Lisbon School of Economics & Management
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MASTERS IN

MANAGEMENT AND INDUSTRIAL STRATEGY

MASTER'S FINAL WORK

DISSERTATION

DOCUMENTO PROVISÓRIO

THE IMPACT OF MUSIC FREQUENCY AND TEMPO ON SUSTAINABLE CONSUMER BEHAVIOR

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Abstract

This research explores the impact of music frequency on consumers' sustainable consumption behavior. It is believed that music in the servicescape is a crucial factor in shaping consumers' purchasing decisions towards sustainable products by evoking certain individual emotions and product perceptions. For a better understanding of which music has the most effective impact, this study examines two musical characteristics: frequency and tempo. An online experimental study was carried out with four conditions, combining different frequencies and tempos of the same music. After being exposed to the background music, participants completed a questionnaire designed to measure their purchase intention and willingness to pay for sustainable products. The results suggest that low music frequency could increase consumers' purchase intention and willingness to pay for sustainable products by fostering their emotion of gratitude and associating the product with a more youthful image. In addition, the music tempo does not have a significant moderating effect on the relationship between music frequency and consumers' sustainable consumption behavior. This current research extends the study of music in servicescape to the context of sustainable consumption and highlights the importance of individual emotion in auditory marketing, providing new insights for further practice.

Key Words: Individual Emotions; Music Frequency; Music Tempo; Product perceptions; Sustainable consumption behavior.

Resumo

Esta investigação explora o impacto da frequência musical no comportamento de consumo sustentável dos consumidores. Acredita-se que a música no ambiente dos serviços é um fator crucial para moldar as decisões de compra dos consumidores relativamente a produtos sustentáveis, evocando determinadas emoções individuais e perceções do produto. Para compreender melhor qual a música que tem um impacto mais eficaz, este estudo examina duas características de música: frequência e o ritmo. Foi efetuado um estudo experimental em linha com quatro condições, combinando diferentes frequências e ritmos de uma mesma música. Depois de serem expostos à música de fundo, os participantes preencheram um questionário concebido para medir a sua intenção e vontade de pagar por produtos sustentáveis. Os resultados sugerem que uma baixa frequência musical pode aumentar a intenção de compra e a disponibilidade dos consumidores para pagar por produtos sustentáveis, promovendo a sua emoção de gratidão e associando o produto a uma imagem mais jovem. Além disso, o ritmo da música não tem um efeito moderador significativo na relação entre a frequência da música e o comportamento de consumo sustentável dos consumidores. Esta investigação atual alarga o estudo da música no em ambientes de serviço no contexto do consumo sustentável e realça a importância da emoção individual no marketing auditivo, fornecendo novas perspetivas para a prática futura.

Palavras-chave: Comportamento de consumo sustentável; Emoções individuais; Frequência musical; Ritmo musical; Perceção do produto.

Content

1. Introduction

In recent decades, sustainability has been gaining more attention. The World Economic Forum introduced the concept of sustainable consumption as a consumption that does not negatively impact future generations (World Economic Forum, 2013). The significance developing of sustainable consumption includes decreasing resource exploitation and waste generation (Tukker et al., 2010), reducing pollution and relieving the pressure on ecosystem (Lorek, 2011), stimulating industrial innovation and reducing the reliance on using non-renewable sources (Geels, 2019). Moreover, deepen the bond between the local community and promote economic development (Jackson, 2005) has been emphasized widely as ways to reinforce sustainable consumption.

In the meantime, sustainable products have become more acceptable and have a better reputation. They are no longer seen as less functional compared to traditional products of the same category, and they were given a social value and positive symbolism (Raman et al., 2024). This 'halo effect' reveals the opportunity to develop sustainable consumption.

Following this trend, firms have begun to view sustainable development as an opportunity for innovation, combining sustainability into their business models, product innovations, and strategies to attract consumers (World Economic Forum, 2013; Statista, 2023). According to a survey of North American companies, more than half of them spend 11%-40% of their marketing budget on sustainable promotion, and even 6% spend more than 60% of their budget on sustainability (Statista, 2023). Nevertheless, the market performance of these sustainable products is still not comparable to that of traditional products, and returns are often inconsistent (Papadas et al., 2024). The main reason behind this is that consumers face numerous barriers when purchasing sustainable products, such as high prices, difficulty in accessing them (Jebarajakirthy et al., 2024), and the deviation of product cognition caused by insufficient perceived sustainable value (Yuan et al., 2022).

