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The enhanced music rhythmic perception of second language learners of English

MA English Language and Linguistics

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Abstract

Rhythm is an organizational device in language and in music. In both domains, rhythm helps to structure the sound stream (speech or music), by grouping auditory events, that is, sounds and pauses, into meaningful units together in a hierarchical manner. In language, speech rhythm is of importance because it helps speech segmentation and intelligibility and it belongs to the linguistic inventory of a language. Mastering the rhythmic properties of a language is just as important as mastering any relevant linguistic information. When learning a second language (L2), together with its vocabulary and grammar, second language learners must also master a set of rhythmic properties that are either in partial or in complete overlap with their first language or that are completely different. This is the case because languages of the world diverge in terms of their use of rhyhtmic properties and metric preferences. Previous research has described the world' s languages as being stress-timed, syllable-timed or mora-timed languages. Stress-timed languages, from which English is the exemplary item, have the metric foot as their unit of speech perception and production. The metric foot is a combination of one stressed syllable dominating zero or more unstressed ones. In syllable-timed languages, is the syllable, regardless of stress that functions as unit of speech production and perception. In mora-timed languages, it is the mora, a sub-unit of the syllable. Being sensitive to different sets of rhythmic properties may present an advantage to L2 learners, as these could help them more promptly identify and select the target language. Previous research has shown that individuals who master languages with different rhythmic properties are more sensitive to music rhythmic variation than individuals who master languages with similar rhythmic preferences or with very low-proficiency in an L2. The current thesis addresses two of these claims, namely, that learning languages with similar

rhythmic properties does not present such an advantage to rhythmic perception as mastering languages with distinct use of rhythm; and that learning a second language, regardless of its rhythmic similarities to or differences from one's first language, enhances individuals' rhythmic perception. This thesis does so by conducting two meta-analyses, using data from two different studies by Roncaglia-Denissen and colleagues (2016; 2013). The results support both claims, namely that learning a second language with similar rhythmic properties as one's first language does not present such a great advantage as mastering languages with different rhythmic properties and that proficiency in a second language is positively associated with individuals' music rhythmic perception. The implication of these findings is that speech rhythm seems to be part of a domain-general skill, which is used in and transferred to different cognitive domains, whenever acoustic similarities between domains are encountered.

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1. Introduction

To achieve speech comprehension, the listener must segment the speech stream and be able to identify meaningful auditory events, such as sounds and pauses, and group them as words. After word recognition, its meaning is retrieved from the listener's mental lexicon and integrated with information from other linguistic domains, such as syntax and pragmatics (Cutler, Mehler, Norris, & Segui, 1986; Frazier, Carlson, & Clifton Jr, 2006; Magne et al., 2007; Schmidt-Kassow & Kotz, 2008). During the entire process of speech segmentation, word recognition and integration, rhythm plays an important role.

Beyond the word level, rhythm continues to organize the speech flow, together with intonation, and interacts with different linguistic domains, such as morphology, syntax and semantics, for instance, combine linguistic elements together into larger prosodic constituents in a hierarchical fashion[1] (cf. Hayes, 1989; Inkelas, 1990; Nespor & Vogel, 1986; Selkirk, 1978, 1984). These larger prosodic constituents may work as processing units (cf. Carroll & Slowiaczek, 1987; Morgan, 1996; Slowiaczek, 1981), cueing sentence segmentation (Beach, 1991; Bögels, Schriefers, Vonk, Chwilla, & Kerkhofs, 2009; Kerkhofs, Vonk, Schriefers, & Chwilla, 2007; Kjelgaard & Speer, 1999; Speer, Kjelgaard, & Dobroth, 1996; Steinhauer, Alter., & Friederici, 1999), and facilitating sentence processing and comprehension (Roncaglia-Denissen, Schmidt-Kassow, & Kotz, 2013).

The use of rhythm in speech organization has been previously investigated in terms of

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[1] While intonation helps to create prominence by means of pitch variation, rhythm does so by means of variation in timing and temporal features, such as duration.

word segmentation and recognition (Cutler et al., 1986; Dupoux, Pallier, Sebastian, & Mehler, 1997; Dupoux, Peperkamp, & Sebastian-Galles, 2001; Jusczyk, 1999; Otake, Hatano, Cutler, & Mehler, 1993; Vroomen & De Gelder, 1995), and the interplay between lexical stress, i.e., meter, and other linguistic domains, such as semantics (Rothermich, Schmidt-Kassow, & Kotz, 2012) and syntax (Schmidt-Kassow & Kotz, 2008; Schmidt-Kassow, Roncaglia-Denissen, & Kotz, 2011; Schmidt-Kassow, Rothermich, Schwartze, & Kotz, 2011).

The implicit knowledge and the use of rhythmic properties, such as in speech organization and metric preference, constitute part of a speaker's competence in a language (Patel, 2008) just as much as his/her vocabulary inventory or knowledge of its grammar. Therefore, to master a second language (L2), its rhythmic properties must be acquired or learned[2] as part of the linguistic inventory of this language.

In the first year of life, babies acquire important rhythmic information in their native language, which is used to detect word boundaries and to segment the speech stream (Jusczyk, 1999; Jusczyk, Cutler, & Redanz, 1993; Jusczyk et al., 1992). After the first year, with the onset of language acquisition, the rhythmic parameters are set for the language(s) to which infants are exposed, so they can optimally segment it (Cutler & Mehler, 1993; Jusczyk et al., 1993; Otake et al., 1993). In this sense, one could think of an ideal period, in which rhythmic properties of a language should be acquired and encoded as relevant information for speech segmentation. Nevertheless, the idea of a critical period for the acquisition of rhythmic properties in a language is not free f controversy.

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[2] For the purpose of the current thesis, the terms "acquired and learned" refer to different processes of language learning. While the former refers to the process of learning a first language or a second language simultaneously with the first one, the latter refers to a sequential language learning. Namely, when a second language is learned after the acquisition of the first language has already started.

If, on the one hand, previous studies report that second language learners fail to use L2 rhythmic properties during word recognition and segmentation (Cutler, 1994, 2000), other studies suggest that learning rhythmic properties of a language at a later time is possible to some extent. Second language learners seem to be able to learn rhythmic properties in L2 to mark stress and are sensitive to some stress variation (Field, 2003; Goetry & Kolinsky, 2000; Guion, Harada, & Clark, 2004; Schmidt-Kassow, Roncaglia-Denissen, et al., 2011; Trofimovich & Baker, 2006). As contradictory as these findings may appear, the fact that L2 learners make use of rhythmic segmentation strategies of their first or dominant language onto a second language does not rule out the possibility that they are sensitive to general acoustic properties underlying rhythm in both languages.

This reported sensitivity of L2 learners to the second language rhythmic properties might result from the fact that speech rhythm relies on general acoustic properties, such as sound intensity, duration and loudness, which are also found organizing other auditory domains, such as in music (Bispham, 2006; Jackendoff, 1989; Lerdahl & Jackendoff, 1983b; Patel, 2003, 2008; Tincoff et al., 2005). Similarly to rhythm in music, speech rhythm relies on acoustic prominence to create perceptual units that support the structure and organization of the speech stream (Hayes, 1989; Jackendoff, 1989; Lerdahl & Jackendoff, 1983b; Nespor & Vogel, 1986).

These perceptual units have been suggested to constitute the basis of rhythmic classifications of languages as stress-timed, syllable-timed, and mora-timed languages [3]

[3] Even though several studies refuted the idea of an objective isochrony (Beckman, 1982; Lea, 1974; Wenk & Wioland, 1982), on which the traditional rhythmic classification of languages is based, the categories "stress-timing", "syllable-timing" and "mora-timing" are still in use by the field literature. For a review and further discussion on this matter, see the section **1.2. English and its rhythmic classification**.

(Abercrombie, 1967; Ladefoged, 1975; Pike, 1945). In stress-timed languages, such as English, German and Dutch, the unit of speech organization is the metric foot, that is, a stressed syllable dominating zero or more relatively weaker syllables (Hay & Diehl, 2007; Hayes, 1985; Nespor & Vogel, 1986). In syllable-timed languages, such as Turkish, the syllable, regardless of stress, is the basis of speech organization and structure (Cutler, 1994; Demiral, Schlesewsky, & Bornkessel-Schlesewsky, 2008; Grabe & Low, 2002; Inkelas & Orgun, 2003; Ladefoged, 1975; Nazzi & Ramus, 2003; Pike, 1945). Lastly, in mora-timed languages, from which Japanese constitute an exemplary item, the mora, a subunit of the syllable, is the unit of speech organization and structure (Itô, 1989; Otake et al., 1993; Warner & Arai, 2001). The above mentioned units of rhythmic production and perception, that is, metric foot, the syllable and the mora are illustrated in Figure 1.

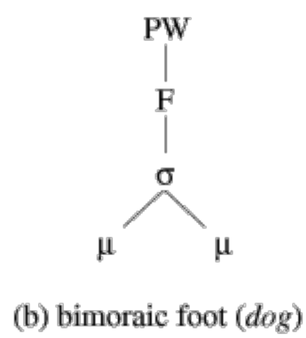

Figure 1. Representation of a phonological word with one metric foot, one syllable and two morae /dɔː/ /g/. Example retrieved from Demuth, 2012.

At the word level, rhythm manifests itself by means of stress assignment, which is also known as meter, defining a language's metric preference. Regarding their metric preference, languages of the world rely either on the trochee or on the iamb as their default metric pattern

(Hay & Diehl, 2007; Hayes, 1985). The trochaic foot is characterized by one stressed syllable followed by zero or more relatively weaker syllables, for instance, in the word "dog" (/'dɔːg/), the metric foot comprises one stressed syllable only, while in the word "kitty" (/ˈkɪti/), the metric foot comprises two syllables, the stressed syllable /'kɪ/ dominating the unstressed syllable /ti/. The iambic foot refers to the opposite metric pattern, that is, at least one unstressed syllable followed by one stressed one (Hayes, 1985, 1989), as in the word "exist" (/ɪgˈzɪst/). English, German and Dutch provide examples of languages that prefer the trochaic stress pattern, while Turkish is an example of an iambic language (Eisenberg, 1991; Inkelas & Orgun, 2003).

In order to use rhythmic information in a language, one must be able to identify variations in acoustic properties, such as duration and intensity, which might be involved, for instance, in stress assignment. The the manner with which these acoustic properties vary are language specific. Hence, if an individual masters languages that have different use of these acoustic features to create their rhythmic and metric preference, one might be more sensitive to a broader set of rhythmic features than another individual who master only one language or languages with a rhythmic overlap.

This greater sensitivity, in turn, might be transferred to other auditory domains, such as music, where similar acoustic features, such as the above given example of variation in sound duration and intensity, are present. This might be the case because, as previous research suggests, rhythm is a general cognitive skill (cf. Jackendoff, 1989), which may be used in different cognitive domains.

