present thesis examines the differences in word processing and evaluation between monolingual German speakers and bilingual Czech-German speakers with respect to two emotional dimensions – valence (positive/pleasant vs negative/unpleasant) and arousal (high level of activation vs low level of activation). This is done on the basis of two psycholinguistic concepts which propose a connection between the level of perceived word emotionality and the context in which it was learned and used – the reduced emotional resonance in L2 and emotional context of learning hypotheses.

A psycholinguistic experiment was conducted with 16 German monolinguals and 19 Czech-German bilinguals. Participants from both groups were asked to rate a presented German word from the same list on a two-dimensional emotional scale, while at the same time they were being monitored by the fNIRS method for differences in brain activity in relevant cortical areas.

The measured ratings of valence did not significantly differ between the two groups, while the ratings of arousal were significantly higher in the bilingual group. The bilinguals did not differ from each other in the levels of arousal as a function of their age of learning German.

The findings were interpreted as broadly consistent with the assumptions of the two selected psycholinguistic hypotheses – the emotionality levels of bilingual participants signifying sufficiently emotional context of learning and use. However, because the neuroimaging data could not be used to confirm the behavioural data due to a technical error and because of the small number of participants, the generalisability of the present findings is limited.

Key words: bilingualism, emotional words, fNIRS, Czech, German, arousal, valence

Abstrakt

Tato práce zkoumá rozdíly mezi monolingvními mluvčími němčiny a česko-německými bilingvními mluvčími ve zpracování a hodnocení slov v kontextu emočních dimenzí valence (pozitivní/příjemná vs negativní/nepříjemná) a vzrušení (vysoká míra excitace vs nízká míra excitace). Hlavním východiskem jsou přitom dvě psycholingvistické teorie, které usouvztažňují míru emocionality slov s kontextem, ve kterém se je mluvčí naučili a používají – hypotéza snížené emoční rezonance v L2 a hypotéza emočního kontextu osvojení.

Za tímto účelem byl proveden psycholingvistický experiment, kterého se účastnila skupina 16 monolingvních mluvčích němčiny a skupina 19 bilingvních mluvčích s kombinací němčina/čeština. Participanti z obou skupin hodnotili identický seznam německých slov na škále dvou emočních dimenzí, zatímco jejich mozková aktivita byla snímána metodou fNIRS kvůli rozdílům ve vybraných oblastech mozkové kůry.

Mezi oběma skupinami nebyl naměřen žádný významný rozdíl v úrovni valence, zatímco hodnoty vzrušení byly významně vyšší v bilingvní skupině. Žádný rozdíl nebyl nalezen mezi hodnotami vzrušení bilingvních mluvčích ve vztahu k věku, ve kterém si osvojili němčinu.

Naměřené výsledky obecně odpovídají předpokladům zvolených psycholingvistických teorií – úroveň emocionality byla interpretována jako výsledek dostatečně emočního kontextu osvojení a užívání bilingvních participantů. Protože však behaviorální data nemohla být kvůli technické chybě porovnána s neurozobrazovacími a počet participantů byl nízký, jsou závěry této práce jen omezeně zobecnitelné.

Klíčová slova: bilingvismus, emoční slova, fNIRS, čeština, němčina, vzrušení, valence

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List of Abbreviations

CEFR – Common European Framework of Reference for Languages

fMRI – functional magnetic resonance imaging

fNIRS – functional near-infrared spectroscopy

GFFO – German Federal Foreign Office

L1, **L2**, **L3** – first, second and third language

LABELS – Laboratory of Behavioural and Linguistic Studies

LHQ 2.0 – Language History Questionnaire, second version

LSBQ – Language and Social Background Questionnaire

SCRs – skin conductance responses

SLA – second language acquisition

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1. Introduction

The aim of this thesis is to investigate whether there are differences between the ways monolingual German speakers and bilingual Czech-German speakers process and evaluate words, with the main focus on the role of emotional dimensions. This will be done with the help of an experiment during which behavioural and functional neuroimaging data will be measured and assessed.

Our approach combines two perspectives: psycholinguistics and research of bilingualism. From the area of psycholinguistics, we will adapt the concept of emotional words. This thesis is based on the dimensional understanding of word emotionality, which does not see emotional words as a separate category, but rather assumes that the two dimensions used for their description – valence (positive or negative) and arousal (low or high level of activation) – represent a more universal aspect of all words to different degrees.

The hypotheses which we would like to test are based on two interconnected concepts which were developed in order to explain the influence of multilingualism on emotionality and word processing. First of them is the effect of reduced emotional resonance in L2 (Harris et al., 2003) which describes the tendency of speakers to perceive languages which they learned later in life or to a lesser degree of proficiency as subjectively less emotional. This can manifest also in the processing of L1 words, which is more strongly modulated by emotional factors than in the case of their L2 equivalents. Complementary to this notion is the so-called emotional context of learning hypothesis (Caldwell-Harris, 2014), which suggests that the level of emotional resonance of words depends on whether they were learned and used in emotional contexts.

During the experiment, both German and bilingual participants will be asked to rate words with respect to the emotional dimensions, while their brain activity will be monitored using near-infrared spectroscopy. Our assumption is that if we find any differences either in the behavioural ratings or in the neurophysiological activity, they will correspond to the theories of emotional resonance and context of acquisition.

Since the majority of bilingual experiments focuses on the pairing of English with some other language, the combination of Czech and German can offer original insights. Because the German minority and Czech-German bilingualism have a long and specific history, we are going

to also include a short overview of the current number of speakers and of Czech-German bilingual education.

The acquired data will be analysed for multiple factors which are known to play a role in bilingualism and which together form a bilingual speaker – proficiency, age and context of acquisition, frequency of use, etc. The results will be interpreted in the context of previous psycholinguistic research, especially the studies based on the framework of affective neurolinguistics, which combines methods and theories from the fields of neurolinguistics and affective neuroscience.

2. Theoretical Background

In the first part of this thesis, we are going to introduce the main concepts and theories on the basis of which the experimental hypotheses shall be made. First of all, we are going to discuss the characteristics of bilingual speakers in general. This will be followed by a brief description of the current situation of Czech-German bilinguals in Czechia. After that, we are going to review the literature related to research on emotional words and dimensions. And finally, the theoretical part concludes with the presentation of the effect of bilingualism on the processing of words and emotionality, and the hypotheses are formulated.

The second part specifies the experimental methodology and presents results. It begins by describing the recruitment process and the characteristics of the groups of participants, as well as the set of stimuli. After that follows the description of experimental design and procedure, including the principles of near-infrared spectroscopy. The final part discusses the findings and states whether the hypotheses were rejected or supported.

2.1 Bilingualism

2.1.1 General Characteristics of Bilingual Speakers

Despite the considerable increase in attention paid to bilingualism by researchers in the last decades and the growing number of studies published on the topic of its effects on cognitive and linguistic processing (Anderson et al., 2018, p. 250; Dörnyei, 2009, p. 15), there is no single definition of the term "bilingual."[1] The intuitive notion that anyone who speaks more than one language can be seen as bilingual is too unspecific, as noted by de Groot, the definitions can vary from "only considering a person bilingual if he or she masters two languages at the same level of fluency and with the same level of control as native speakers of the two languages . . . , to regarding people who only possess some minimal competence in one of the four linguistic skills as bilingual." (Groot, 2011, p. 4) There are many variables which must be taken into account when defining a bilingual person. For example, Wei (2007, p. 5) argues that the most important are: age and manner of acquisition, proficiency level in specific languages, domains of language use and self-identification and attitude. While some researchers see proficiency as the defining criterion, e.g. Braun or Bloomfield define bilingualism as active, complete and balanced mastery of two languages (Lachout, 2017, p. 34), others put emphasis on language

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[1] Within this thesis the terms „bilingualism" and „multilingualism" will be used interchangeably.

use, e.g. Weinreich or Mackey argue that "bilingualism is the use of two or more languages (or dialects) in everyday life" (Grosjean & Li, 2013, p. 7).

As the number of defining criteria can be confusing, here follows a summary of some of the most common. They can be used not only for definition of who is and is not bilingual, but also for further classification of bilingual speakers into multiple categories:[2]

1. **Identification**: Do other native speakers accept the person as a speaker? Does the person themselves identify with both languages, language communities and cultures?

2. **Proficiency/Relative competence**: Does the speaker possess similar degrees of proficiency in both languages ("balanced bilingual") or is the proficiency in one of them higher ("dominant/unbalanced bilingual")? Are they only able to understand written or spoken word ("passive bilingual") or are they also capable of language production ("active bilingual")?

3. **Age of acquisition**: Since when did the person begin learning their languages – birth/childhood ("early b.") or adolescence/adulthood ("later b.")?

4. **Manner of acquisition and use**: In what way did the person acquire their languages? Was it at the same time ("simultaneous b.") or was one of them first ("sequential b.")? Was it from family members or at school? If at school, was it used as the language of instruction or learned as a second language?

5. **Language status**: Are both languages equally socially valued and encouraged ("additive b.") or is one of them seen as less prestigious and there is social pressure not to use it ("subtractive b.")? Do we speak about the usage of more than one language on the level of individual speakers, communities or states? What functions do they fulfil, what is their status?