Despite these challenges, foundational research has established that the in-store ambience can actively affect consumer behavior, emphasizing the background

music as an essential atmospheric factor (Bitner, 1992). Subsequent studies have reinforced this perspective, demonstrating that appropriate music in retail settings, such as stores or restaurants, can consciously affect consumers' current emotional state, thereby affecting their cognition and evaluation of products and ultimately encouraging consumption (Jain & Bagdare, 2011). Further exploring this mechanism, researchers have summarized several structural musical features, such as frequency, which refers to the number of sound fluctuations, determining the pitch of the sound (Sekeroglu, 2025), and tempo, which means the speed of the music (Kellaris et al., 1993). According to these studies, different combinations of these features can create various ambient and value perceptions, influencing consumers' purchasing experiences and decisions. Based on that, it is reasonable to believe that certain musical characters have the same effect on stimulating sustainable consumption.

One key reason music impacts consumer perceptions and responses in retail environments is its effect on consumers' individual emotions(Meyers-Levy, 2005). As Meyers-Levy (2005) stated, consumers often align their decision-making process with the emotion brought by background music. In detail, consumers' emotional state directly influences their product preferences (Lowe et al., 2019) and shopping experience, which in turn influences the time they spend shopping and the amount of money they spend (Morrison et al., 2011).

Apart from emotion, music can also influence consumers' product perceptions, particularly shaping their subjective evaluation of product quality and values, which consequently modifies their brand recognition and final purchase (Sunaga, 2018). Furthermore, while the higher price serves as the primary obstacle to consumers' sustainable purchasing, it has been suggested that high perceived product values, particularly functional, social, and experiential values, can help reduce this negative perception (Yuan et al., 2022). In summary, based on Sunaga (2018) and Yuan et al. (2022), product perception forms consumers' attitudes toward the product and determines their final purchasing decisions; therefore, a favorable product impression can increase consumers' willingness to pay and promote consumption.

The existing literature emphasizes the influence of specific musical features on

consumer purchasing behavior, pointing out that music is an effective tool for businesses to facilitate consumer purchasing decisions (Jain & Bagdare, 2011; Kellaris et al., 1993; Sekeroglu, 2025). However, previous studies have rarely examined this effect in the framework of sustainable consumption(A. Biswas & Roy, 2015; Peck & Childers, 2008). For instance, Biswas and Roy (2015) investigate the determinants that affect sustainable consumption in emerging markets without taking into account sensory marketing tools such as music. In addition, Peck and Childers (2008) present an extensive review of sensory influences, including auditory stimuli, on consumer behavior, but do not address sustainability.

Since sustainable consumption has great potential for development, this dissertation aims to answer the following research question: How does music frequency influence sustainable consumption behavior? The specific objectives of this study are: 1) Explore whether music frequency could influence consumers' purchase intention and willingness to pay for sustainable product; 2) Investigate whether music tempo can modify the effects of music frequency on sustainable consumption behaviors; 3) Explore whether individual emotions can explain the relationship between music frequency and sustainable consumption behavior; 4) Analyze whether product perceptions can explain the relationship between music frequency and sustainable consumption behavior.

This dissertation is organized into five chapters. This chapter is an introduction which outlines the research background, presents the research questions and objectives, and introduces the research objects in detail. The following chapter is the literature review that introduces the existing literature about the influence of music on consumer behavior, proposing hypothesizes of the potential relationship between music and sustainable consumption and introducing the conceptual model. The third chapter explains the research method and logic. In Chapter 4, all the results are summarized and discussed. Finally, Chapter 5 describes the final conclusions of this study, and points out the limitations of this study and the possible direction of future research.

2. Literature review

2.1. Music in retail

Music is a widely used marketing tool in retail (Bitner, 1992; Bruner II, 1990). Since 1990, researchers have defined music as a non-verbal communication medium, and they have proved that music is an external stimulus like the commonly used visual and verbal incentives in marketing dissemination, which can influence consumers' perceptions and decision-making (Bruner, 1990). In the context of retailing, Bitner (1992) introduced the concept of 'Servicescape' to describe the atmosphere created by service places, such as stores or restaurants, encompassing both physical and sensory factors that can actively affect consumers' experience and purchase intentions. Particularly, background music can unconsciously stimulate sensory responses in consumers, so it is considered an essential element in shaping the shopping ambient (Bitner, 1992).