Furthermore, being sensitive to different use of rhythmic properties as a result of mastering languages with distinct rhythmic features may present a linguistic advantage for L2 learners. Second language learners may rely on a language's rhythmic properties to identify the language context at hand and correctly select the target-language. If rhythmic properties is then informative, namely, rhythmic properties in L2 are different than in L1, then rhythmic information will provide a reliable cue to be used for language recognition and selection.

As follows, this thesis will firstly define what is understood by rhythm and address the importance of rhythm and its function in speech organization. Next, the rhythmic classification of world's languages will be presented and discussed. To illustrate the presented matters, English will be used as case study. Afterwards, the implications of learning rhythmic properties in English as a second language for general auditory enhancement and, more specifically, its impact on the music and language domains will be addressed.

Subsequently, to address the presented theoretical framework, two meta-analyses of the data published by Roncaglia-Denissen and colleagues (2016; 2013) will be presented. These analyses were conducted to further investigate two claims made by the authors in their studies:

1) That individuals mastering languages with similar rhythmic properties are less sensitive to rhythmic variation than individuals mastering languages with distinct rhythmic properties;
2) that learning a second languages, regardless of its similarity or differences from one's first language, enhances music rhythmic perception.

In these analyses, different groups of L2 learners were compared in terms of their perception of music rhythmic variation.

In the first analysis, conducted to address the first claim made by Roncaglia-Denissen and colleagues (2016; 2013) that mastering languages with similar rhythmic properties is less advantageous for rhythmic perception than mastering languages with distinct rhythmic properties, three groups of high-proficient L2 learners of English were compared. That is, Turkish, German and Dutch L2 learners of English. In the second conducted analysis to investigate if there is a positive association between learning a second language and one's sensitivity to rhythmic variation, an additional group of Turkish low-proficient L2 learners of English was included. Finally, the implications of the reported results will be discussed in light of the presented theoretical framework.

1.1. Prosody, rhythm and speech organization

Prosody is the linguistic domain comprising two organizational devices: intonation and rhythm. While intonation refers to the speaker's controlled pitch variation across the utterance (Nooteboom, 1997), rhythm is here defined as a systematic pattern of sounds and intervals (i.e., pauses) regarding grouping, timing and prominence as a result of variations in acoustic features such as intensity, duration and loudness (Patel, 2008). The knowledge and use of rhythmic properties is part of one's competence in a language (Patel, 2008). Hence, the mastery of a second language, such as English, includes the recognition and use of its rhythmic organization and metric preferences as much as the use of its vocabulary and grammar.

In the speech stream, rhythm creates acoustically prominent boundaries, helping to organize its segments[4] into meaningful units (Patel, 2003), guiding the listener in word recognition and segmentation and grouping words together into larger processing units. It has been suggested that languages of world have their utterances organized in a hierarchical fashion (Hayes, 1985; Nespor & Vogel, 1986).

In this hierarchy, rhythm is one of the devices (together with intonation) that organizes linguistic segments into meaningful units. Thus, through the use of rhythm, segments are organized into syllables, syllables into metric feet, feet into phonological words and phonological words into phonological phrases. In each one of these prosodic domains, phonological rules[5] operate, interacting with different linguistic domains, such as morphology, semantics and syntax, helping to create prosodic constituents, which may serve as speech perceptual and processing units (Morgan, 1996; Roncaglia-Denissen, Schmidt-Kassow, & Kotz, 2013).

The lowest prosodic constituent is the domain of the syllable. The syllable is a single peak of sonority and is contained in the domain of the metric foot. The metric foot domain is where rhythmic operations can be firstly noticed, by means of stress assignment to one of the syllables it contains. The metric foot comprises one stressed syllable dominating zero or more relatively weaker ones.

Encompassing the domain of the metric foot the domain of the phonological word is found. In this domain, primary and secondary word stress are assigned. In terms of word stress assignment, languages prefer either the trochaic or the iambic stress pattern (Hay & Diehl, 2007; Hayes, 1985). The trochaic pattern comprises a stressed syllable preceding at least one relatively

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[4] The segment can be understood as the minimal unit of perception in speech (Repp, 1981).

[5] Phonological rules can be understood as sound-related operations and computations processes that the listener/speaker make, when perceiving/producing speech (Nespor & Vogel, 1986).

weaker one, while in the iambic pattern a weak syllable is followed by a stressed one. English is an example of a language that predominantly uses the trochaic stress pattern, for instance in the word salad(/ˈsæləd/). The preferred trochaic pattern is already recognized and used by infants as young as 9 months to infer word boundaries, as a study carried out by Jusczyk and colleagues (1993) to test word boundary perception of North-American babies report.

The three above mentioned prosodic domains, namely the syllable, the metric foot and the phonological word are the lowest domains of the prosodic hierarchy and are operated by language-specific phonological rules (Hayes, 1985; Nespor & Vogel, 1986). The domains of the syllable, metric foot and the phonological word are illustrated below with the English word *tiger:*

1a) [[[ˈtaɪ]$_{\text{syllable}}$ [.gə(r)]$_{\text{syllable}}$]$_{\text{metric foot}}$] $_{\text{phonological word}}$[6]

The phonological word is part of the domain of the clitic group. In this domain, rhythm operates by binding together syntactic heads with their dependent material. For instance, in the sentence *Let me be!*, the content word *Let* together with the grammatical word *me* carry together one single stress, while the content word *be* constitutes a clitic group on its own, as illustrated in the example *1b)*. It is in the domain of the clitic group that phonology and syntax interact for the first time (cf. Nespor & Vogel, 1986).

1b) [[/lɛt mi]] $_{\text{phonological word}}$]$_{\text{clitic group}}$ [[bi!/]$_{\text{phonological word}}$]$_{\text{clitic group}}$

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[6] The square brackets indicate the delimitations of a prosodic constituent and its use conforms what it is proposed by Nespor & Volge, 1986.

In the domain of the phonological phrases, different heads are connected to their complements by means of one phrasal stress, while in the immediately higher domain of the intonational phrase the first features shaping intonational contours may be observed, such as descending tones (Millotte, René, Wales, & Christophe, 2008). In this domain, rhythm can be found manifested as pre-boundary lengthening (cf. Lehiste, 1973; Nooteboom, 1997). Finally, the utterance domain is the most complex one, combining phonological rules which operate in all linguistic domains, such as morphology, semantics, syntax and pragmatics. These interactions are of greater complexity because they are also influenced by and result from interactions occurring in the previous and lower domains (Nespor & Vogel, 1986). The three higher domains of the phonological phrase, intonational phrase and the utterance level are operated by universal phonological rules (Nespor & Vogel, 1986) and are illustrated in the example below with the sentence *Tomorrow, he will give her his phone number:*

1c) [[[Tomorrow]$_{\text{phonological phrase}}$]$_{\text{intonational phrase}}$, [[he will give her] $_{\text{phonological phrase}}$ [his phone number]$_{\text{phonological phrase}}$]$_{\text{intonational phrase}}$]$_{\text{utterance}}$.

As rhythmic features, such as duration and intensity, are present and operating from the domain of the syllable to the domain of the utterance, speech rhythm is of extreme importance for the organization of sounds into meaningful and larger units in the prosodic hierarchy, as it helps to create units of speech perception and production (Morgan, 1996; Slowiaczek, 1981; Tyler & Warren, 1987). These units may be used during speech processing, facilitating its segmentation and comprehension (Carroll & Slowiaczek, 1987; Murray, Watt, & Kennedy, 1998; Roncaglia-Denissen, Schmidt-Kassow, & Kotz, 2013).

1.2. English and its rhythmic classification

At the lower levels of the prosodic organization, namely the syllable, the metric foot and the phonological word, the operating phonological rules assigning stress are language-specific. As a result of this specificity, languages of the world were described as either having their rhythm resembling the sound of morse-code or a machine-gun (James, 1940). This classification would later be referred to as *stress-timing* and *syllable-timing*, with English and French being the prototypes for each one of these categories respectively (Abercrombie, 1967; Pike, 1945). Stress-timed languages, e.g., English, Dutch and German, are rhythmically organized using the metric foot[7]. In syllable-timed languages, among which French is an archetypical case and Turkish is another exemplary item, the utterance is organized using the syllable as its rhythmic unit of production and perception (Abercrombie, 1967; Cutler & Norris, 1988; Pike, 1945; Slobin, 1986).

When originally proposed, the rhythmic classification of languages was based on the idea of rhythmic isochrony. According to this idea, a stress-timed language, such as English, German and Dutch, would present inter-stress intervals of nearly equal duration, while syllable-timed languages, such as French and Turkish, would present neighboring syllables of nearly constant

[7] As previously described, the metric foot consists of one stress syllable dominating zero or more relatively weaker ones (Nespor & Vogel, 1986).

length (Abercrombie, 1967; Pike, 1945)[8].

Additionally to these two rhythmic categories, a third one has been proposed, namely *mora-timing* (Bloch, 1950; Han, 1962; Ladefoged, 1975). The mora is a syllabic sub-unit and it comprises a consonant as its onset followed by a short vowel, as for instance in the word "pig", which has two morae /pɪ/ and /g/ (Itô, 1989; Otake et al., 1993; Warner & Arai, 2001). In mora-timed languages, of which Japanese[9] is the exemplary language, it was believed that neighboring morae had nearly constant length (Warner & Arai, 2001).

To further investigate this matter, research was carried out to objectively measure the proposed rhythmic isochrony in different languages, however, no support for the rhythmic isochrony was found. Intervals between metric feet in stress-timed languages are not of constant duration (Bolinger, 1965; Dauer, 1983; O'Connor, 1965; Roach, 1982)[10], neither is the duration of neighboring syllables in syllable-timed languages (Wenk & Wioland, 1982) or adjacent morae in mora-timed languages (Beckman, 1982; Hoequist, Jr., 1983b). Rather they vary proportionally to the number of segments they contain.

Despite the lack of evidence to support isochrony in speech rhythm, the classification categories *stress-timing*, *syllable-timing* and *mora-timing* are still very much in use by the field

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[8]Moreover, a physiological base for the rhythmic isochrony has been proposed, (Abercrombie, 1965) in which two types of pulses would occur during language production: stress or chest pulses. Stress pulses were stronger contractions of the breathing muscles, occurring less frequent than chest pulses. Stress pulses were said to enforce chest pulses. Chest pulses would result from breathing muscles contraction and relaxation, which would cause air puffs coming from the lungs. Speech rhythm would result from the combination of these two types of pulses. In stress-timed languages, such as English, Dutch and German, stress pulses would create an isochronous sequence of chest pulses, while in syllable-timed language, such as Turkish, for instance, chest pulses and not stress pulses would be isochronous.