The situation is further complicated by a few misconceptions about bilingualism common both among some researchers and the general public. One of the most widespread is the idea that in order to be "properly" bilingual one needs to possess equal fluency in both of their languages (Wei, 2007, p. 5). This has manifested in a palpable way when some of the potential

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[2] Based on (Lachout, 2017, p. 33-39) and (Groot, 2011).

participants who we tried to recruit for the purpose of this thesis declined, even though they grew up in Switzerland or live and work in Austria, because they were afraid of "not being bilingual enough" due to their accent or lack of experience with using German in academical context. In reality, for the majority of speakers the opposite of perfect balance is true. Grosjean calls this the Complementarity Principle: „Bilinguals usually acquire and use their languages for different purposes, in different domains of life, with different people. Different aspects of life often require different languages" (Grosjean & Li, 2013, p. 12). What does it mean in practice? One person can grow up in Brno with German as the language of their mother and Czech as the language of their father. Because learning English is mandatory and the person later studies programming at university, English slowly becomes their preferred language in academia and at work. This person finds it natural to use German (with a noticeable Czech accent) when discussing emotional issues with their mother but struggles when trying to explain their new work project to her, as they never thought about programming tasks in other language than English. This person could be considered monolingual or trilingual, depending on the criteria.

Another misconception regarding bilingualism can be the presumed constancy in language abilities in a bilingual's respective languages. Over their lifetime, these abilities are by no means stable, but fluctuate, sometimes even to the point of complete loss.[3] This makes the task of defining and classifying a bilingual even more complicated but is nevertheless a relevant point to keep in mind when selecting individual bilinguals for a study (Wei & Moyer, 2008, p. 79).

In order to circumvent some of the above-mentioned difficulties and obtain results which would be comparable across studies a number of self-report questionnaires has been developed and utilized by teams across the world, sometimes in combination with standardized proficiency tests[4] (Marian & Hayakawa, 2021, p. 530). To name some of the most frequently used, there is the Language and Social Background Questionnaire (LSBQ) (Anderson

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[3] For more on bilingual attrition, see Pavlenko (2009, p. 209) or Schwieter (2015, p. 645).

[4] Whereas some studies indicate that proficiency levels reported by bilinguals are consistent with those obtained by objective measures (Brantmeier et al., 2012; Scholl et al., 2021), other put these findings in question (Wagner et al., 2022).

et al., 2018), which covers a broad range of variables and was prepared based on the results of more than 600 participants, but is only reliable for bilinguals and cannot be used on multilingual speakers. Then there is the Language History Questionnaire (LHQ 2.0) (Li et al., 2014), whose newer versions offer useful online tools and the scope of questions can be adjusted, but some of the versions in other languages were translated by machine and the interpretation instructions can be unclear. The Language Experience and Proficiency Questionnaire (LEAP-Q) (Marian et al., 2007) can be used on multilingual speakers and also covers a broad range of aspects of bilingual life, but some researchers point out the insufficient number of respondents (ca 50) and other methodological issues (Anderson et al., 2018, p. 251). As can be seen, each of these questionnaires has its strong points, but also limitations which need to be taken into account when choosing between them.

In conclusion, there is no unified way of assessing individual bilingualism, but the discussion is going on and some progress has been made in the development of assessment tools. Because the findings of bilingual studies are somewhat inconsistent, which is oftentimes blamed on inconsistent research methods (Grosjean, 1998), a broad range of responses to such criticism has developed in the community of researchers, e.g. Wagner and Bialystok (2022) argue that bilingualism is not a categorical variable at all, on the other hand Marian and Hayakawa (2021) propose a unified bilingual quotient similar to IQ. On closer inspection, the differences between these perspectives diminish, as most of them aim at similar goals: more nuanced approach to defining bilinguals, increased transparency in presentation of obtained data and selection criteria, as well as deeper cooperation between research groups and possible further agreement on assessment criteria enabling interstudy comparison.

Depending on the understanding of what constitutes a bilingual speaker, there can be an overlap between the field of bilingual studies and research of second language acquisition (SLA). Dörnyei (2009, p. 21) offers an overview of commonly accepted differences between learning of L1 and SLA, in the first place proficiency and acceptance by speakers, but also the type of language input and amount of exposure, implicitness vs explicitness of instruction, etc. However, as noted by him and also the previously cited article by Bialystok and Wagner (2022), the borders between SLA and bilingual acquisition are not always clear. The existence of speakers who attained native-like proficiency even when they had started learning their L2 in

adulthood suggests that bilingualism is more of an emergent property with multiple components than a distinct category.

In research that explores bilingualism from a psycholinguistic perspective, it is common practice to define a bilingual person broadly as anyone who has achieved proficiency in two languages (Chen et al., 2015; Wei & Moyer, 2008, s. 214). Nevertheless, as will be further discussed in a later section on bilingualism and emotionality, the context of acquisition and use can be an important factor in processing emotional words. For that reason, for the purpose of this study the recruitment criteria originally specified that the Czech-German bilinguals need to have high proficiency in both languages (equivalent to C1 or higher according to CEFR) and use them regularly with friends and family. The recruitment process, its adjustments and characteristic of the bilingual participants will be further discussed in section 3. Method.

2.1.2 Czech-German Bilingualism in Czechia

After the previous section which offered a general overview of bilingualism, now is the time to focus on the particular group of interest of this study – the Czech-German bilinguals. Even an attempt to summarise the long and complicated history of the phenomenon would go far beyond the scope of this thesis, which is why we concentrated only on two aspects of the current situation:

> a) how many Czech-German bilinguals live in Czechia at the moment and what are the most recent developments in their numbers,

> b) what is the state of Czech-German bilingual education, eventually how many students learn German as foreign language in Czechia.

These two questions seemed the most pertinent to the topic of this thesis – if we examine the differences in word processing between Germans and bilinguals, it is relevant to know how many speakers this might concern. The question of bilingual education will be summarised only very shortly, but nevertheless we decided to include it because many respondents who participated in the study had experiences with it and the contact networks among their absolvents were used during the recruitment of participants.

Just to put the current numbers in a bit of historical context, there have been speakers of German in the present-day territory of Czechia for more than ten centuries (Kaplan & Baldauf, 2008) and just a hundred years ago there were more than three million residents of this area

with German as their nationality, comprising almost one third of the population,[5] with varying levels of bilingualism (Čmejrková & Nekvapil, 2003). As a consequence of the Second World War and the following displacement and assimilation, the numbers of autochthonous Czech Germans have drastically fallen to only tens of thousands (Nekvapil et al., 2009), with new speakers being mostly immigrants from Germany, Austria and Switzerland. In spite of that development, German is still a language of an officially recognised national minority and protected by the European Charter for Regional or Minority Languages.[6] As mentioned in the previous chapter, the role of identification with the language and community is an important aspect of understanding bilingualism, even though the influences are not always necessarily as straightforward as one might expect – for illustration, one of the bilingual participants of this study who grew up with Czech and German since birth, lived in Germany and was completely proficient, did not identify with any aspects of German culture at all, whereas another participant who began acquiring German in late childhood had much higher levels of identification, used German in daily life much more often and in a wider variety of contexts and took part in the activities of the German community, even despite their comparatively stronger accent.

After setting our subject of investigation into some historical context,[7] let us now turn to the present situation and ask the first question – how many Czech-German bilinguals are there?

Bilingualism and Census

While it is not possible to ascertain the exact number and type of Czech-German bilinguals directly, we can obtain a general idea of the situation with the help of census data. The following figures are based on the latest census in Czechia, which was carried out in 2021, and

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[5] In the territory of Bohemia, Moravia and Czech Silesia in 1921 the precise number was 3 061 369 people (30.6 % of overall population), growing to 3 149 820 (29.5 %) in 1930 (Velčovský, 2014, p. 149).

[6] During the work on this thesis, the protection under the second section of the Charter was in eight districts extended to a higher level with future impact in the spheres of education, media, judiciary and administration. For more details see "Council of Europe - Newsroom" (2024).

[7] For further details on the historical developments see Velčovský (2014) or Kaplan and Baldauf (2008), for representation and activities of the German minority in Czechia see *Landesversammlung der deutschen Vereine in der Tschechischen Republik* (2024).

published by the Czech Statistical Office (*Census 2021*, 2022).[8] In 2021, from the total Czech population of 10 524 167, about 0.3 % (31 756) of respondents identified German as their mother tongue.[9] Approximately one third of these speakers (10 151) indicated German exclusively, while the other two thirds (21 605) chose German in combination with another mother tongue. As illustrated in Table 1, after a small peak in 2001, both the proportion and total number of speakers with German as the sole mother tongue have decreased sharply.

Year of the Census	Total population	German as exclusive mother tongue - total	German as e. m. - proportion
1991[10]	10 302 215	40 907	0.39 %
2001	10 230 060	41 328	0.40 %
2011	10 436 560	14 148	0.13 %
2021	10 524 167	10 151	0.10 %

Table 1 Mother tongue

Regarding ethnicity, if we compare the number of speakers with the number of people who self-identify as Germans, we can observe an analogous tendency. The question was voluntary, with the possibility of up to two ethnicities, and even if we consider that almost one third (31.6 %) of respondents in 2021 has decided to leave it unanswered, as shown in Table 2, there is a visible downwards trend. Lachout (2017, p. 103) explains this by the combination of gradual extinction of the older generations with simultaneous absence of a younger generation, which would identify with German ethnicity.

Year of the Census	Total population	German as exclusive ethnicity - total	German as e. e. - proportion
1991	10 302 215	48 556	0.47 %
2001	10 230 060	39 106	0.38 %
2011	10 436 560	18 658	0.18 %
2021	10 524 167	9 128	0.09 %

Table 2 Ethnicity

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[8] The statistical data are published according to the Act No. 89/1995 Sb., on the State Statistical Service, as amended. Further explanation of the terms of use is available via *https://www.scitani.cz/conditions-for-use-of-the-statistical-data*

[9] As explained on the page under "Explanatory notes" *"The mother tongue was stated as the language spoken with the enumerated person as a child by his/her mother or those who raised him/her (the first language the enumerated person learned to speak). It was possible to state two languages."*

[10] Because at this time Czechia still formed a part of Czechoslovakia the figures for the year 1991 in both charts include only the population of the Czech parts of the federation, i.e. Bohemia, Moravia and Czech Silesia.