[9] Some researchers have classified Japanese, which is the prototypical mora-timed language, as being syllable-timed (Arai & Greenberg, 1997; Pamies Bertrán, 1999). This would result from being the mora considered a syllabic sub-unit.

[10] See Kohler (2009) for further discussion on this matter.

literature. Some scholars argue that this might be the case because of a perceived isochrony by the listener (Couper-Kuhlen, 1993), resulting from a tendency to constant duration between two metric feet in stress-timed languages (Lehiste, 1977) or in the length of two neighboring syllables or morae in syllable-timed and mora-timed languages respectively (Beckman, 1982; Laver, 1994).

The idea of a perceptual isochrony led to further investigations of languages' rhythmic classification using the listener's view point and perception rather than the objective approach of using acoustic measurements of the speech. Hence, a series of studies have been carried out in which natural speech fragments of languages with different rhythmic classification were played to rats (Toro, Trobalon, & Sebastián-Gallés, 2003), monkeys (Ramus, Hauser, Miller, Morris, & Mehler, 2000; Tincoff et al., 2005) and new-borns (Ramus, 2002; Ramus et al., 2000). In these studies, participants could successfully discriminate language based solely on the rhythmic information available to them. Furthermore, research has been conducted with verbal humans using manipulated speech fragments from languages with different rhythmic properties. In this kind of research, the semantic content was removed from the speech fragment by replacing all the consonants in the fragment by /s/ and the vowels by /a/. Moreover, a flat fundamental frequency (F0) ensured that no intonational information was present. Hence, temporal cues, i.e., rhythm, were the only prosodic information available to participant in order for them to discriminate languages from each other (Arvaniti & Rodriquez, 2013; Ramus, Dupoux, & Mehler, 2003; Rodriquez & Arvaniti, 2011). In these studies as well, languages could be discriminated based on their rhythmic properties, supporting the idea of a perceived regularity in their rhythm.

Even though general agreement regarding languages rhythmic classification is found in the field literature, this is not free of controversy (cf. Pamies Bertrán, 1999). Some language varieties, such as Singapore and Malaysian English, are considered being rhythmically closer to syllable-timed than to stress-timed languages (Tan & Low, 2014; Tongue, 1979). Spanish is also a controversial case of rhythmic classification. For some researchers, it is a solid syllable-timed language (Abercrombie, 1967; Pike, 1945), but for others it is considered rhythmically closer to stress-timed languages (e.g., Hoequist, Jr., 1983a, 1983b; Pamies Bertrán, 1999).

In order to handle these potential controversies, instead of the treating *stress-timing* and *syllable-timing* as categories, Nolan and Asu (2009) suggest these to be orthogonal, that is, independent dimensions. In this sense, languages of the world could present characteristics of the the *stress-timing* and the *syllable-timing* dimensions, but they would be ultimately defined according to the predominant and most salient one. For instance, the authors investigated four languages with regard to their use of these two dimensions, i.e., *syllable-timing* and *stress-timing,* namely English, Estonian, Castilian Spanish (Europe Spanish) and Mexican Spanish. English was the prototypical stress-timed language, with low stability regarding syllable duration and high stability in terms of the duration of the metric foot. Estonian was described as a mixed language. It has been previously described as being syllable-timed (Eek & Help, 1987) and, at the same time, presenting characteristics from the stress-timing dimension, such as a tendency to a constant metric foot duration (J. Ross & Lehiste, 2001). A third language investigated by the authors (2009) was Castilian Spanish, which is regarded as a syllable-timed language, nevertheless, it presents more stability in metric foot duration than Mexican Spanish, and less than English. That is, there seems to have a gradation in the use of the *stress-timing* dimension by these languages, with English and Estonian being closer to each other and displaying greater stability in the duration of the metric foot. Castilian Spanish comes in an intermediary position between Estonian and English and Mexican Spanish, which is the language presenting the least constancy in the duration of the metric foot. This proposed coexistence of the two rhythmic dimensions in a same language may have important implications for L2 learning. If both dimensions could be part of the same language, this could suggest that, when learning a second language, individuals would not necessarily have to learn a completely new set of rhythmic features of a language, they would rather have to refocus on and prioritize different ones.

1.3. English a second language and speech rhythm

English is spoken as native and non-native language around the world, making its importance as a cross-cultural language indisputable (Kachru, 1992). Roughly three out of four people using English to communicate have a different native language (Crystal, 2012), which has granted English the status of *Lingua Franca* (Seidlhofer, 2005). This means that in order to use English to communicate, most of its users have to learn and master a partly or completely different set of linguistic properties than in their first language.

The mastery of English as a second language [11], or any given language as a matter of fact, comprises the attainment of skills in different linguistic domains, such as phonology, morphology, semantics, syntax, and prosody, to which domain rhythm belongs. Second language (L2) learners may attain a native-like[12] outcome in semantics and lexical processing (Hernandez

[11] The use of the term second language (L2) here refers to any language different than one's first language, being the second or any additional language (Ln).

[12] Some of the field literature use the term "native-like" to refer to the language competence of an ideal monolingual speaker. Such an ideal speaker is an abstraction and, as such, his/her competence unattainable. In the current thesis,

& Li, 2007; Ojima, Nakata, & Kakigi, 2005; Wartenburger et al., 2003), as well as in the processing and use of morphosyntactic information, such as gender agreement (Sabourin & Haverkort, 2003). Less successful attainment has been reported in the processing of complex syntactic structure in L2 (Love, Maas, & Swinney, 2003; Marinis, Roberts, Felser, & Clahsen, 2005; Roncaglia-Denissen, Schmidt-Kassow, Heine, & Kotz, 2015).

Regarding the attainment and use of speech rhythm in L2, little is known about its attainment and outcome among L2 learners[13] (cf. Chun, 2002; Rasier & Hiligsmann, 2007). In second language learning, rhythm plays an important role shaping speech intelligibility and comprehension (Munro, 2008; Munro & Derwing, 2001). Furthermore, speech rhythm is important for language comprehension and production, once it helps to organize the speech stream into meaningful linguistic units (Nespor & Vogel, 1986).

The few studies investigating the use of speech rhythm by L2 learners did so by addressing word segmentation strategy (Cutler et al., 1986; Otake et al., 1993), stress perception (Dupoux et al., 1997; Dupoux, Sebastián-Gallés, Navarrete, & Peperkamp, 2008; Field, 2003; Goetry & Kolinsky, 2000; Guion et al., 2004), and its use during syntactic processing (Roncaglia-Denissen et al., 2015; Schmidt-Kassow, Roncaglia-Denissen, et al., 2011; Schmidt-Kassow, Rothermich, et al., 2011).

The use of speech rhythm in the second language could provide an important source of information for its user, as it not only helps to correctly cue word boundaries and speech segmentation, but it may also provide an important indication for language identification. This

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the term native-like should be understood as a highly proficient attainment. For further discussion on this issue, see (Davies, 2005).

[13]For the purpose of the current thesis, second language learners are individuals who learn English as a consecutive language, namely, after having started to acquire their first language.

may be the case because languages of the world use their rhythmic properties in different fashion. As such, what it could constitute an important cue for word segmentation in one language might not be so in another. For instance, the use of duration and intensity to mark lexical stress in English (Sluijter et al., 1995), a trochaic language, which contributes to the creation of speech rhythm, does not necessarily happen in the same fashion in other languages, such as French, a language with no lexical stress (Charette, 1991), or Turkish, a language with lexical stress but with the metric preference for the iambic foot (Inkelas & Orgun, 2003; Slobin, 1986).

These acoustic features of stress marking, which contribute to the creation of speech rhythm, such as sound intensity, duration and loudness, are not exclusive in the language domain, rather can be found in any auditory event, such as in the sound of a hammer striking repeatedly a surface (Pickens & Bahrick, 1997) or in music (Bispham, 2006). As such, scholars have been interested in the use of these acoustic properties and rhythmic skills across cognitive domains, such as language and music (Bhatara, Yeung, & Nazzi, 2015; Jackendoff, 1989; Lerdahl & Jackendoff, 1983a; Patel, 2003; Roncaglia-Denissen et al., 2016; Roncaglia-Denissen, Schmidt-Kassow, Heine, et al., 2013).

1.4. Rhythm in language and music: cognitive transfer

In music, similarly to language, rhythm organizes auditory events according to a perceived hierarchy, in which some events are more salient than others (Hayes, 1989; Jackendoff, 1989). In music, rhythm operates through meter and grouping. While meter refers to the regularity created by the alternation between a strong and a weak beat, grouping refers to the organization of acoustic events into larger perception units, such as motives and musical phrases (Lerdahl & Jackendoff, 1983b). The use of grouping in music could find its parallel in the prosodic hierarchy, in which linguistic events are organized and combined into larger prosodic constituents, which may work as perception units as well (Hayes, 1989; Inkelas, 1990; Nespor & Vogel, 1986; Selkirk, 1978, 1980). Meter, in natural languages, refers to word stress assignment. Differently than in music, in natural speech, no periodicity occurs, thus, one should not speak of a regular alternation between stressed and unstressed syllables (cf. Pamies Bertrán, 1999). Yet, it has been argued, as previously mentioned, that there is a subjective perception of rhythmic regularity in natural speech (Lehiste, 1977; Patel, 2008). Similar to music, speech rhythm groups meaningful units such as syllables, metric feet and words, into larger prosodic units, creating units of speech organization and perception by means of general acoustic properties, e.g., duration and intensity (Bispham, 2006; Patel, 2003, 2008; Tincoff et al., 2005).

General acoustic features, e.g., segment and syllable duration, intensity and loudness, are used in a language-specific manner. Therefore, mastering languages with different rhythmic properties may draw on the sensitivity to these general acoustic properties. Being sensitive to different acoustic cues in the rhythmic organization of a language may help L2 learners to recognize more efficiently the target language and successfully select it. This sensitivity to general acoustic features could manifest itself in any cognitive domain in which it might be useful, such as the language and the music domain.

The idea that acoustic properties are shared and transferred between the language and the music domain has found support in the field literature with reports that musical aptitude positively impacts L2 pronunciation (Milovanov, 2009) and phonological perception (Slevc &

Miyake, 2006). Moreover, evidence has been provided that tone perception in language enhances the tone perception in music (Deutsch, Henthorn, Marvin, & Xu, 2006a; Elmer, Meyer, Marrama, & Jäncke, 2011). In terms of rhythmic perception, previous studies have investigated the transfer of skills from one domain, language, to the other, music. Among these studies, Bhatara and colleagues (2015) investigated 147 monolingual French individuals in terms of their musical aptitude and L2 experience. The authors report a positive correlation between participants music rhythmic perception and the total amount of years of L2 learning.