Other possible explanation of the decrease of **exclusive** Germans could be their gradual shift to a combined German-Czech ethnic and/or bilingual identity. This might be supported by the increase of people who identify ethnically both as Czechs and Germans – from 6 158 in 2011 to 13 637 in 2021. In contrast, the number of respondents with Czech and German as their mother tongue was 26 642 in 2011, while 21 605 respondents chose German in combination with another mother tongue (presumably Czech) in 2021.

The situation is further complicated by two major factors. First the Covid-19 pandemic, which has strongly influenced the movement of people across borders with Austria and Germany around the time the 2021 census data have been collected. And second, the number of terms which are used when speaking about ethnicity and language and their various combinations. For example, some respondents are not included in the ethnic category of Czech-Germans, because they consider themselves Moravian-German or Czech-Austrian, or even European. Another example might be the 16 523 people who are not included in the Czech native speakers, because they stated their mother tongue to be exclusively Moravian, even though Moravian is generally not considered to be a separate language from Czech, possibly not even a unified dialect ("CzechEncy", 2012-2020).

It is hard to obtain comparable data from the German point of view (i.e. the number of people who live in Germany with Czech as their mother tongue) because of methodological differences between the two national censuses. Additionally, results of the latest German census, which took place in 2022, will not be made public until later in 2024 ("Ergebnisse 2022"). Because this thesis concentrates on the situation in Czechia, the question was not followed further, but for establishing at least an idea of the scale – according to the earlier results of the 2011 census, from the total German population of 80 219 695, there were 32 798 citizens of Czechia ("Bevölkerung 2011").

In summary, if we consider the official demographic indicators and use the definition of mother tongue (and respectively bilingualism) applied by the Czech national census, we may arrive at the approximate number of lower tens of thousands of Czech-German bilingual speakers, with a decreasing tendency.

Bilingual Education and German as Foreign Language

Another way of looking at the Czech-German bilingual situation is to consider the number of those speakers who learn German in a formal setting. Although most of them would not be considered bilingual in a stricter sense, as was shown in the previous section the autochthonous German and Czech-German population in Czechia is in decline, and thus migration and education present the most probable "source" of new bilingual speakers. This point of view was considered relevant also because bilingual Czech-German education facilities and organisations played a significant role during the recruitment phase of this study and because from the final 19 bilingual participants 11 learned German also in school besides in family.

According to the newest data of the German Federal Foreign Office on the number of learners of German as a foreign language (Deutsch als Fremdsprache), in 2020 there were around 352 980 such students in Czechia ("Deutsch als Fremdsprache weltweit. Datenerhebung 2020", 2024). This number includes pupils in the official school system (350 558) and also learners of all ages (2 422) who attend the language courses at Goethe Institute in Prague, which is an independent cultural association supported by the GFFO (*Goethe-Institut Tschechien*, 2024). From 5 536 schools which provide foreign language classes, 3 398 offer German. In contrast to other countries, the report did not include any specific number of learners outside the system and as university subject, but it mentioned 54 colleges/universities with German courses and estimated that they were attended by about 9 000 students. It is hard to assess the total number of learners, but it is probably much higher than the figures of the GFFO, since German courses are also frequently offered at work by employers, some people prefer personal online tutors or other language schools, etc.

If we focus specifically on bilingual education, there are currently six Czech-German bilingual schools in Czechia: one primary school in Prague and five grammar schools in Prague, Liberec and Znojmo[11] (*Ministerstvo školství, mládeže a tělovýchovy*, 2024). German is also sometimes used as a language of instruction on other levels of the education system. Some grammar

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[11] They are: *ZŠ německo-českého porozumění, Gymnázium F. X. Šaldy, Gymnázium Thomase Manna, Gymnázium Dr. Karla Polesného, Rakouské gymnázium v Praze - Österreichisches Gymnasium Prag* and *Deutsche Schule Prag - Německá škola v Praze*.

schools offer expanded instruction in German[12] and the Czech Ministry of Education, Youth and Sports actively participates on a bilingual school project in Saxony.[13] Especially in the last few years, the offer has expanded also to children's groups and kindergartens.[14]

Another aspect of Czech-German bilingual education, which should not be underestimated also from the psycholinguistic perspective, is the role of English which has been expanding both in the Czech education system and globally as lingua franca. The percentage of Czech pupils at primary and secondary schools who chose German as a foreign language has fallen inversely with the rise of learners of English (Velčovský, 2014, p. 238). Without exception all of the participants who were recruited for the experiment, both in the German and the bilingual group, were also speakers of English, and frequently some other languages like French, Spanish or Dutch. This should be taken into account during the selection of suitable questionnaires and experimental design (e.g. LSBQ is not validated for multilinguals), or at least when examining the effects of bilingualism the participants should be inquired about their knowledge of a third language. In the case of this study, almost a quarter of the German participants had to be excluded because it turned out they were raised with multiple mother tongues.

This section has attempted to provide a brief overview of the state of Czech-German bilingualism and also to identify the key aspects of bilingualism in general. In the following part we will move on to discuss emotional dimensions of words and subsequently the specific interaction between emotionality and bilingualism.

2.2 Emotional Words and Dimensions

2.2.1 Characteristics of Emotional Words

In the field of psycholinguistics there is a large and ever-growing number of factors which are known to play a role in the way our brains process words and language in general, among many others word length and frequency, age of acquisition, social context, concreteness and abstractness, etc. However, one important factor remained for a long time underexplored – namely the influence of emotions not just on language, but cognitive functions generally

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[12] *Gymnázium Na Pražačce - šestileté gymnázium s rozšířenou výukou německého jazyka*.

[13] *Friedrich-Schiller-Gymnasium Pirna - Gymnázium Friedricha Schillera v Pirně*.

[14] *Bilingualis: Deutscher Sprach- und Kulturverein für bilinguale Kinder in Prag* and *KIDS Company Praha: česko-německá školka - tschechisch-deutscher Kindergarten*.

(Schiewer et al., 2022, p. 47). This has been the case not only in linguistics, but also psychology and cognitive science for a better part of the twentieth century (Dörnyei, 2009, p. 219; Schiewer et al., 2022). And even with the later progress in the fields of affective neuroscience and neurolinguistics, these two traditions remained largely separated – while neurocognitive affective studies concentrated on the processing of pictorial and facial stimuli, neurolinguistics focused on the neural bases of lexical, syntactic, semantic and other similar processes, paying little attention to the effects of emotions on these processing levels (Hinojosa et al., 2019, p. 814).

Nevertheless, the interest in this problematic has been growing for the last two decades, going hand in hand with the increased use of neuroimaging technologies in language research, producing a body of studies concerned with the interplay of emotions and language, especially the so called "emotional words".[15] Attempts at closing the former gap between neurolinguistics and affective neuroscience have been made under the proposed framework of affective neurolinguistics, which tried to summarise the research findings so far, establish a common methodology and formulate future questions.[16] It is in conversation with this line of research that we wish to carry out this study.

One key concept already mentioned above are the emotional words. As with bilingualism, no single definition exists, but there are a few key approaches which have been used to define and operationalise emotional words and which have gained prominence, which we attempt to summarise in the following paragraphs.

First, there is the **intuitive approach**, which relies either on simply stating examples of words that the researcher considers to be emotional or taking word lists which have already been used in older studies. A development of this way of thinking is the **propositional approach**, which uses some sort of proposition to determine whether a word describes a genuine emotion, e.g. Clore et al. (1987) use the formulations "feeling something" and "being something" to make this distinction. Because *angry* fits both "feeling angry" and "being angry", they see it as a genuine emotion, in contrast to "feeling like eating Chinese food". Going further,

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[15] For a review of these studies see Kissler et al. (2006) and Citron (2012).

[16] For the proposal see Hinojosa et al. (2019), for discussion van Berkum (2020), Herbert (2020), Kissler (2020) and Wu and Zhang (2020).

they developed a taxonomy system to organise words, with the group of Internal Affective States seen as the most prototypical. Their system was used by other researchers, e.g. Church et al. (1998) applied it to speakers of Tagalog with mixed results. Another formulation used by Carson and Wallace (1973) is "He has a feeling of …" and "He feels …", which they applied to nouns and adjectives one by one when going through a dictionary. The intuitive approach was criticised for its inexactness, whereas in the case of propositional approach some researchers argue that it is limited to languages like English or French, but cannot be applied to Polish or Russian because of a fundamental difference in the way emotions are expressed in them.[17]

An alternative way to describe the emotional values of words is the so called **dimensional approach**, which poses that there are a few universal dimensions or scales on which all stimuli can be judged.[18] The range of stimuli is not restricted to words, dimensions can be used to assess emotionality of faces, scenes, objects, etc. (Herbert, 2020). An example of such dimensions is the E-P-A triad (Evaluation, Potency and Activity) developed by Osgood (1969, Osgood et al., 1975). Other combinations of dimensions might include intensity, valence, familiarity and duration (Niedenthal et al., 2004), pleasure-displeasure and activation-deactivation (Russell, 2003) or arousal, pleasantness and dominance (Church et al., 1998). However, the most prominent pair of dimensions is **valence** (pleasant or unpleasant) and **arousal** (low activation/calm or high activation/tension) (Hinojosa et al., 2019). The effects of valence and arousal, as well as their interplay are a frequent subject of affective neurolinguistic studies (e.g. Espuny et al. (2018), Citron (2012), Bayer and Schacht (2014) or Recio et al. (2014)). The dimensional approach has a number of advantages: it is easy to operationalise, universally applicable and the high number or studies with similar method opens up the possibility of comparison of results. For these reasons, valence and arousal were chosen as the preferred dimensions to be used in this thesis. While some previous studies used the dimensional approach to identify neutral and emotion words (i.e. if a word accumulates higher rating on the dimensional scales than an arbitrarily set value, it is considered to be an emotion word), we decided to utilize this concept as an assessment tool which can be applied to any word in order to assess its perceived emotionality by respondents. (More on this in the chapter 3.2 Stimuli.) This approach has also its weaknesses, e.g. the arbitrariness of the cut-off line for

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[17] For further discussion, see Pavlenko (2008).