In addition to that, Roncaglia-Denissen and colleagues **(2016; 2013)** conducted a series of experiments testing the music rhythmic perception of monolinguals and L2 learners. In their first study (Roncaglia-Denissen, Schmidt-Kassow, Heine, et al., 2013), German L2 learners of English were compared with Turkish early and late L2 learners of German in terms of their perception of music rhythmic variation. The comparison between these language pairs (i.e., German-English and Turkish-German) is very interesting because of the languages' rhythmic similarities in the former and differences in the latter. While German shares a complete overlap with English with regard to their rhythmic properties. That is, both are stress-timed languages and use the trochee, as in the word "salad", as preferred metric pattern (Eisenberg, 1991; Féry, 1997; Hayes, 1985; Pike, 1945), the languages in the pair Turkish-German could not be more different from another. Turkish is regarded as a syllable-timed language and uses the iamb, as in the English word "exist", as its preferred stress pattern (Çakici, 2005; Inkelas & Orgun, 2003; Slobin, 1986).

In addition to that, in their study, Roncaglia-Denissen and colleagues investigated whether learning a second language early or later in life could affect one's perception of music rhythmic variation in different ways, making early L2 learners more of less sensitive to music rhythmic perception than their late L2 learner peers.

In their findings, the authors' report that both groups of Turkish L2 learners of German, that is, early and late L2 learners, performed comparably to one another and outperformed German L2 learners of English in their rhythmic perception. This seems to imply that L2 age of acquisition does not seem to play a role in individuals' sensitivity to the perception of music rhythmic variation. Moreover, results suggest that mastering two languages with distinct use of rhythmic preferences and properties may enhance one's perception of rhythmic variation in music.

In their second study (Roncaglia-Denissen et al., 2016), as a follow-up study, individuals with different language pairs were investigated. Turkish monolinguals, who were learning English as a second language at the time of data collection, and three groups of L2 learners of English were compared regarding their music rhythmic perception: Turkish, Dutch and Mandarin L2 learners of English. Once again the choice of the language pairs was motivated based on language rhythmic similarities and differences. Dutch and English constitute a language pair with a complete rhythmic overlap, being both languages stress-timed and sharing the metric preference for the trochee (Booij, 1999; Crosswhite, 2003; Pike, 1945; Vroomen & De Gelder, 1995). Turkish-English and Mandarin-English, on the other hand, constitute language pairs with completely different rhythmic preferences. While Turkish and Mandarin are syllable-timed (Çakici, 2005; Cao & Hanyu Putonghua Ci Zhongyin Zaitan, n.d.; Inkelas & Orgun, 2003; Mok, 2009; Shen, 1993; Slobin, 1986), English, as stated before, is a prototypical stress-timed language. In addition to that, Turkish prefers the iambic stress pattern, while Mandarin is a tonal language, which means that variations in pitch are used at the word and sentence level to convey meaning. In this study, Roncaglia-Denissen and colleagues investigated if mastering languages with different rhythmic properties (such as Turkish and English or Mandarin and English) enhances individuals' sensitivity to music rhythmic perception in comparison with individuals who master languages with rhythmic similarities (such as Dutch and English). In addition to that, the authors investigated wether learning an L2 with a stress based prosodic system (such as English, cf. Hirst, 2013) could also be advantageous for individuals' music rhythmic perception when their L1 relied heavily on tone variation and less on stress variation, as it is the case of Mandarin L2 learners of English.

The authors report an advantage of Mandarin and Turkish L2 learners of English over the Dutch participants, providing further evidence that learning a second language with distinct rhythmic properties from the first language enhances one's music rhythmic perception. The authors argue that, because of the rhythmic similarities between their first and second languages, Dutch L2 learners of English did not have such an enhanced rhythmic perception in music. Interestingly enough, Turkish monolinguals performed the worst, leading the authors to conclude that learning a second language also improves the sensitivity to rhythmic perception. The main findings of the first and the second described studies are summarized in Table 1 and 2, respectively:

Participants	L2 listening skills (self-report)		Rhythmic performance (% correct)	
	M	*SD*	*M*	*SE*
German L2 late learners of English	76.78	13.62	64.60	1.46
Turkish early L2 learners of German	99.61	1.96	70.15	1.91
Turkish late L2 learners of German	86.92	11.52	71.78	1.57

Table1. Summary of the main results reported by Roncaglia-Denissen et al., (2013).

Participants	L2 listening skills (self-report)		Rhythmic performance (% correct)	
	M	*SD*	*M*	*SD*
Turkish monolinguals	n.r.*	n.r.*	54.35	10.31
Turkish late L2 learners of English	88.00	12.64	73.97	7.11
Dutch late L2 learners of English	91.33	10.60	66.15	8.77
Mandarin late L2 learners of English	80.66	10.99	75.64	6.15

Table 2. Summary of the main results reported by Roncaglia-Denissen et al., (2016).
*n.r. = not reported.

Based on the information provided in these two tables, a gradation in participants' perception of music rhythmic variation can be observed. Performing the worst are the Turkish monolingual participants (Roncaglia-Denissen et al., 2016), with a mean of 54.35% correct responses when discriminating music rhythmic variation, followed by German (Roncaglia-Denissen, Schmidt-Kassow, Heine, et al., 2013) and Dutch L2 learners of English with 64.60% and 66.15% correct responses, respectively. Finally, performing seemingly better than the other groups are Turkish early and late L2 learners of German, with a mean of 70.15% and 71.78%

correct responses, respectively, and Turkish and Mandarin L2 learners of English, with 73.97% and 75.64% correct responses to music rhythmic variation.

Together, the findings of these two studies suggest that learning a second language enhances one's music rhythmic perception and even more so if the second language presents different rhythmic properties than the first one. As discussed by the authors, the reported enhancement in music rhythmic perception indicate that there may be a cognitive transfer from rhythmic skills from the language to the music domain. Despite providing both studies evidence to support their claim of a perceptual enhancement as a result from a cognitive transfer from the language to the music domain, one cannot ignore the fact that different language pairs were used in the two studies, i.e., German (L1) and English (L2), Turkish (L1) and German (L2) in the first study, Dutch (L1) and English (L2), Turkish (L1) and English (L2), Mandarin (L1) and English (L2) in the second one. No cross-study comparison has been carried out.

If the authors' claim is true, namely that mastering languages with similar rhythmic properties is not as advantageous as mastering languages with distinct rhythmic properties, then the two groups mastering languages with similar rhythms, namely German L2 learners of English and Dutch L2 learners of English, should present comparable performance in music rhythmic perception.

In addition to that, Roncaglia-Denissen and colleagues (2013) tested German L2 learners of English with different proficiency levels in their second language. In their study, participants were divided into 3 groups according to their proficiency and compared regarding their music rhythmic performance. Their analysis results indicate that no statistically significant differences in music rhythmic performance were found among the different proficiency groups of German

L2 learners of English. Thus, the variable of language proficiency was no longer pursued. The lack of a significant group difference in the rhythmic performance of individuals with different proficiency levels does not rule out the possibility that L2 proficiency might be associated with individuals' rhythmic perception. That is, with the increase of the proficiency level one's rhythmic perception could also improve. This could be the case because learning a language requires to be attentive to variations in acoustic cues, such as sound duration and intensity, which may play a role in stress marking, as it is the case of the English language (cf. Crosswhite, 2003). Hence, L2 learners of English (being them beginners or high-proficient learners) should be more attentive to rhythmic variation in language, which may be translated into a greater sensitivity to rhythmic variation in music. Therefore, it would still be interesting to investigate whether an association can be observed between L2 proficiency and individuals' musical rhythmic performance.

In face of the above discussed information, this thesis will carry out a meta-analysis of the data published by Roncaglia-Denissen and colleagues (2016; 2013) concerning the music rhythmic performance of L2 learners of English to address the following questions:

1) Is there a difference in the rhythmic perception of German and Dutch L2 learners of English?

If the reasoning provided by Roncaglia-Denissen and colleagues is correct, namely that mastering languages with similar rhythmic properties does not enhance one's music rhythmic performance as much as mastering languages with distinct use of rhythmic features, then no statistically significant difference will be encountered between the German (2013) and the Dutch L2 learners of English (2016). However, these two groups shall still perform worse than Turkish L2 learners of English, whose first and second language do not share rhythmic similarities.

This may be the case because all three languages are considered stress-timed and prefer the trochee as stress pattern. Since similar rhythmic cues are used in both first and second languages of these participants, no group differences are expected in terms of their music rhythmic perception. Therefore, Dutch and German L2 learners of English should perform just the same, but worse than their Turkish peers. If, however, German and Dutch L2 learners of English do not present comparable rhythmic perception, this could indicate that these two populations, German and Dutch L2 learners of English, diverge with respect to other dimensions, not controlled or anticipated by the authors. That is, these two populations are not comparable to begin with. This would be a very unlikely outcome, once in terms of their age, social-economical status and education these two populations are very similar, what makes the lack of significant differences between these two groups the most likely outcome.

2) Does language proficiency play a role in terms of rhythmic perception among L2 learners of English? That is, is there a positive association between L2 proficiency level and individuals' music rhythmic perception?

This question was motivated by a claim Roncaglia-Denissen and colleagues made in their second study, namely that learning a second language, regardless of its rhythmic similarities or differences with one's first language, would enhance individuals' rhythmic perception. To answer this question the data from four groups of participants will be re-analyzed in a second meta-analysis. Namely, German L2 learners of English tested by Roncaglia-Denissen and colleagues in their first study (2013), Turkish monolinguals, Dutch and Turkish L2 learners of English from their second study (2016). These four groups will have their scores in the rhythmic perception task correlated with their proficiency level in English listening skills.

If L2 listening proficiency level is associated with one's music rhythmic perception, a positive correlation will be expected, which means that with an increase in L2 listening skills, an enhancement in individuals' rhythmic sensitivity can be observed and the other way around. If no association between these two variable is encountered, this will provide counter evidence to the claim that learning a second language improves one's rhythmic perception. In such a case, the worst performance of Turkish monolinguals in comparison with the performance of L2 learners of English reported by the authors could not be explain by learning an L2, rather by differences in cognitive abilities that were not captured by the study with the tested populations. This could represent a potential methodological shortcoming in the conducted study. However, due to the cognitive comparability between all the tested groups reported by Roncaglia-Denissen and colleagues (2016: 2013), this is very unlikely outcome. As follows, the methods used to conduct the two above mentioned meta-analyses will be presented and described.

2. Methods

2.1. Participants

For the meta-analysis addressing the first research question, namely whether German and Dutch L2 learners of English present comparable, but worse music rhythmic perception than Turkish L2 learners of English, data from 45 participants were used. From these 45 participants, 15 were Dutch L2 learners of English (8 females, M_{age} = 25.53 years, SD = 4.64, *mean age of L2 first exposure, AoL2FE* = 8.80 years, *SD* = 3.27), 15 German L2 learners of English (8 females, M_{age} = 25.00 years, *SD* = 4.73, M_{AoL2FE} = 10.10 years, *SD* = 1.27), and 15 were Turkish L2 learners of English (8 females, M_{age} = 26.33 years, *SD* = 3.08, M_{AoL2FE} = 10.13 years, *SD* = 4.34). The German participants were a subgroup of the population tested by Roncaglia-Denissen and colleagues (2013), and were selected to match the Dutch and Turkish participants in terms of gender, age and L2 listening skills as much as possible.

For the second meta-analysis carried out to investigate if learning a second language has a positive association with music rhythmic perception, data from 77 participants were used. From these 77 participants[14], individuals were divided into four groups: three groups of high-proficient L2 learners of English and one group of low-proficient L2 learners of English. From the high-proficient groups, 15 were Dutch (8 females, M_{age} = 25.53 years, *SD* = 4.64, M_{AoL2FE}

[14] All participants reported having no formal musical training and were either university students or recent graduates at the time of data collection (cf. Roncaglia-Denissen et al.,2016; Roncaglia-Denissen et al., 2013).

= 8.80 years, *SD* = 3.27), 15 were Turkish (8 females, M_{age} = 26.33 years, *SD* = 3.08, M_{AoL2FE} = 10.13 years, *SD* = 4.34) and 32 were German (16 females, M_{age} = 25.71 years, *SD* = 2.55, M_{AoL2FE} = 10.04 years, *SD* = 1.27), the whole population of German L2 learners of English tested by Roncaglia-Denissen and colleagues (2013). The group of low-proficient L2 learners of English was constituted by 15 Turkish individuals[15] (8 females, M_{age} = 18.93 years, SD = 1.94, M_{AoL2FE} = 15.73, SD = 3.55). Thus, for this meta-analysis, the complete data sets collected by Roncaglia-Denissen and colleagues of German (2013), Dutch, and Turkish (low-proficient and high-proficient) L2 learners of English (2016) were used. These groups were selected based on the fact that English was the language mastered or aimed to be mastered as a second language[16].

The group of Mandarin L2 learners of English tested by Roncaglia-Denissen and colleagues in their second study (2016) was not part of this meta-analyses for the reason of consistency, as Mandarin would be the only tonal language to be included in the analysis. Inspite of being very interesting, the tonal nature of the Mandarin language is beyond the scope of this thesis. Demographic information about the participants included in these meta-analyses is

[15] In their 2016 publication, Roncaglia-Denissen and colleagues used the term "Turkish monolinguals" to refer to the Turkish participants who were studying the English language at the university in order to continue their education degree in this language. Because these individuals had such a limited knowledge of English at the time of data collection, and were not able to communicate with the researcher carrying out the experiment without having a translator present at all times, the authors chose to refer to them as "monolinguals". However, the term “monolinguals” is not the most accurate one to describe this population, once these participants report having some comprehension skills in English (*M* = 27.33%, *SD* = 17.01), very little and extremely limited in fact, but existent. Thus, for the purpose of this thesis, this population will be referred to as Turkish low-proficient L2 learners of English in contrast to the other three high-proficient L2 learners group, i.e., Turkish, Dutch and German L2 learners of English.

[16] This is the reason why the two groups of Turkish participants tested by Roncaglia-Denissen and colleagues in their first study (2013) were not included in this meta-analysis. The two Turkish groups were constituted by early and late L2 learners of German.

summarized in Table 3 and 4 and it was either retrieved from the two studies by Roncaglia-Denissen and colleagues **(2016; 2013)** or computed for this thesis:

Study	Participants	Language	Age		L2 first exposure	
			M	*SD*	*M*	*SD*
Roncaglia-Denissen et al., 2013	15* (8 females)	German-English	25.00	4.73	10.10	1.27
Roncaglia-Denissen et al., 2016	15 (8 females)	Dutch-English	25.53	4.64	8.80	3.27
	15 (8 females)	Turkish-English	26.33	3.08	10.13	10.34

Table 3. Participants' demographic information retrieved from Roncaglia-Denissen et al., **(2016; 2013)**.

* Data subset from Roncaglia-Denissen and colleagues (2013) computed for the current meta-analysis.

Study	Participants	Language	Age		L2 first exposure	
			M	*SD*	*M*	*SD*
Roncaglia-Denissen et al., 2013	32 (16 females)	German-English	25.71	2.55	10.04	1.27
Roncaglia-Denissen et al., 2016	15 (8 females)	Dutch-English	25.53	4.64	8.80	3.27
	15 (8 females)	Turkish	18.93	1.94	16*	3.00*
	15 (8 females)	Turkish-English	26.33	3.08	10.13	10.34

Table 4. Participants' demographic information retrieved from Roncaglia-Denissen et al., **(2016; 2013)**.

*Unpublished data.

2.2. Material

The first meta-analysis will be carried out using participants' scores in the music rhythmic perception task (Musical Ear test, MET), in the cognitive tasks involving the use of phonological memory (Mottier test, a non-word repetition task) and working memory (Backward digit span) capacity. In their studies, Roncaglia-Denissen and colleagues made use of additional data (test scores) for their analyses. These included melodic aptitude test (the melodic subset of the Musical Ear Test) and daily exposure to music (hours per day that participants listened to music). Unfortunately, measures of daily exposure to music in the two studies are not comparable. In their first study (2013) Roncaglia-Denissen and colleagues collected categorical data concerning the amount of hours participants were exposed to music in a day (from 0 to 1 hour/day, from 1-3 hours/day, more than 3-7 hours/day and more than 7 hours/day). In their second study, on the other hand, participants had to fill in the amount of hours per day they were exposed to music, which generated a much more precise answer (ratio data). As such, these two data sets cannot be precisely compared or used as variable in this meta-analysis

In addition to that, participants scores in the melodic sub-test were not used as a covariate in this meta-analysis. This was the case because, except for the Mandarin L2 learners of English, speakers of a tonal language, no group differences were found in terms of melodic aptitude among the L2 learners of English tested by Roncaglia-Denissen and colleagues in both of their studies. Therefore, this variable does not seem to be relevant for the current meta-analysis, which takes into account only languages that are stress-based and not tonal ones (Mok, 2009).

Regarding the second conducted meta-analysis to investigate whether there is a positive association between L2 proficiency level and individuals' perception in music rhythmic variation, participants' scores in the rhythmic perception task will be correlated with their self-reported listening skill in English. For this analysis only participants' self-reported scores in L2 comprehension will be entered as a dependent variable in the analysis due to the fact that music rhythmic perception is an auditory process. As such, the L2 modality that makes use of cognitive and sensory processes in the perception of auditory information that most closely resembles the ones used during the perception of music rhythmic information is L2 listening (comprehension) skills. Thus, for the purpose of the current thesis, participants' self-reported L2 listening skills were used as a proxy for their L2 proficiency level.

As follows each task from which participants' scores were collected will be presented, together with a brief explanation about their scoring. The below presented tasks were either used as the dependent variables in each analysis or as a covariate, to account for individual differences which might have influenced participants' performance in the rhythmic variation task.

Musical Ear Test - Rhythmic subset (MET-r). The Musical Ear Test comprises a melodic and a rhythmic sub-test and was developed to access individuals' musical aptitude independently in these two domains (Wallentin, Nielsen, Friis-Olivarius, Vuust, & Vuust, 2010). For the purpose of the current thesis only participants' data from the rhythmic sub-test will be taken into account. The rhythmic subset of the Musical Ear Test (MET-r) assessed participants music rhythmic perception (cf. Roncaglia-Denissen et al., 2016; Roncaglia-Denissen, Schmidt-Kassow, Heine, et al., 2013), by presenting individuals with 52 pairs of rhythmic phrases, which were formed by either two identical or two different rhythmic phrases. Twenty six of these rhythmic phrase pairs were constituted by identical phrases and the other half by different ones. Participants had to judge these pairs as being comprised by identical or different phrases. All rhythmic phrases were recorded using wood blocks and were 4 to11 beats long. Rhythmic phrases had the duration of one measure and were played at 100 bpm. Trials which constituted two distinct rhythmic phrases differed only by one rhythmic change. Rhythmic complexity was achieved by including triplets in 21 trials, while the other 31 trials presented even beat subdivisions. Thirty-seven trials began on the downbeat while the remaining trials began on the beat removed. The order, in which these features occurred, was randomized[17].

Mottier test (non-word repetition task). The Mottier Test (1951) is composed of sets of 6 non-words, ranging from 2 to 6 syllables each. The non-words presents a constant syllabic structure of one consonant followed by one vowel, that is CV. Three versions of the Mottier test was created, one version in German, one in Dutch and one version in Turkish. The non-words in each version were the same ones, however, they were pronounced according to the pronunciation rules of each language. In the German version, the non-words were spoken by a female native speaker of German, while a male native speaker of Dutch was recorded as stimulus material. In the Turkish version, a female native speaker of Turkish spoke the non-words, following the pronunciation rules of Turkish. As such, all participants performed this task following the pronunciation rules of their own native language. The non-words were presented to participants via headphones. In this task, participants must correctly recall at least 4 non-words per set in order to continue the test. The number of syllables increased according to participants' progression in the task. If the minimum number of correctly recalled non-words was not reached, the test was terminated.

Participants' score in the Mottier test was used as a measure to access their phonological

[17] In its original version, the rhythmic sub-test, MET-r, was conducted using an answer sheet to be filled out by the participants. For their two studies, Roncaglia-Denissen and colleagues created a version of the test to be presented and performed using the computer. In this version, participants had one second to make a decision about each phrase pair before the next one would be presented.

memory capacity (cf. Roncaglia-Denissen et al., 2016; Roncaglia-Denissen, Schmidt-Kassow, Heine, et al., 2013). Phonological memory capacity has been described as the ability to store and recall sounds, which is believed to help in language learning (Baddeley, Gathercole, & Papagno, 1998).

Backward digit span. The backward digit span version used in data collection was composed of 14 sets of 2 trials, ranging from 2 to 8 numbers. Three versions were created for this test, in which numbers were spoken in German (by a female native speaker), in Dutch (by a male native speaker) and in Turkish (by a female native speaker). This procedure was adopted to ensure that all participants could perform this task in their native language. In all three versions, i.e., in German, Dutch and Turkish, numbers were recorded at a rate of one number per second. Numbers were presented via headphones and participants had to recall the numbers in the reversed order of their presentation. With this task, participants' working memory capacity was assessed (cf. Roncaglia-Denissen et al., 2016; Roncaglia-Denissen, Schmidt-Kassow, Heine, et al., 2013). Working memory capacity concerns the ability to store information while additional cognitive processes are taking place. (Baddeley, 2003; Conway et al., 2005). Thus, in the case of the backward digit span task, numbers must be stored while the order of recollection must be transformed from the order of presentation to its reverse. Previous research suggests that phonological memory and working memory capacity correlate with general intelligence, providing an indicator of cognitive resources (Conway et al., 2005; Daneman & Carpenter, 1980; Engle, Tuholski, Laughlin, & Conway, 1999; Oberauer, Süß, Schulze, Wilhelm, & Wittmann, 2000; Süß, Oberauer, Wittmann, Wilhelm, & Schulze, 2002; Unsworth & Engle, 2007). As such, by using these two measurements to assess participants' cognitive resources as covariates, the first conducted meta-analysis aimed to account for individual differences, which could influence participants' performance in the music rhythmic task (MET-r).