[18] For an overview, see Panayiotou (2008).

rating values and other perceived issues were subject of criticism from multiple perspectives, whose points and general positions we will now also address.

First of them and overall the third approach presented here has, as far as we know, no established name, and will thus be called the **functional approach** for the purpose of this study. Proponents of this approach argue that emotion words have specific characteristics which separate them from other abstract words (Altarriba, 2018), that they are processed differently in the brain (Foolen et al., 2012; Landis, 2006) and most importantly that there is a further division among two or more types of emotion words which can differ in the way they are processed even among themselves (Schwieter, 2015; Wu & Zhang, 2020; Zhang et al., 2020). This subdivision is a matter of debate, but based on their function, there is a tendency to distinguish at least between two:

> a) *emotion words/emotion-label words*, which are "words that directly refer to particular affective states ('happy', 'sad') or processes ('to worry', 'to rage'), and function to either describe ('she is sad') or express them ('I feel sad')" (Pavlenko, 2008, p. 148).

> b) *emotion-laden words*, which are "words that do not refer to emotions directly but instead express ('jerk', 'loser') or elicit emotions from the interlocutors ('cancer', 'malignancy')" (ibid.).

Pavlenko mentions a third additional category called *emotion-related words* "('tears', 'tantrum', 'to scream') which describe behaviours related to particular emotions without naming the actual emotions," but comments that there is a lack of consensus whether to regard them separately or whether they belong to one of the aforementioned subcategories.

From the functional point of view, the dimensional approach lacks a clear-cut criteria for selection of emotion words and additionally ignores the emotion-label vs emotion-laden distinction. While keeping that in mind it is to be noted that one does not necessarily exclude the other – some researchers combine components of both the dimensional and functional approaches (e.g. Moseley et al. (2012) or Knickerbocker and Altarriba (2013)). Nevertheless, the functional approach is also not without its critics. Hinojosa et al. (2020) argue that the behavioural evidence for the emotion-label/emotion laden division is inconclusive, citing studies that have failed to report a difference in their processing (e.g. Martin and Altarriba

(2017)) as well as others with methodological issues. Some other studies have had mixed results (Wang et al., 2019). More importantly, as noted by Pérez-Sánchez et al. (2021) the distinction between emotion-label and emotion-laden words was done intuitively in these studies, indirectly circling back to the propositional approach. Considering all this, we found the functional approach to be too controversial and unclear and thus decided not to implement it.

The last approach to be presented here is the **basic/discrete emotion approach**, which assumes that "there exists a limited number of qualitatively different, hard-wired and universal emotional processes … (and) a core set of emotion terms is assumed to have the basic emotions as their referents" (Fontaine, 2013, p. 39). Any additional emotion words can be then described using the three factors of intensity, context and blending of the basic terms/emotions. The most prominent theory in the basic emotion approach was developed by Ekman (1992), with his proposed basic emotions being: happiness, surprise, fear, sadness, anger and disgust. Although the research carried out based on the basic emotion approach has mostly concentrated on facial and vocal expressions (Fontaine, 2013), there have recently been studies which used it in the field of psycholinguistics, some even arguing that the concept of basic emotions has more explanatory power than the dimensional approach (Briesemeister et al., 2011; Silva et al., 2012). Despite these developments, the basic emotion approach was considered to be unsuitable for the purpose of this study for three reasons. Besides the lack of agreement about the basics (e.g. the abovementioned work by Briesemeister et al. uses happiness, disgust, fear, anger and sadness, but does not use surprise like Ekman), there are only a few studies which combine it with neuroimaging methods and as stated by Tracy and Randles (2011), its proponents generally agree that the basic emotions originate in subcortical brain areas which can be monitored by tools such as fMRI, but are inaccessible to fNIRS, which was used in the present study.

Having introduced the concept of emotional words and dimensions, with the dimensional approach chosen as the best way to operationalise it for the purpose of this study, in the following section we will review the literature related specifically to the relation of emotionality and bilingualism. With it the theoretical part of the thesis will be concluded, and it will also serve as a basis for formulation of the experimental hypotheses.

2.2.2 Emotionality and Bilingualism

A number of studies have tried to examine the mutual influence between language emotionality and bilingualism with inconclusive results (Caldwell-Harris, 2015; Ferré et al., 2018). Whereas some groups of researchers have found a significant difference between the ways bilingual speakers process emotion words in their two languages (e.g. Degner et al. (2012), Chen et al. (2015) or Ayçiçeği and Harris (2004)), results of other teams did not corroborate these findings (e.g. Conrad et al. (2011), Champoux-Larsson and Nook (2024) or Ponari et al. (2015)). When there are differences, the tendency seems to be that if one of the languages is learned later or to a lesser degree of proficiency, it is subjectively perceived as less emotional (Champoux-Larsson & Nook, 2024) and "that processing words in L1 is more strongly modulated by emotional factors than processing the same words in L2" (Weimer et al., 2022). This tendency is referred to as **reduced emotional resonance** (Harris et al., 2003) and can manifest in a variety of ways, such as multilinguals perceiving taboo and swearwords in their L1 as stronger compared to L2 (Dewaele, 2004), smaller pupillary responses to L2 (Toivo & Scheepers, 2019), or childhood reprimands eliciting larger skin-conductance responses when presented auditorily in L1 compared to L2 equivalents (Harris et al., 2003).

Importantly, not all studies showed the reduced emotional resonance in the non-dominant/later language, with the researchers offering diverse explanations. For example, Eilola et al. (2007) conducted an experiment in which late unbalanced Finnish-English bilinguals showed similar effects in a Stroop paradigm in their L1 and L2, which the authors explain by their high proficiency in L2. Similar results were obtained by Sutton et al. (2007) in a Stroop paradigm experiment by Spanish-English bilinguals, with high proficiency and age of acquisition being considered as explanatory factors, whereas Harris (2004) and Harris et al. (2006), who compared early and late English-Spanish bilinguals' skin-conductance reactions to emotion-laden words, interpreted the lack of difference which was measured by the late, but not early bilinguals as a function of the age and manner of L2 acquisition.

What cause lies behind these discrepant findings? Besides issues such as inconsistent methods and diverse types of bilinguals used across studies which might be to blame for unclear or contradictory results, there are also theoretical proposals that focus on the context of language acquisition and usage as possible explanatory factors. Winskel (2013) explains the lower arousal as well as overall lower emotional reaction to L2 words as depending on the

context of acquisition – if the language is learned in the home environment, it is possible to build connections between the underlying emotions and the corresponding words. On the other hand, if the language is learned in a more formal setting such as school, the emotional connection is weaker. Likewise, Degner et al. (2012), who worked with a group of sequential French-German bilinguals, show evidence for increased L2 emotionality depending primarily on the frequency of use and immersion into the language environment. Both of these proposals can be summarised and further developed through the so-called **emotional context of learning hypothesis** (Caldwell-Harris, 2014), which proposes that "words and phrases accrue emotional resonances when they have been learned and used in emotional contexts" (Caldwell-Harris, 2015). The hypothesis does not deny the influence of the other abovementioned factors, but rather shows how they are interconnected "In the broader literature on L1/L2 effects, these four factors (i.e. high usage frequency, early age of acquisition, high proficiency and learning through immersion rather than formal instruction) are linked in reciprocal, causal relationships, and indeed, are important for determining individual differences in bilingual experiences and abilities. Early age of acquisition typically results in high proficiency; high proficiency usually leads to frequent use. Frequency of use improves proficiency; immersive learning leads to higher frequency of use and better proficiency" (Caldwell-Harris, 2014).

Despite the ongoing debate about the advantages and disadvantages of this theory and its supporting evidence,[19] it is widely accepted by researchers and together with the concept of reduced emotional resonance it offers a practical starting point from which the hypotheses to be tested in this study can be formulated. Based on the emotional context of learning hypothesis and previous studies, what results are to be expected? **Firstly**, if we measure the response (behavioural as well as neurophysiological to words in the context of emotional dimensions, whether there will be any difference depends on the level of bilingualism of the Czech-German group. If the group is sufficiently bilingual, no major differences are to be expected. **Secondly**, if the group is too Czech-dominant, we expect the levels of emotionality in German to be lower – the effect of reduced emotional resonance manifesting as lower levels of arousal and narrower range of valence. And **finally**, if there are internal differences in the

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[19] For further discussion and criticism see Ferré et al. (2018).

bilingual group as to the variability in ratings of the German words, they will correspond to the context in which the participants learned and used the language.

So far, this thesis has focused on the theoretical framework and social background. Now, after having formulated the hypotheses, we will proceed to the description of the methods which were chosen for their empirical testing.

3. Method

In order to examine our hypotheses about the supposed differences in emotional responses in bilinguals, an experiment was carried out. In this experiment two groups of participants were presented with the same set of German words and given a task to evaluate them on a scale measuring simultaneously valence and arousal. During the task, their brain activity was recorded using fNIRS (functional near-infrared spectroscopy), so that two types of data were obtained: behavioural and neurophysiological.[20] This experiment was based on an earlier reference study conducted by a team of scientists from University Heidelberg and the Institute of Psychology of the Czech Academy of Sciences. The aim of the reference study was to establish a new method of collecting word ratings in emotion dimensions and was tested on two groups of Czech and German speakers (Gerwien et al., in preparation). For the purpose of our new experiment, which has a different goal, a third group of Czech-German bilingual speakers was tested using the same set of stimuli and experimental design and their results were analysed and compared with the older data from German speakers.