L2 listening skills. Participants were given a language history questionnaire concerning both their first (L1) and second languages. Three versions of this questionnaire were created, one in German, another in Dutch, and a third one in Turkish. As such, all participants could provide their answers in their native language. This questionnaire assessed language competence, such as listening, writing, reading and speaking skills, age of first exposure to each language, situations in which each language was acquired, and current language use. Participants had to rate their competence in each language by using a 10-point-liker scale, with 1 indicating very poor and 10 excellent.

Self-reported language questionnaires have been successfully used to assess L1 and L2 acquisition/learning, history and competence skills (Elston-Güttler, Paulmann, & Kotz, 2005; Marian, Blumenfeld, & Kaushanskaya, 2007; Roncaglia-Denissen et al., 2016; S. Ross, 1998; Schmidt-Kassow, Roncaglia-Denissen, et al., 2011). Based on the results reported by Roncaglia-Denissen and colleagues (2016; 2013), English was regarded as the second language among all participants. This language history questionnaire has been included as appendix material in this thesis.

For a more detailed description of the above mentioned tasks and scoring, see Roncaglia-Denissen et al., 2016; Roncaglia-Denissen, Schmidt-Kassow, Heine, et al., 2013.

2.3. Procedure

Testing session. Participants were tested individually in a quiet room. The tests were administered in a pseudo-randomized order, using a computer and each individual session lasted approximately one hour (Roncaglia-Denissen et al., 2016; Roncaglia-Denissen, Schmidt-Kassow, Heine, et al., 2013). Participants received written instructions for each test in their native language (i.e., instructions in Dutch, German and Turkish), either on separate instruction sheets or presented on the computer screen. Practice trials were provided before each test and participants were allowed to repeat them until the test was understood correctly. After the tests, participants were given the written language history questionnaire to access information about their first, second and additional languages.

Musical Ear Test - Rhythmic subset (MET-r). The MET-r was presented via headphones using a computer. A white star presented at the center of a black screen cued the auditory presentation of the rhythmic phrase pairs to be judged as being formed by identical or different rhythmic phrases. With the end of each trial, the white star was replaced by the response screen with the words "YES" and "NO" placed at the middle hight and at opposite sides of the screen, matching the position of the response key. For this test, three versions of the response screen were created to match participants' native language, one in Dutch, one in German and another one in Turkish. As such, all participants performed the test in their native language. Participants had 1 s to press the corresponding answer key. The position of the correct-response key was counter-balanced across participants (Roncaglia-Denissen et al., 2016; Roncaglia-Denissen, Schmidt-Kassow, Heine, et al., 2013).

Mottier test (non-word repetition task). Participants self-initiated the Mottier Test by pressing the space key. With a white visual cue placed in the center of a black computer screen, participants heard via headphones the first non-word and were instructed to repeat it as accurately and as fast as possible. After which the next non-word was presented and the same procedure was repeated. At the end of each trial set, participants were given a short break and self-determined when the test should be re-initiated. Participants' responses were computed ad-hoc by the experimenter with the help of a response sheet. The test was terminated when participants failed to correctly recall a minimum of 4 items of the same trial set. Scoring was based on the total number of correctly recalled non-words (Roncaglia-Denissen et al., 2016; Roncaglia-Denissen, Schmidt-Kassow, Heine, et al., 2013).

Backward digit span. In this task, participants listened to the sequences of numbers via headphones while facing away from the computer. At the end of each trial, participants had to repeat the numbers they just heard in the reversed order of their presentation. The test was terminated when participants failed to correctly recall two trials of the same set. Scoring was given according to the total number of trials correctly recalled (Roncaglia-Denissen et al., 2016; Roncaglia-Denissen, Schmidt-Kassow, Heine, et al., 2013).

Meta-analyses. To answer the first proposed research question, namely whether there is a difference between the music rhythmic perception of German and Dutch L2 learners of English and if these are worse in perceiving rhythmic variation than Turkish L2 learners of English, three groups of participants were compared: 15 Dutch and 15 Turkish L2 learners of English (Roncaglia-Denissen et al., 2016), and a subset of 15 German L2 learners of English tested by Roncaglia-Denissen and colleagues (2013). The German subset was selected to match their

Dutch and Turkish peers regarding their gender, age and L2 listening proficiency as much as possible.

The data of these three groups were entered in an analysis of covariance (ANCOVA), using the statistics software SAS University Edition (version 9.4). Participants' scores in the MET-r were used as the dependent variable, *group* (German, Dutch and Turkish L2 learners of English) as a between-subjects factor. Participants' scores in the Mottier test (non-word repetition task assessing individuals' phonological memory capacity) and in the backward digit span (assessing participants' working memory capacity) were used as covariates.

To address the second raised question, that is, whether there is a positive association between English proficiency and music rhythmic perception among L2 learners of English, a Pearson product-moment correlation coefficient was computed using the statistics software SAS University Edition (version 9.4). For this correlation, the two variables MET-r scores and L2 listening skills from all participants (Turkish low-proficient, and the remaining high-proficient groups, i.e., Turkish, Dutch and German L2 learners of English) were used. Data from all German L2 learners of English tested by Roncaglia-Denissen and colleagues (2013) were included in this correlation.

3. Results

Descriptive statistics concerning the first meta-analysis of the three compared groups, that is, German, Dutch and Turkish L2 learners of English are summarized in the Table 5 and 6:

Group	Age		Age of L2 first exposure		MET scores (% correct)		L2 listening skills (%)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
German- English (8 females)	25.00	4.73	10.10	1.27	65.76	7.20	92.00	10.14
Dutch-English (8 females)	25.53	4.64	8.80	3.27	66.15	8.77	92.33	10.32
Turkish-English (8 females)	26.33	3.08	10.13	4.34	73.97	7.11	88.00	12.64

Table 5. Summary of the descriptive statistics for age, age of L2 first exposure, MET-r scores and L2 listening skills of the three compared groups of German, Dutch and Turkish L2 learners of English.

Group	Mottier test		Backward digit span	
	M	*SD*	*M*	*SD*
German- English (8 females)	28.00	2.97	8.00	2.59
Dutch-English (8 females)	28.00	3.10	8.00	2.25
Turkish-English (8 females)	24.73	6.09	7.53	2.55

Table 6. Summary of the descriptive statistics for the Mottier test (non-word repetition task) and backward digit span of the three compared groups of German, Dutch and Turkish L2 learners of English.

Descriptive statistics concerning the second meta-analysis of the four compared groups, that is, Turkish low-proficient L2 learners of English, Dutch, German and Turkish high-proficient L2 learners of English are summarized in the Table 7:

Group	Age		Age of L2 first exposure		MET scores (% correct)		L2 listening skills (%)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Turkish low-proficient L2 learners of English	18.93	1.94	15.73	3.55	54.35	10.31	27.33	17.01
German- English (16 females)	25.71	2.55	10.04	1.27	64.60	7.70	76.78	13.62
Dutch-English (8 females)	25.53	4.64	8.80	3.27	66.15	8.77	92.33	10.32
Turkish-English (8 females)	26.33	3.08	10.13	4.34	73.97	7.11	88.00	12.64

Table 7. Summary of the descriptive statistics for age, age of L2 first exposure, MET-r scores and L2 listening skills of the four compared groups of Turkish low-proficient L2 learners, German, Dutch and Turkish high-proficient L2 learners of English.

The conducted ANCOVA comparing German, Dutch and Turkish L2 learners of English in their music rhythmic perception, while controlling for individual differences in phonological memory and working memory capacity, yielded a statistically significant group difference, F (2,40) = 6.37, p = 0.004. Pairwise comparison using the Bonferroni correction revealed a significant difference between the rhythmic perception of Turkish (*M*= 73.97%, *SD* = 7.11) and German L2 learners of English (*M*= 65.76%, *SD*= 7.20) and between Turkish and Dutch L2 learners of English (*M*= 66.15%, *SD*= 8.77). No statistically significant difference was found between Dutch and German L2 learners of English. Figure 1 summarizes the main results of the first conducted meta-analysis.

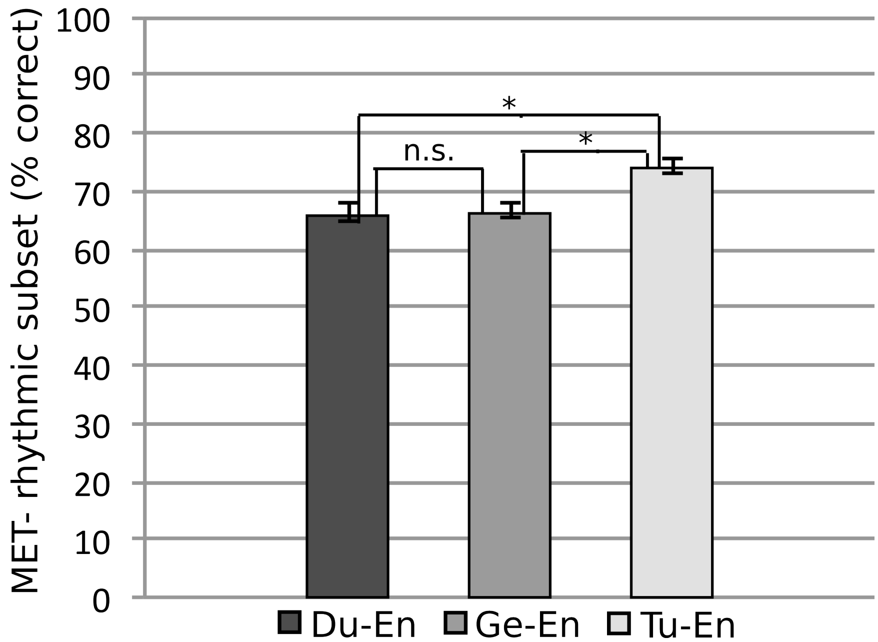

Figure 2. Correct responses in the rhythmic perception task of Dutch (Du-En), German (Ge-En) and Turkish L2 learners of English (Tu-En).

Regarding the second meta-analysis, namely the association between participants' MET-r scores and L2 listening skills, a significant positively moderate correlation was found between these two examined variables, $r(77) = .9$, $p < .001$, $R2 = 0.24$. Thus, with the increase of L2 listening proficiency an enhancement in music rhythmic perception is also observed or the other way around. Figure 3 depicts the data plot of the second conducted meta-analysis, investigating the association between individuals' rhythmic perception and their L2 comprehension skills.

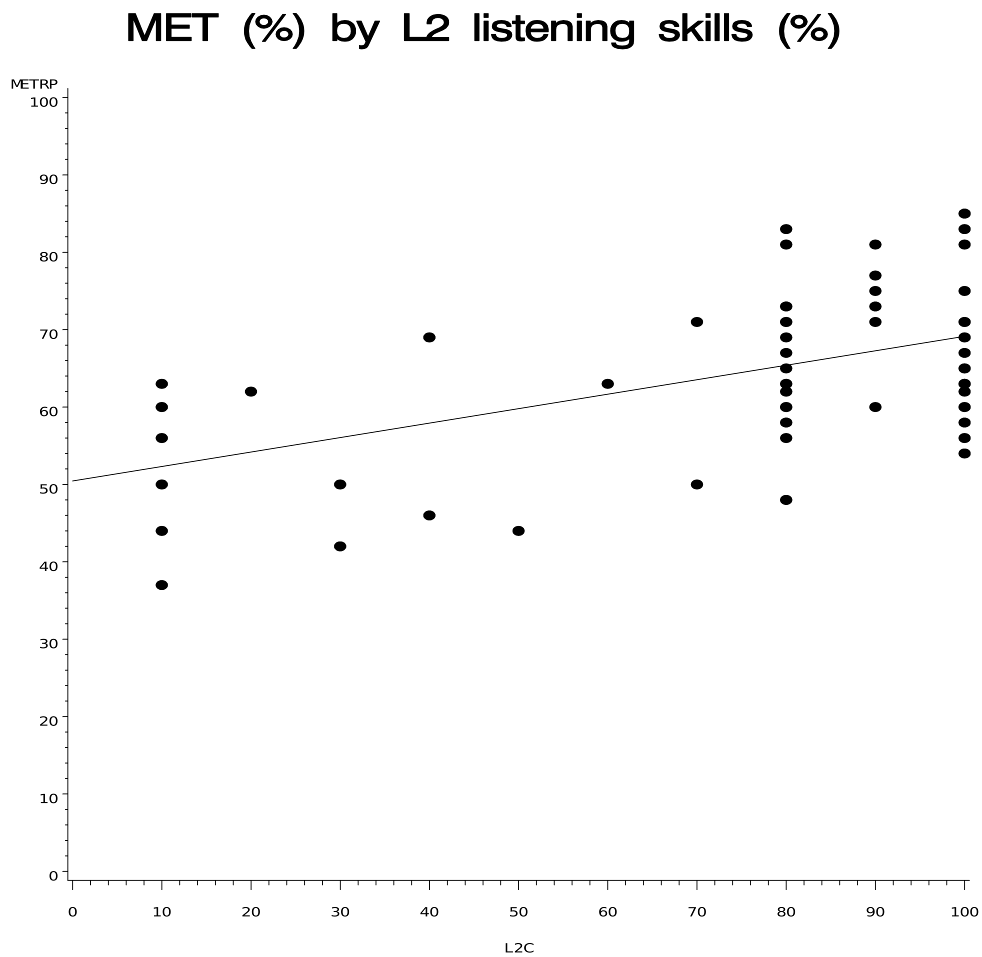

Figure 3. Correlation between participants correct responses in the MET-rhythmic sub-test (METRP) and their L2 listening comprehension (L2C) skills

4. Discussion

In this thesis, two meta-analyses were conducted using data subsets from two different studies published by Roncaglia-Denissen and colleagues (2016; 2013). The first meta-analysis was computed comparing the music rhythmic performance of German (Roncaglia-Denissen, Schmidt-Kassow, Heine, et al., 2013), Dutch and Turkish high-proficient L2 learners of English (Roncaglia-Denissen et al., 2016). For this analysis, a subgroup of the German L2 learners of English participants tested by Roncaglia-Denissen and colleagues (2013) was selected to match the Dutch and Turkish L2 learners (2016) in gender, age and their L2 listening proficiency as much as possible.

This analysis was carried out to further investigate the authors' claim that mastering languages with similar rhythmic properties does not present such an advantage to one's music rhythmic perception as mastering languages with distinct rhythmic properties. Based on their claim, the two populations, i.e., German and Dutch L2 learners of English, should be very much comparable in terms of their perception of music rhythmic variation and still be outperformed by the Turkish L2 learners of English.

This should be the case because while German, Dutch and English, are considered stress-timed languages (Eisenberg, 1991; Ordin & Polyanskaya, 2015; Pike, 1945), that is, they make use of the metric foot as their unit of speech perception and production, Turkish is a syllable-timed language, using the syllable to perceive and produce speech (Slobin, 1986). In addition to that, German, Dutch and English use the trochee as its metric foot of preference (Booij, 1999; Féry, 1997; Jusczyk et al., 1993), while Turkish prefers the iamb (Inkelas & Orgun, 2003).

Because German and Dutch L2 learners of English make use of similar rhythmic preferences in their L1 and L2, they should be less sensitive to a variations in rhythmic properties than Turkish L2 learners of English, whose first and second language have very different rhythmic properties. This should be the case because rhythmic information is less informative to language recognition for the German and Dutch L2 learners of English than for their Turkish peers. As such, German and Dutch L2 learners of English should display comparable music rhythmic perception. Moreover, these two groups of participants should present worse performance than Turkish L2 learners of English, who, by mastering languages with different use of rhythmic properties, should be more attentive and sensitive to rhythmic variation.

The results of the conducted meta-analysis revealed that, in fact, German and Dutch L2 learners of English do not differ in terms of their music rhythmic perception and perform comparably to one another and worse than Turkish L2 learners of English. This was true even when controlling for individual differences in working memory and phonological memory capacity, which could play a role in participants' rhythmic perception (cf. Roncaglia-Denissen, 2013). In this sense, the original claim made by Roncaglia-Denissen and colleagues (2016;2013) that learning a second language with similar rhythmic properties as one's first language does not enhance individuals' rhythmic perception as much seems to be supported.

The fact that German and Dutch L2 learners of English did not show as great enhancement in their music rhythmic perception as their Turkish peers still does not mean that they present no enhancement at all. As reported by Roncaglia-Denissen and colleagues (2016), Turkish monolinguals presented worse rhythmic perception than Dutch L2 learner of English.

The authors claim that learning a language, regardless of whether its rhythmic properties are similar or different from one's first language, already improves one's music rhythmic perception.

In this sense, it would be interesting to investigate other L2 learners of English whose first language is also a stress-timed one, but it makes use of different acoustic properties to perceive and produce rhythm. For instance, duration which plays an important role in stress marking in Dutch, English and German (Dauer, 1983; Schneider & Möbius, 2007; Sluijter et al., 1995; Sluijter & van Heuven, 1996) is not as important in marking stress in languages such as Bulgarian (Dimitrova, 1997), which has been described as "weakly stress-timed with lexical stress" (Crosswhite, 2003, p. 767).

Maybe, Bulgarian L2 learners of English could display an enhanced rhythmic perception in comparison to Dutch or German L2 learners of English due to their different use of rhythmic correlates to produce and perceive stress. It could be that, with the need to learn new acoustic cues to perceive and produce word stress, these L2 learners of English would also become more attentive and sensitive to rhythmic variation in language, which could be, in turn, transferred to the music domain and translated into an enhanced music rhythmic perception.

An enhancement in one's sensitivity to rhythmic properties can be very advantageous in terms of the selection of the correct target language. When the use of rhythmic properties in the languages mastered by individuals is distinct, this can be used to more promptly identify and zoom into the target language. As such, individuals who can rely on different use of rhythmic correlates to perceive and produce the mastered languages should be more attentive to and better at identifying rhythmic variation, once it can be very informative for language discrimination and selection.

The second meta-analysis was conducted to investigate another claim made by the authors in their 2016 study, namely that learning a second language increases overall sensitivity to rhythmic properties, which can manifest itself as an enhancement in music rhythmic perception. For this analysis, all the L2 learners of English tested by Roncaglia-Denissen and colleagues (2016; 2013) were included in the analysis, except the Mandarin L2 learners of English. This population was excluded from the conducted meta-analysis due to the tonal nature of Mandarin, which, despite being very interesting, is beyond the scope and focus of the current thesis. To address the possible association between musical rhythmic performance and L2 listening proficiency, a Pearson's correlation was conducted using participants' scores in the MET-r task and their self-reported L2 listening skills.

The results of the second conducted meta-analysis indicate that there is a moderate positive association between L2 listening skills and individuals' sensitivity to rhythmic variation. Namely, with an increase in one's L2 listening proficiency, an enhancement in his/her rhythmic perception may be observed as well, and vice-versa. As such, the claim that learning a second language, regardless of its rhythmic similarities or differences with one's first language, increases overall rhythmic sensitivity finds support in the current results.

This could be the case because similarly to how musical training can shape individuals' auditory skills (Vuust, Brattico, Seppänen, Näätänen, & Tervaniemi, 2012), language practice and use might shape one's auditory sensitivity as well. As such, an enhancement in individuals' auditory skills may be subject to two factors: to learning a second language and to the difference in the use of rhythmic properties in the second language (L2) in comparison with the first (L1).

Together, the results from the first and the second conducted meta-analysis provide further evidence of shared mechanisms between the use of rhythmic properties in language and music, as suggested by previous research (Jackendoff, 1989; Mithen, 2005; Patel, 2003, 2008). In this two domains the use of rhythm relies on acoustic properties, such as duration and intensity, to organize events and group them into perceptual units (Bispham, 2006; Lerdahl & Jackendoff, 1983b; Nespor & Vogel, 1986; Patel & Daniele, 2003; Ramus et al., 2000; Tincoff et al., 2005; Toro et al., 2003).

These perceptual units help to create expectations towards the forthcoming event in the acoustic stream, whether this is a linguistic or a musical one (Cummins & Port, 1998; Lerdahl & Jackendoff, 1983a; Schmidt-Kassow & Kotz, 2008). Whenever a skill, such as the use of rhythmic properties in language, is highly practiced and used, it may be transferred and applied to other situations and domains which are perceptually similar (cf. Salomon & Perkins, 1989), such as in the perception and use of rhythm in music. Whenever similar rhythmic properties, such as stress, are observed in language and music, individuals might transfer procedural skills from one domain to the other.

In face of the above presented and discussed results some questions remain. One should not forget that mostly high-proficient L2 learners of English were tested in the L2 learner groups (with the exception of the Turkish low-proficient L2 learners of English). As Roncaglia-Denissen and colleagues report, learning an L2 may enhance music rhythmic perception overall, regardless of its similarity or differences from one's first language. This should be the case because "learning an L2 might enhance the overall perception of acoustic variation, such as the variation in sound duration, intensity and pitch " (Roncaglia-Denissen et al., 2016, p. 7). In this sense, these two tested population should be better in perceiving music rhythmic variation than their monolingual peers.