The study was approved by the Institute of Psychology of the Czech Academy of Sciences Ethics Committee. Participants gave written informed consent prior to taking part.

3.1 Participants

The recruitment of bilingual speakers was carried out in two phases, using a variety of methods: the database of potential participants provided by LABELS,[21] recruitment via Goethe Institut Prag, Facebook groups of the German minority in Czechia, graduates from bilingual grammar schools as well as personal contacts in the bilingual community and word of mouth. During the first phase, the scope of contacted members of the LABELS database was restricted only to those with explicitly stated high proficiency in German and there was no prospect of

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[20] An additional third type of data (physiological) was recorded using an eye-tracking device for pupillometry. Because fNIRS data acquired from adults are limited by the nature of light transport properties of tissue to the cortical regions, the dilation and constriction of the pupil might be used as a substitute indicator of activity of subcortical parts of brain. However, the analysis of this physiological data goes beyond the scope of this thesis and is intended for a future study.

[21] The Laboratory of Behavioural and Linguistic Studies is a joint facility of the Faculty of Arts (Charles University) and the Institute of Psychology of the Czech Academy of Sciences.

financial compensation, only credits for those who were students. The formulation of requirements was also stricter, calling for regular use of German with family and friends.

Despite the effort, not enough participants enrolled, which necessitated a change of criteria during the second phase. The following formulation of requirements was the final used:

> *We are looking for bilingual speakers of Czech and German who: a) either learned both languages from birth/childhood and/or b) have a high level of proficiency in both languages (equivalent to C1 or higher) and use both of them regularly.*

Additionally, they were promised a 300 CZK voucher and this time all members of the database were contacted (more than 6 500 people). The final formulation was less strict but tried to factor in the aspects discussed here in the section on general characteristics of bilinguals, namely: age of acquisition, proficiency and frequency of use. Even though these changes led to the desired increase in number of enrolled participants, it had the adverse effect of many people reading the requirements only up to the part which mentioned financial compensation and not further. For that reason, each of the people who registered for participation was in advance directly contacted to check that they fulfil the criteria.

To assess the type and level of bilingualism, the Czech-German participants filled in a modified version of the Language History Questionnaire (LHQ 2.0) (Li et al., 2014). The LHQ 2.0 was chosen because of its suitability for speakers of more than two languages as well as its online interface and automatic analysis and visualisation of results. A high number of respondents were expected to speak at least one additional language to Czech and German, which turned out to be the case – aside from the anticipated English, Slovak and Vietnamese, there were also trilingual combinations with French or Spanish, but also Norwegian, Dutch etc. After a consideration whether to administer the questionnaire in German or in Czech, the Czech version was given preference, because the school systems vary widely across the German speaking territories and it would be hard to answer the questions on educational background for speakers who live in Czechia and most likely participated in the Czech education system. The issue of choosing an appropriate language of instruction will be further discussed in the section on procedure.

Although one of the anticipated benefits of the LHQ 2.0 was supposed to be a multidimensional score for each participant with a recommended cut-off rate of those with

too low values, the online user interface of the questionnaire was unexpectedly out of service during the administration, which besides the translation into Czech necessitated also printing it out and filling in manually, making the calculation of numerical scores impossible. Despite this, the printed and translated questionnaires could at least serve as the source of basic characteristics of the respondents.

Participants in both groups, bilingual and German, were required to be of age and have no visual or hearing impairments (or vision corrected to normal), as well as no neurological diagnosis or use any psychopharmaceuticals.

From the original 23 bilingual persons, 22 completed the experiment to the end. As a sort of shibboleth or reliability check, those who rated the word *giebel* (gable) in any way were after the end of the experiment asked to explain what it means, because the word is not very frequent. This and a following discussion revealed that one participant had been clicking at random, because they did not have sufficient knowledge of German, which resulted in them being removed from the dataset, together with two other participants who were using psychopharmaceuticals. In the end the bilingual group consisted of **19** speakers (mean age 21.7, 11 female, 1 non-binary and 7 male).

The socio-demographic data of the German group were collected a few months earlier using a different, shorter questionnaire. Even though it would be preferable to use an identical assessment tool for both groups, the privacy protection procedures prevented us from contacting the German participants and asking them to complete the questionnaire post hoc. The important fact is that besides the same age and ability requirements as the bilingual group, the German participants had to be brought up with only one mother tongue. From the 26 German respondents, 22 completed the experiment. The questionnaire has shown that 4 of them were brought up with multiple mother tongues (French, Russian, Polish and Portuguese) and two other had either been using psychopharmaceuticals or had a neurological diagnosis, which lead to their exclusion, leaving **16** German respondents (mean age 24.9, 9 female and 7 male). They were compensated for their participation either with 15 EUR or credits.

3.2 Stimuli

As stimuli were chosen 114 German words taken from the Berlin Affective Word List Reloaded (BAWL–R) (Võ et al., 2009), which contains normative ratings of valence, arousal, imageability

and other factors. The stimuli set was based on the set used in the reference study in order to be able to draw comparisons between the two groups. One potential restraint resulting from this was that the stimuli were not further controlled in terms of lexical variables (frequency, abstractness, length, etc.), because the decisive selection criterion of the reference study was that the Czech and German words were equivalents in terms of translation and also their emotionality – they obtained similar ratings of valence and arousal. Nevertheless, this has the additional benefit of limiting the lexical interference of the Czech equivalents (i.e., if the bilingual participant gives a particular valence rating to the word *schwimmen* (to swim), we know that it is not influenced by the valence of its Czech counterpart *plavat*, because their values of valence are the same). More importantly, both the German and the bilingual group rated the exact same set of words (only in German). The words were presented auditorily and in random order.

As stated in the discussion on emotion words, this thesis uses the concept of two emotional dimensions as a universal characteristic which may be applied to any word (the dimensional approach), meaning that it was more important that the stimuli cover the affective space well (representing words with high arousal and negative valence, low arousal and positive valence, and so on), rather than if they belong to a preselected group (the functional approach). The analysis done by Gerwien et al. (in preparation) has shown that the set is indeed spread relatively evenly across the affective space.

The participants were instructed to leave any unfamiliar word without rating. Based on this, from the list of 114 words, five were left out from the subsequent analysis, because less than 75 % of the participants responded to them. They were: *giebel* (gable), *ahorn* (maple), *möhre* (carrot), *falte* (wrinkle/a fold) and *predigen* (to preach).[22] Consequently, the final list consisted of **109** separate words. To assure the consistency of vocal parameters, the audio stimuli were created using a synthesised female voice with the standard accent of Germany ("Cloud Text-to-Speech", 2024).

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[22] According to the rules of German orthography, even common nouns are capitalised. Some of the words in the set have multiple meanings which cannot be distinguished on auditory basis alone, e.g. *Wissen* (knowledge) vs. *wissen* (to know). So as to maintain this ambiguity, within this thesis, all words will be written with small letters.

3.3 Instructions and Procedure

Before the whole session, each participant was informed about the course of the following procedure and gave their informed consent. After completion of the questionnaire followed the set-up of fNIRS cap and optimisation of signal quality. The first part was conducted in German for the German participants and in Czech for the bilinguals. During the experiment, participants were seated in front of a computer screen with the fNIRS cap on and their head was fixated in a comfortable position on a stand. The instructions were presented visually and the stimuli by loudspeakers. The instruction phase and the experiment were in German for both groups. The experiment itself took ca 20 minutes, 40 including the setting up of measuring devices and the trial phase, plus another 20 for the questionnaire, so overall each participant spent about 1 hour 15 minutes in the laboratory.

In planning of the study, the choice of appropriate language of communication with the bilinguals was considered since it could potentially influence the results. On the one hand, since the procedure was already taxing enough due to its length and because it is generally recommended in such situations to let the participant choose the language they feel most comfortable with (Wei & Moyer, 2008, p. 166, 172), we considered the option of providing two versions of the questionnaire and also offering to communicate either in German or Czech in an effort to provide a welcoming setting. On the other hand, this would create one more undesired variable (who chose which language of instruction?), and more importantly, it could influence the language mode of the respondent. The concept of language mode, proposed by Grosjean (1998, p. 136), denotes "… a state of activation of the bilingual's languages and language processing mechanisms." This does not mean the binary choice between using L1 or L2, but rather the position on a continuous scale between the activation of just one language (regardless of it being L1 or L2) and the full activation of both (e.g. in a situation where two bilinguals communicate while code-switching). Because the mode is believed to play a role in language processing, some studies tried to control for it by inhibiting the activation of L2 through methods such as putting their participants in strictly monolingual setting (Spivey & Marian, 1999), or even recruit trilingual speakers while sophisticatedly hiding that their multilingualism is the desired criterion (Van Hell & Dijkstra, 2002). However, in the end neither of those succeeded.

Since even just the awareness of the research topic being bilingualism is judged to be enough to put the participant into a bilingual mode (Grosjean & Li, 2013, p. 17) and because of practical and financial reasons, the final decision was for the questionnaire and communication to be only in Czech and the training phase and the experiment itself only in German. In this way, the comparability of the experimental measurements was assured together with maximum clarity of the questionnaire.

The participants were informed that during the experiment they will hear words, one at a time, and their task is to rate each of them according to how positive or negative it makes them feel, as well as how excited they are by the word. They were instructed not to think about the meanings of the words too deeply, because the time for response was limited. They rated the words by a single mouse click into a square with two axes, which marked the boundaries of the emotional space.

The axes were continuous, indicating no numerical values. The vertical axis represented arousal – a click in the upper part of the emotional space indicated maximal arousal, while lower part indicated no arousal. The horizontal axis showed valence – the more to the left, the more negative, the more to the right, the more positive with the middle part standing for neutral words. (See Figure 1) All of the axes and their poles were labelled during the whole experiment as a reminder.
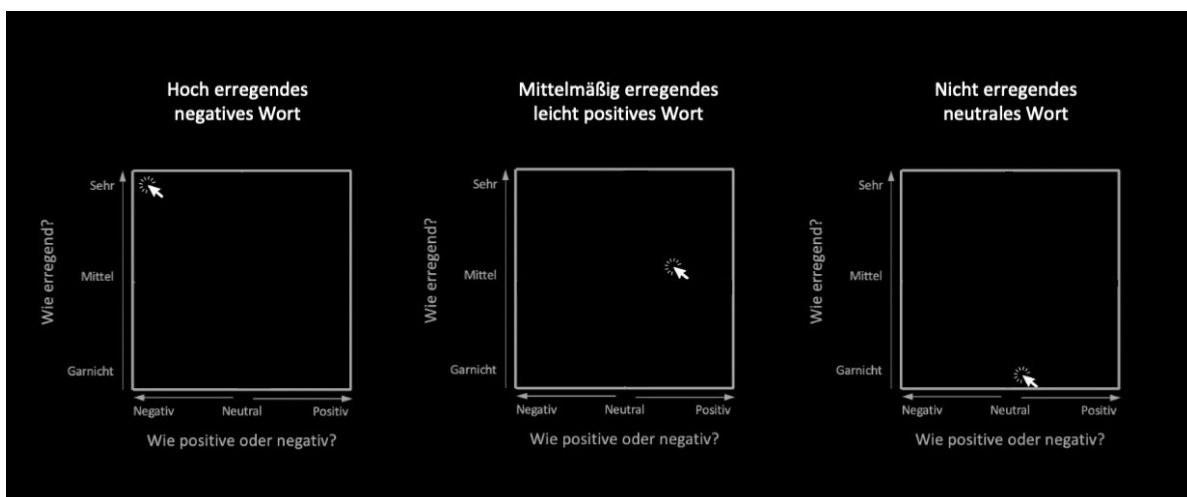

Figure 1 Display from the training phase, examples of a word with high arousal and negative valence (left), medium arousal and slightly positive valence (middle) and low arousal and neutral valence (right)

To make sure the respondents understand the paradigm, they were shown examples of where words with various combinations of valence and arousal would be placed in the square and they were also given three test trials to familiarise themselves with the tempo and the

procedure. They calibrated the mouse by clicking in the corners of the emotion space which stood for maximal values.

After the presentation of the stimulus when the speech ended there was a 4 000 millisecond pause with dark screen, after which the rating square appeared, and the respondents had another 4 000 milliseconds to click. During this time, their answer could be altered if they changed their mind or clicked by mistake, but after the onset of a new word, the last response was recorded. There were no breaks between the presentation of the emotion space and the next word. Throughout the whole process, the participants' neurophysiological activity was monitored using the fNIRS method, which we will describe in the next section.

Functional Near-Infrared Spectroscopy

The fNIRS is an optical method used to monitor brain activity by detecting the changes in the relative concentrations of different light-absorbing molecules (Chen et al., 2020, p. 3). It takes advantage of the distinct properties of infrared light – while some biological tissues (such as bone) are relatively transparent for this wavelength, the two chromophores in human blood (oxyhaemoglobin HbO and deoxyhaemoglobin HbR) absorb it much more strongly. Changes in neuronal activity trigger specific changes in the local concentrations of the chromophores, enabling indirect monitoring of this activity (Issard & Gervain, 2018, p. 182). Typically, an fNIRS device does this by measuring the difference in light intensity between pairs of optodes – sources emitting near-infrared light at several wavelengths and detectors placed at a systematic distance, which paired together form a measurement channel (Issard & Gervain, 2018, p. 183).

For this experiment the fNIRS measurements were acquired with the NIRSport 2 System (NIRx Medical Technologies, LLC. 15 Cherry Lane – Glen Head, NY 11545, USA). In total 16 optodes (8 light sources and 8 detectors, see Figure 2 and Figure 3) were used to establish an array of 20 channels, covering cortical areas which have been indicated in previous studies as relevant to the processing of emotional words and dimensions, i.e. the inferior frontal gyrus (Herbert et al., 2009; Kuchinke et al., 2005; Maddock et al., 2003; Matsubara et al., 2014; Styliadis et al., 2018), the dorsolateral prefrontal cortex (Compton et al., 2003; Hoshi et al., 2011), the ventrolateral prefrontal cortex (Hoshi et al., 2011; Tupak et al., 2014), and the middle temporal gyrus (Herbert et al., 2009; Kuchinke et al., 2005). Although amygdala and the cingulate cortex have also proven relevant to these questions (Kensinger & Schacter, 2006; Phan et al., 2002),

because of their location they are not accessible via NIRS in adult population (Almajidy et al., 2020).
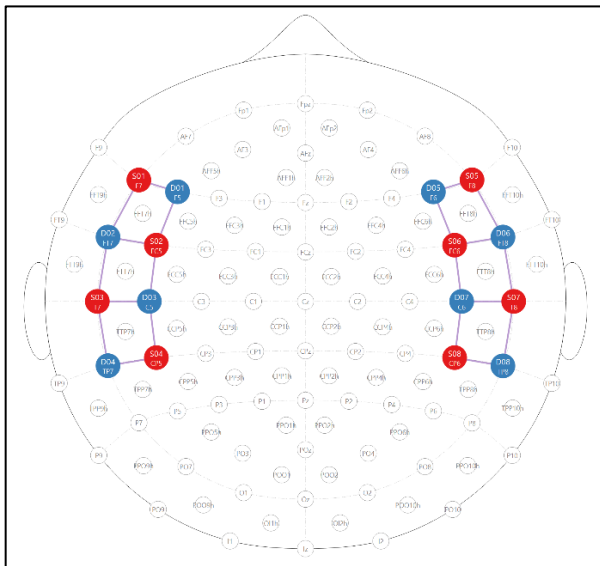

Figure 2 Configuration of optodes (sources red, detectors blue)
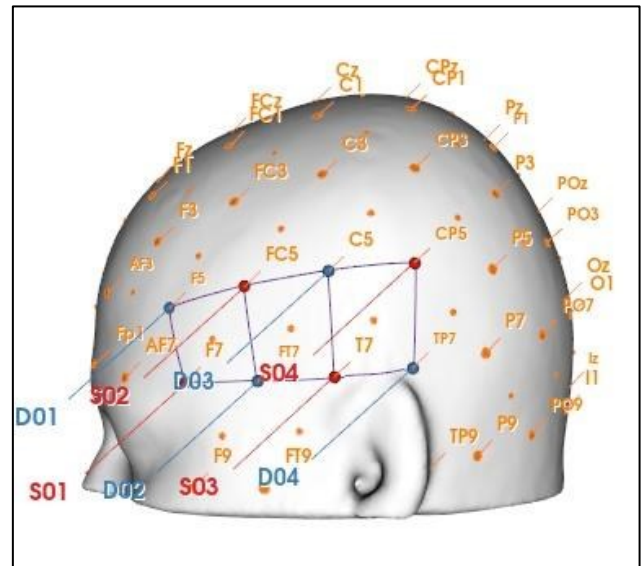

Figure 3 Configuration with highlighted channels

Unfortunately, due to a programming error, the timings of stimuli triggers had not been recorded correctly into the signal, rendering the fNIRS measurements unusable. Despite the signal itself being intact and regardless of the efforts to find a solution, in the end the neurophysiological data could not be used. On this account, the following chapter which deals with the analysis of results focuses only on the behavioural data.[23]

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[23] For methods of fNIRS data analysis see Groot and Hagoort (2018).

4. Analysis

4.1 Statistics and Word Comparison

As a first step, the behavioural data were aggregated and cleaned in Microsoft Excel and then imported into JASP (JASP Team, 2024) statistical software for analysis. Because the first and second hypotheses (as formulated in the section on emotionality and bilingualism) are concerned with the differences between two groups, the initial intent was to use an independent samples *t*-test to test it. To make sure the assumptions of the test were met, we assessed the data using Levene's test for homogeneity of variance and Shapiro-Wilk's test for normality of distribution. Neither the Shapiro-Wilk's test of valence (bilingual group $W = 0.984$, $p = 0.976$, German group $W = 0.969$, $p = 0.819$) nor of arousal (bilingual $W = 0.948$, $p = 0.365$, German $W = 0.972$, $p = 0.870$) showed a significant departure from normality. The Levene's test indicated equal variance of both valence ($F = 0.330$, $p = 0.569$) and arousal ($F = 0.927$, $p = 0.343$).However, as noted by Sullivan (2024) "tests for normality can be subject to low power. Specifically, the tests may fail to reject H_0: Data follow a normal distribution when in fact the data do not follow a normal distribution." And as a matter of fact, even though the tests indicated that the assumptions were formally met, the subsequent data visualisation revealed that the distribution was not normal. When taking into account also the limited final number of respondents, a nonparametric equivalent of the *t*-test was chosen as more appropriate.

A non-directional Mann-Whitney U test was used to test whether the two groups differ in their levels of valence and arousal. Despite the potentially complex interactions between these two dimensions, as summarised by Citron (2012, p. 220) "The fMRI data support the view that emotional valence and arousal constitute distinct dimensions, as suggested by their dissociation in terms of brain activation …". On this basis, during the statistical analysis they were considered separately. The expectation was that the groups would either not differ at all, or if they differ, the German group will have higher levels of arousal, as well as wider range of valence – both more positive and more negative values. The hypotheses were formulated as H_0 (the two populations are equal) and H_1 (they are not equal), and we run the test at the level of significance of $\alpha = 0.05$ (two-sided), which means that for our number of participants the critical value of *U* is **92**. The decision rule is to reject H_0 if U ≤ 92.