Therefore, future studies should address this matter by comparing German or Dutch populations with similar cognitive capacity, gender and age, who differ only regarding their L2 (English) proficiency level. Hence, in future studies, the full spectrum of the L2 learner population should be represented in the collected data, beginner, intermediate and highly proficient L2 learners of English should be compared in terms of their music rhythmic perception. In this sense, a better understanding could be gained about the threshold after which the benefits of learning a second language may be observed and rhythmic sensitivity is gained. Then, stronger claims about an overall enhancement of music rhythmic sensitivity by means of learning a second language could be made.

Moreover, future studies should also investigate English native speakers who are L2 learners of Turkish, Dutch and German (English-Turkish, English-Dutch, English-German), for instance, and compare their music rhythmic perception with Turkish, Dutch and German L2 learners of English (Turkish-English, Dutch-English and German-English). If mastering languages with different rhythmic properties is the true explanation for the findings of Roncaglia-Denissen and colleagues (2016;2013) and the results from the first meta-analysis conducted in this thesis, then the two possibilities of language combinations, e.g., Dutch-English and English-Dutch, should be comparable. That is, English-Turkish individuals should perform comparably to their Turkish-English peers and better than their English-Dutch and Dutch-English individuals. Following the same logic, English-German individuals should be as sensitive to rhythmic variation as their German-English peers and both groups should be as sensitive as their English-Dutch and Dutch-English peers. All four groups, i.e., English-Dutch, Dutch-English, English-German and German-English, in turn, should be less sensitive to rhythmic variation than their English-Turkish and Turkish-English peers.

In addition to that, if on the one hand mastering a second language enhances one's musical rhythmic perception, perhaps similar reasoning should be applied to the other direction. That is, through rhythmic training in music, benefits could be gained in L2 skills. Evidence supporting this kind of reasoning has been provided by previous studies investigating the influence of musical training in rhythmic grouping in language (Boll-Avetisyan, Bhatara, Unger, Nazzi, & Höhle, 2015), and the transfer in the use of pitch variation between the music and language domains. If on the one hand sensitivity to pitch information in language may be beneficial to one's sensitivity to pitch variation in music (Deutsch, Henthorn, Marvin, & Xu, 2006b; Elmer et al., 2011), improving the ability to discriminate pitch in music may have impact on language as well. As previous studies report, melodic aptitude positively correlates with pronunciation in a second language (Milovanov, 2009; Milovanov, Huotilainen, Välimäki, Esquef, & Tervaniemi, 2008; Milovanov & others, 2009) and with L2 phonological perception (Slevc & Miyake, 2006).

If a transfer effect can be observed in both directions regarding the sensitivity to and use of pitch information, a comparable bidirectional effect may be expected with regard to rhythmic information in language and music. Thus, more studies investigating rhythm concerning its transfer from the language to the music domain and the other way around should be carried out.

5. Conclusions

This master's thesis carried out two meta-analyses to further investigate two claims made by Roncaglia-Denissen and colleagues in two of their publications (2016;2013). The first claim was that mastering a second language with similar rhythmic properties as the first language does not present such an advantage to one's rhythmic perception as mastering language with different rhythmic properties does. The first meta-analysis compared data from two populations regarding their music rhythmic perception, i.e., German (Roncaglia-Denissen, Schmidt-Kassow, Heine, et al., 2013) and Dutch L2 learners of English (Roncaglia-Denissen et al., 2016) with a third group, namely Turkish L2 learners of English (Roncaglia-Denissen et al., 2016). The results of the conducted meta-analysis indicate that, indeed, German and Dutch L2 learners of English perform comparably in terms of their music rhythmic perception and worse than Turkish L2 learners of English. Therefore, the claim made by Roncaglia-Denissen and colleagues seems to be supported by the conducted analysis.

This may be the case because all the three languages (Dutch, German and English) are considered stress-timed languages and prefer the trochaic foot as word stress pattern. Turkish on the other hand it considered a syllable-timed language and has the metric preference for the iambic foot. As such, L2 learners of a language that has a different use of rhythmic properties than his/her first language, must be more attentive to rhythmic variation, as this provides important linguistic cues for word segmentation and recognition and speech comprehension. As a result of learning rhythmic properties in a second language, which are different than the ones in one's first language, these L2 learners might become more sensitive to rhythmic variation, once experience (learning different rhythmic properties) might shape auditory perception (cf. Vuust et al., 2012).

If sensitivity to rhythmic speech properties enhances the perception of rhythmic properties in music, such evidence may support the notion of shared resources in these two domains. It may also suggest that a domain-specific skill can be transferred to another cognitive domain, e.g., music (Perkins & Salomon, 1989).

The results of the the second conducted meta-analysis seem to corroborate the claim that learning a second language, regardless of its rhythmic similarities with or differences from one's first language, might improve individuals' sensitivity to music rhythmic perception. This could be the case because when learning a second language, individuals might become more aware of acoustic features present in its rhythmic structure, which might help to mark stress, for instance. Hence, being more sensitive to rhythmic variation might provide an important cue to more promptly identify word boundaries and correctly parse and comprehend speech.

Taken together, these results seem to provide further evidence of the cognitive transfer in the use of language specific properties, that is rhythmic features, to the music domain (Besson & Schön, 2001; Marques, Moreno, Castro, & Besson, 2007; Patel, 2008; Schön, Magne, & Besson, 2004; Slevc & Miyake, 2006). This could be the case because individuals might recognize acoustic similarities in language and music, such as stress (Hayes, 1995; Jackendoff, 1989; Lerdahl & Jackendoff, 1983b; Patel, 2003), which may be transfer from one domain to the other (Magne, Schön, & Besson, 2003; Perkins & Salomon, 1989; Salomon & Perkins, 1989; Schön et al., 2004; Vuust, Wallentin, Mouridsen, Østergaard, & Roepstorff, 2011).

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Appendix - Self-reported language questionnaire

Self-reported language questionnaire

Part 1: Language profile

Age:	Gender: □ Feminine □ Masculine
Country and place of birth:	
How long did/have you live/lived in your home country? (from ___ until _____):	
How long did you go to school or have any formal education in your home country? (Please write down the name of the country, number of years and your age at that time):	
How long did you go to school or have any formal education in a foreign country? (Please write down the country, number of years and your age at the time):	
Profession/study path	Years of formal training/ university

Please estimate your language competence:

1 □ I speak and write only in my native language.
2 □ I speak and write in my native and in (an)other language(s).
3 □ I am bilingual: I speak fluently in my second language almost like a native speaker.
4 □ I am bilingual: I learned two languages simultaneously as a child.
5 □ I am multilingual: I speak fluently or like a native speaker more than one language and I master (an) additional language(s).

Please write down the age at which you learned each language, describe briefly its learning situation (at home, in school, abroad) and write down your current use of each language.

Language:	Age:	Learning situation:	Current use
Native language			
Second language			
Other language (please rank by competence)			

Part 2: Language contact and self-assessment

1. In case you stayed in a country other than your home country longer than two weeks, please outline this briefly.

Country:	Length of stay/ Age:	Spoken language

2. Please write down all standardized language tests you took, including your score (also if you did not pass it).

Language:	Test:	Result:

3. Please estimate your language competence in your native, second and further languages.

I - Reading I find it …

1= very difficult to read and understand regular text (ex.: Newspaper), 10 = very easy to read and understand regular text.

a. Native language:

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

b. Second language:

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

c. Other language (which?)

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

II - Writing I find it…

1= very difficult to express ideas, 10 = very easy to express ideas.

a. Native language:

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

b. Second language:

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

c. Other language (which?)

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

III - Understanding I find it…

1= very difficult to understand spoken language (such as regular conversation, news), 10= very easy to understand spoken language.

a. Native language:

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

b. Second language:

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

c. Other language (which?)

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

IV - Speaking I find it…

1=very difficult to formulate and verbalize natural-sounding sentences in a conversation, 10= very easy to formulate and verbalize natural-sounding sentences in a conversation.

a. Native language:

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

b. Second language:

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

c. Other language (which?)

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

V - Grammar I find it…

1= very difficult to understand how a sentence is built, 10 = very easy to understand how a sentence is built.

a. Native language:

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

b. Second language:

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

c. Other language (which?)

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

VI - Language independence

1= If I use this language, I have to translate first in my native language, 10= I feel completely independent in this language and can “think” in it.

a. Native language:

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

b. Second language:

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

c. Other language (which?)

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

Part 3: Language preference and experience

Native language or first fluent language:	
Second language or second fluent language:	
Other language (which?)	

1. Which language do you use mostly on a daily basis?

□ Native language □ Second language

2. Which language did you learn when you learned how to speak?

□ Native language □ Second language □ both simultaneously

3. Please write down the native language of your parents and the language you spoke with each one of them.

	Native language:	Spoken language:
Mother:		
Father:		

4. If you learned two languages as a child, please describe briefly the learning situation in which this happened.

5. If you did not learn a second language as a child, please mark all the correct answers regarding your second language:

□ Traditional learning of a foreign language in school (number of years ___)
□ Learning a language in a school where the language is spoken (number of years_)
□ Contact through family members or through the partner (who _______________________)
□ Contact through an exchange program (where ____________and when________________)
□ Contact through a longer trip (where __________________and when_________________)
□ Contact via the profession or via the university (how_________________________________)
□ Other circumstances (which____)

6. Which language(s) do you speak more frequently at home with your family and friends? With whom do you speak these languages?

Spoken language at home: With whom:

7. In which environment was your native language used the most?

During your childhood:

□ home	□ school	□ both	□ other (which________________)

Currently:

□ home	□ work/university	□ both	□ other (which______________)

9. How much time in a day (in %) do you use each one of these languages (speaking, reading, writing and thinking)?

Native language __________ Second language _________ other language ________

10. (In) which language do you prefer to …

speak?

Native language __________ Second language _________ other language ________

hear?

Native language __________ Second language _________ other language ________

read?

Native language __________ Second language _________ other language ________

write?

Native language __________ Second language _________ other language ________

11. At which age did you begin to…

speak?

Native language ___________ Second language _________ other language ________

Understand spoken sentences?

Native language __________ Second language _________ other language ________

read?

Native language __________ Second language _________ other language ________

write?

Native language __________ Second language _________ other language ________

12. How often do you switch between your native and your second language and vice-versa?
1=I never switch languages, 10=I switch languages very often

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

13. How easy is it for you to switch between languages?
1=very difficult, 10=very easy

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	10 □

14. Please add any further information that you find relevant which was not captured by this questionnaire. THANK YOU!