The first Mann-Whitney U test was performed to assess the difference in average valence between the bilingual group (n = 19, median = 0.079) and the German group (n = 16, median = 0.088). This difference was not significant; U = 137, p = 0.635, effect size by rank biserial correlation = -0.099. Because U was higher than 92, we fail to reject the null hypothesis. At this level of significance, we do not have sufficient evidence to conclude that the two groups differ.

The same test was then used to compare the levels of arousal (bilingual group median = -0.035, German group median = -0.313). This time the difference was significant; **U = 65**, p = 0.003, effect size by rank biserial correlation = 0.572 (see **Error! Reference source not found.**). As the observed U value was lower than 92, we reject H_0 in favour of H_1.
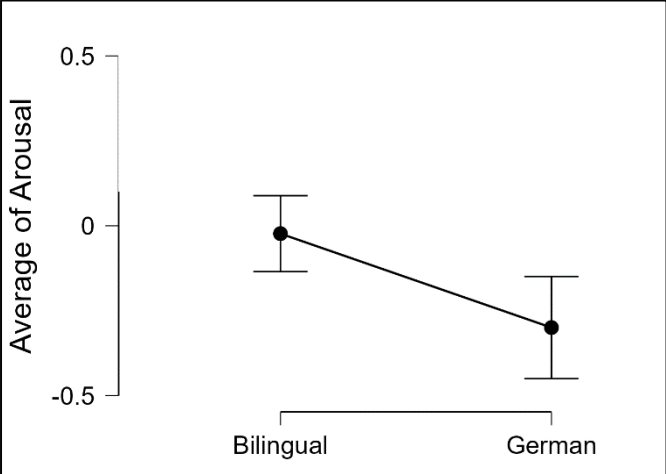

Figure 4 Difference in the average arousal between the two test groups.

The tests indicate that while the difference in valence was not significant, the difference in arousal was. Nonetheless, contrary to our expectations the higher average values of arousal were not observed in the German group, but in the bilinguals. If we plot the measured ratings of the stimuli on the affective space (see Figure 5 and Figure 6), and compare the two groups visually, we can see that the pattern is similar – both groups avoided extremes and used almost
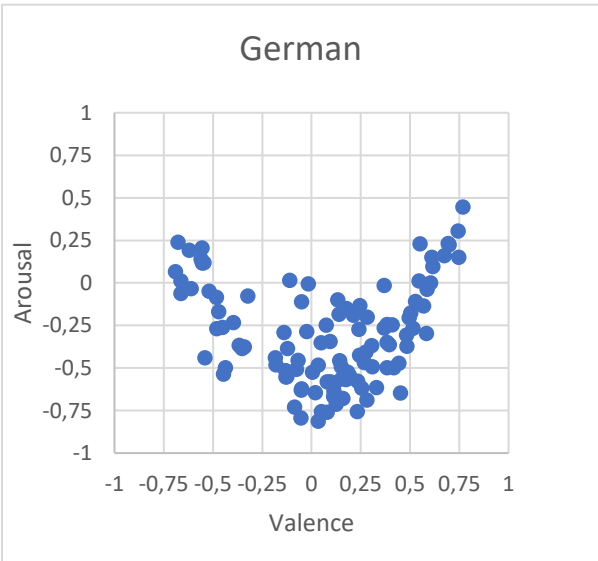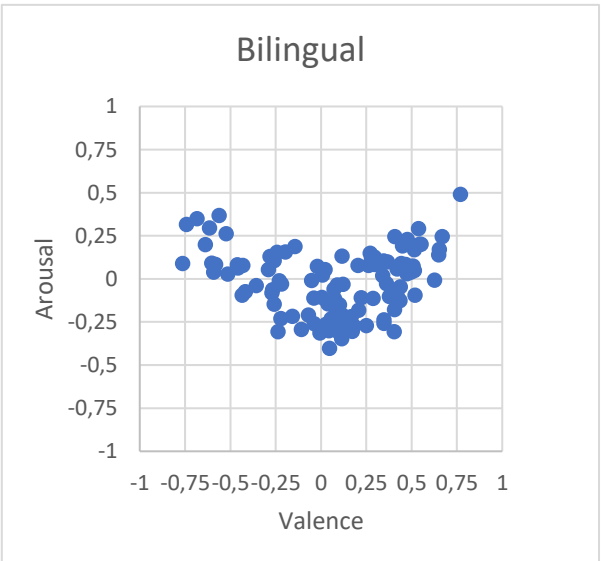

Figure 5 German ratings of selected words

Figure 6 Bilingual ratings of selected words

the full scale of valence, but only a relatively smaller proportion of the arousal axis. Yet it also confirms that the bilingual ratings of arousal tend to be much higher.

Initially, the third hypothesis about internal differences in the bilingual group was supposed to be tested using a more complex statistical test, which could examine the effect of multiple variables which are all considered to play a role in multilingualism – age and context of acquisition, proficiency, frequency of use etc., but the number of participants was not sufficient for such analysis. Before the start of the experiment, there were plans to divide the bilingual group into subgroups on the basis of context of acquisition and use. One subgroup would contain those who acquired German in early childhood in the family and used it in emotional contexts, the other later bilinguals who learned German to high level of proficiency in formal education. Such division turned out to be unrealistic. From the 19 bilingual participants 12 have acquired German in familiar context. Five of them learned it from birth simultaneously with Czech, the other seven in middle to later childhood. Of those seven, one learned it by moving to Germany at age 5, watching German TV cartoons and talking to their parents who were not native speakers. Another learned it in a "prototypical" way, speaking German with close family members in the country in early childhood, but used it only rarely or never in the last few months. A third one started to learn German relatively late at age 13 in a formal setting but was now working as a professional translator and lived with a native German speaker in a common household, using the language daily in emotional context. How are such speakers supposed to be categorised? Even though some researchers propose for example a cutoff age of 7, after which the effects of context on emotional arousal should be smaller (Harris et al., 2006, p. 266), the criteria for categorical separation seemed too arbitrary to have any explanatory power.[24]

Because we did not want to leave the last hypothesis completely unanswered, we attempted to use the age of acquisition as a stand-in value, which according to the emotional context of learning hypothesis should be linked with the other factors. Thus, the arousal values of the bilingual group were inspected for correlation with the age of acquisition of the German language (mean age of acquisition = 7.9, SD = 4.9). The expectation was that the higher the age the lower the emotional arousal will be. In order to test this hypothesis, we intended to

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[24] For discussion of the problem of dividing bilingual participants into subgroups see Grosjean (1998, p. 134).

use the Spearman's rank correlation coefficient, often referred to as Spearman's ρ ("rho"). Nevertheless, when we used a scatter plot to visualise the correlation between arousal and age of acquisition, it revealed that their relationship was not monotonic, which is inconsistent with the assumptions of Spearman's ρ. Because no other test was deemed suitable for the type and amount of data we had, the last hypothesis could not be statistically tested. In any case, the visualisation showed no correlation between the two variables.

In order to get a better understanding of what these general tendencies mean on a more specific level of individual words, for each group the top ten words with the highest and lowest valence and with the highest arousal were selected and compared.

bilingual		German	
freiheit	0.489	freiheit	0.447
schreien	0.367	retten	0.306
schlagen	0.349	krise	0.240
krise	0.315	sonne	0.232
weinen	0.295	tanzen	0.231
feiern	0.291	meistern	0.224
spinne	0.261	dummheit	0.206
sonne	0.245	weinen	0.193
haus	0.244	singen	0.160
fliegen	0.227	feiern	0.152

Table 3 Words with highest average arousal (the maximum possible rating being 1)

Table 3 shows the top ten words with the highest average values of arousal for both groups. From these, five occur on both lists: *freiheit* (freedom), *krise* (crisis), *feiern* (to celebrate), *weinen* (to cry) and *sonne* (the sun). Except for *freiheit*, which is the word with highest arousal in both groups, the rest of them is not arranged in any particular order. There is a noticeable shift between the groups: the average bilingual values are in general higher, which corresponds to the results of statistical analysis. Similarly, on the opposite end of the list, there is some overlap: both the Germans and the bilinguals rated *finger* (finger), *lineal* (ruler), *butter* (butter) and *kamm* (comb) as one of the ten least arousing words. As with the highest values, the lowest also support the observation of higher average arousal of bilinguals, e.g. while both

groups matched in their choice of least arousing word – *kamm*, the bilinguals have given it an average rating of -0.403, whereas the Germans -0.811.

bilingual		German	
freiheit	0.770	freiheit	0.768
sonne	0.669	wissen	0.747
spielen	0.652	retten	0.744
wissen	0.648	meistern	0.698
obst	0.626	sonne	0.693
tanzen	0.551	singen	0.674
retten	0.543	literatur	0.614
feiern	0.537	feiern	0.610
park	0.517	künstler	0.603
tochter	0.515	sinnlich	0.586

Table 4 Words with highest average valence

As can be seen from Table 4, participants across groups showed similar preference in their ratings of positive valence. From the top ten words with highest average valence, five were shared: *freiheit* (freedom), *sonne* (the sun), *wissen* (knowledge/to know), *retten* (to rescue) and *feiern* (to celebrate). In this case, the ratings by bilinguals tend to be more negative.

bilingual		German	
krank	-0.765	wespe	-0.690
krise	-0.744	krise	-0.678
schlagen	-0.685	krank	-0.664
dummheit	-0.639	schlagen	-0.663
weinen	-0.615	weinen	-0.621
wespe	-0.604	stechen	-0.611
staub	-0.593	schreien	-0.561
vergessen	-0.582	dummheit	-0.557
schreien	-0.563	fürchten	-0.555
spinne	-0.525	leugnung	-0.546

Table 5 Words with lowest average valence

Table 5 illustrates the opposite end of the scale – words with the lowest average valence. At this point, the two groups overlap even more – seven of the ten words are identical: *krank* (ill), *krise* (crisis), *schlagen* (to hit), *weinen* (to weep), *dummheit* (stupidity) *wespe* (wasp) and *schreien* (to shout). As was the case with positive words, the ratings by bilinguals tend to be more negative. When taking into account also the statistical aspect of slightly lower variability of valence in the German group (the German standard deviation was 0.069, the bilingual 0.087), the obtained results do not support the hypothesis of reduced emotional resonance.

4.2 Interpretation of Results

The analysis of results has revealed two main findings which are to be explained. Firstly, there was no statistically significant difference of average valence between the two groups, and also the additional supposition of wider valence range of the German group could not be confirmed. And secondly, although there was a significant difference of average arousal, it was the bilingual respondents, who indicated higher arousal values and inside the group there was no connection between arousal ratings and age of acquisition.

The first finding could be explained on the basis of the emotional context of learning theory and is in accordance with our first hypothesis. As stated in the corresponding section, the assumption was that if the proficiency of the bilinguals in both of their languages is high enough, and/or they acquired them in an emotional context, the effect of reduced emotional resonance does not manifest (Eilola et al., 2007; Sutton et al., 2007). Yet this does not clarify the elevated arousal of bilinguals – the factors of high proficiency, regular use, etc. should, according to the theory, result in the same level of arousal as in the German group. This was in complete opposition to the values presumed in the second hypothesis.

In search for explanation, other studies which have arrived at unexpected results in their research of emotional words processing in bilinguals were consulted. In an experiment by Kazanas and Altarriba (2016), Spanish-English bilinguals performed a masked lexical decision task in either English or Spanish. The participants, who's L1 was Spanish but now lived in the US, had surprisingly lower reaction times to stimuli in English and simultaneously no decrease in accuracy was observed. This was explained by language dominance – even though the participants' first language was Spanish, they predominantly used English in their daily life (ca 80 % of the time), started to learn their L2 at a young age (ca 5.5 on average) and now resided in an English-speaking environment. Because most of the Czech-German participants resided

at the time of the experiment mainly in Czechia, the mean age of acquiring German was comparatively higher (7.9) and all of them were Czech-dominant, this explanation is not plausible.

In contrast Caldwell-Harris et al. (2011) studied Chinese-English bilinguals who also resided in the US, but because most of them were foreign students from the People's Republic of China and Taiwan, English was not their dominant language. First, a bilingual group was interviewed about their experience of using emotional expressions (reprimands, endearments, insults and taboo phrases) and tasked with rating their intensity. Later, skin conductance responses (SCRs) of a similar group were measured to determine if physiological reactions matched the self-reported values. The results were similar for both languages, with the exception of terms of endearment which elicited larger SCRs in English. The unexpectedly high values for English, even when the language was not dominant, were interpreted as a result of cultural differences, with the Chinese speaking cultures purportedly allowing for less open expressions of positive emotions. Given the cultural closeness of central European countries and also the difference in the nature of the stimuli, this interpretation also does not seem applicable.[25] However, the authors mention an additional factor, which is the possibility that the results were influenced by the cognitive effort during the rating of words which were not as familiar. The speakers with lower abilities in Chinese or less frequent use of it had heightened reactions to Chinese terms of endearment, perhaps because the task was more taxing or stressful for them. Even if the situation does not correspond perfectly to our experiment, we will come back to this idea in more detail below.

Similarly to our experiment, Eilola and Havelka (2011) measured differences in behavioural and physiological responses to emotion words tasks, with participants consisting of one English and one bilingual English-Greek group. The two groups did not differ in their behavioural responses, even the effects of interference of negative and taboo words were identical. Only the physiological data revealed higher skin conductance levels of the English group in response to such words. The findings indicate that "… the semantic activation of L2 word meanings does not seem to lead to similar increases in autonomic activation as is the case in L1" (Eilola & Havelka, 2011, p. 367). The researchers interpret the lessened emotionality of L2 as a result of

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[25] For a study examining cultural variation and universality of emotion semantics see Jackson et al. (2019).

the lowered physiological response which is associated with it. This corresponds with the positions of the context of learning hypothesis which explains the identical values of valence in our experiment as a result of sufficient bilingualism, but offers no help in explaining the high bilingual levels of arousal.

At this point, we would like to slightly shift perspective and address one additional suggestion which was raised during a discussion with other researchers, namely that the arousal ratings could be explained as a result of collective psychological and cultural differences. The lower arousal ratings of one group would be a sign of supposed "emotional coldness" of Germans, whereas the higher arousal of the bilingual group could be affected by "Slavic emotionality". Our position on this topic is that we remain deeply sceptical of any sweeping generalisations about national characteristics, especially in the light of the recent resurgence of European nationalism. In the context of research showing that there are still widespread and empirically incorrect stereotypes about collective psychological traits in central Europe (Hřebíčková & Graf, 2014), and that there is an ongoing tendency of othering and vilification of Germans in Czech political discourse (Naxera, 2021), we refrain from interpreting the present findings through the lens of collective psychological differences between Czechs and Germans, or even East Germans and West Germans, etc. Even if we were to accept the extremely problematic premise of psychological characteristics based on national culture, researchers who operate in the framework of geographical psychology have shown that, unsurprisingly, any large collective is psychologically diverse, which applies not only to the regions of Germany (Obschonka et al., 2019), but also to the numerous and relatively smaller cantons of Switzerland (Götz et al., 2018). Because the German participants grew up in regions all across Germany and the bilingual participants lived in and had connections to all three major German-speaking countries, both groups were too heterogeneous to allow for any claims on the basis of some collective "national" psychological traits.

After the additional review of the psycholinguistic literature, and having addressed the issue of nationality, we came to the conclusion that the most likely reason for the difference in arousal levels was the pressure felt by the bilingual participants during the experiment. Because they were repeatedly questioned as to the level of their proficiency both during the recruitment process and at the beginning of the experiment, combined with the relatively short time for rating response and possibly also encountering lesser known words, all these

factors could contribute both to overall excitement and the inner pressure to "perform" or "prove" that they are sufficiently bilingual. The German speakers would not feel the same type of pressure in this situation, even though they would also be in some way affected by the presence of a researcher.

An additional factor could complicate the interpretation of results – the widespread influence of L3, especially English. It is relevant not only in this experiment but generally when comparing bilinguals with any two languages other than English. As noted in the section on Czech-German bilingualism, and as confirmed when examining the questionnaires of both the bilingual and German participants, at least some knowledge of English is to be expected, particularly from students who tend to form a significant proportion of experimental subjects. This makes the task of extricating the effects of bilingualism from the influence of a third language and all the other confounding variables even more intricate, but proposing any solution to this issue goes far beyond the scope of this study.[26] For our experiment is important that all participants across both groups had approximately similar exposition to English and knowledge of the language.

To sum up the analytical section, the results of the experiment showed no influence of reduced emotional resonance and are at least partially in agreement with the claims of the emotional context of learning hypothesis. The heightened levels of arousal were interpreted as a side effect of situational pressure.

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[26] For a discussion of the interplay between L2 and L3 see Dörnyei (2009, p. 23).

5. Conclusions

The main purpose of this thesis was to experimentally investigate the differences between the ways monolingual German speakers and bilingual Czech-German speakers process and evaluate words, focusing on the role of emotional dimensions.

Despite the technical issues with the fNIRS signal and with the Language History Questionnaire, thanks to the complex experimental design we were able to compare the two groups on the basis of their behavioural data.

The analysis of valence ratings has revealed no significant difference between the bilingual and the German group. These findings were consistent with the emotional context of learning hypothesis, which suggests that the bilingual speakers' acquisition and use of German happened in a sufficiently emotional context.

In contrast to valence, the arousal ratings contradicted our hypothesis in a surprising way. According to the context hypothesis and the concept of reduced emotional resonance, the levels of arousal were expected to either not differ at all or be lower for the bilingual group. The fact that they were significantly higher was considered from multiple perspectives, with the final interpretation being that the heightened arousal levels were most likely caused by situational pressure and expectations.

The third hypothesis stated that if there were differences inside the bilingual group, they would correlate with the factors predicted by the context hypothesis, especially context of learning and use, age of acquisition, but also proficiency, frequency of use, etc. Using the age of acquisition as a stand-in value, no such differences were found. Because the number of bilingual respondents (n = 19) was not high enough and their results were not normally distributed, no further statistical analysis was performed.

In general, no effect of reduced emotional resonance was observed, and the experimental results can be interpreted as broadly consistent with the hypothesis of emotional context of learning. However, because we were not able to verify the behavioural results with complementary neurophysiological data and the number of participants was restrained, the generalisability of the present findings is limited.

The ability to control for additional variables was in some ways restricted by the character of the reference study (considering primarily the selection of stimuli and availability of information about the German participants). But the benefits of being able to coordinate and consult with other Czech and German scientists from University Heidelberg and the Institute of Psychology of the Czech Academy of Sciences, as well as to use their research facilities far outweighed any negatives.

Nonetheless, in any future study using the same paradigm, in order to be able to clearly distinguish between the effects of monolingualism, bilingualism and any other confounding variables, it would be desirable to have more unified selection criteria. A higher number of participants would also allow for more robust statistical analysis, which could help disentangle the complex of factors which influence bilingual language processing.

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