2.1.1. Composition of music

Furthermore, to clearly analyze the difference in consumer responses caused by different musical elements, music has been categorized into different structural elements, such as tempo, pitch, or texture, aiming to summarize the influence mechanism of music (Bitner, 1992). Based on that, many studies have further expanded the division of music structure, specifying previous elements and proposing new features such as frequency and volume (Sekeroglu, 2025). For example, music pitch is clarified as the subjective perspective about whether the music is sharp or low, which is determined by the frequency at which sound waves vibrate. Research results on the influence of music pitch and frequency on consumption behavior have all pointed in the same direction(Huang & Labroo, 2020; Lowe et al., 2019). Besides, since music frequency is a modifiable characteristic, later research has increasingly focused on this aspect of music (Sekeroglu, 2025).

Two dimensions have been discussed and applied most widely among all the examined music features. They are music frequency, which refers to the sound wave vibration, measured in Hertz, and usually categorized as high or low, and music tempo, which refers to the speed of music, usually measured by beats per minute(BPM),

categorized as fast or slow (Jain & Bagdare, 2011; Sunaga, 2018).

While a considerable amount of research has investigated the effects of music frequency (Huang & Labroo, 2020; Sekeroglu, 2025; Sunaga, 2018) or music tempo(Alpert & Alpert, 1990; Pantoja & Borges, 2021) on consumer behavior, there is no study has explored their combined effects, with an even smaller number addressing this within the context of sustainable consumption. Given this, this study aims to explore more deeply the combination of these two features.

2.1.2. Music frequency and sustainable consumption behavior

Frequency has been widely used in research as a key musical element to examine its effect on consumer behavior, with studies indicating that it has a significant impact on consumer purchase intentions and willingness to pay (Lowe et al., 2019; Sekeroglu, 2025). Purchase intention reflects an individual's motivation for a specific action, namely, the efforts they are willing to put into the behavior. So purchase intention is often considered as a direct predictor of actual purchase behavior (Ajzen, 1991). Determining factors of purchase intention are widely studied because they are believed to be essential for promoting consumption. Specifically, the purchase intention comes from consumers' positive evaluation of the product, the stress given by their surrounding social group’s behaviors, and perceived product availability (Jebarajakirthy et al., 2024).

Willingness to pay (WTP) refers to the highest price that consumers are willing to pay for a particular product, and it is a key determinant of whether consumers will buy the product (Kohli & Mahajan, 1991). Studies show that WTP reflects consumers' perceived value of a product, which influenced by attributes such as quality, functionality, and brand image (Paley et al., 2024; Wertenbroch & Skiera, 2002). As previously mentioned, music can influence an individual’s perspective of product value (Sunaga, 2018).

Considering that purchase intention and willingness to pay are vital drivers of consumer behavior (Ajzen, 1985; Kohli & Mahajan, 1991). This study aims to investigate how music frequency influences consumers' purchase intentions and willingness to pay for sustainable products.

2.1.2.1. Music frequency influences sustainable purchase intention

Research has shown that the frequency of music influences consumers' purchase intentions across different types of products (Huang & Labroo, 2020; Lowe et al., 2019). For example, high frequency music has a positive impact on consumers' intention to buy products that can offer them a healthier lifestyle (Huang & Labroo, 2020). In addition, low music frequency increases consumers' product intention of products that can help to reduce risk, such as insurance (Lowe et al., 2019).

Moreover, music frequency has a more significant effect when it aligns with the product's presentation approach (Sunaga, 2018). Specifically, Sunaga stated that high frequency music is better suited for detailed products, while low frequency music is more effective for abstract products. Namely, for products that focus on specific details, price, and practical use, high frequency music is likely to increase consumers' intention to purchase. In contrast, for products that emphasize emotional brand storytelling and long-term value, low frequency music can enhance consumers' purchase intentions.

Meanwhile, sustainable products typically highlight their environmental values and positive impacts on the future, which align more with the characteristics of abstract and emotion-driven products (Yu et al., 2025). Given this, the following hypothesis is proposed:

H1: Low (vs. high) music frequency increases consumers' purchase intention for sustainable products.

2.1.2.2. Music frequency influences the WTP for sustainable products

Music frequency not only influences intention but also influences variable that closely relates to actual buying behavior, consumers' willingness to pay (WTP).

Similar to the effects on purchase intention, when the product with a detailed description is placed under background music with high frequency, consumers reveal a greater willingness to pay (Sunaga, 2018). Sunaga (2018) believed the reason for this finding is that the frequency of background music matches the product's demonstrated style. Additionally, Sekeroglu (2025) discovered that even for expensive products, exposure to high frequency background music increases consumers' willingness to pay.

When it comes to sustainable consumption, WTP is often an essential indicator of actual purchase behavior because sustainable products usually have a higher price (Yuan et al., 2022). This leads to the following hypothesis:

H2: High (vs. low) music frequency increases the WTP for sustainable products.

2.1.3. Music tempo and sustainable consumption behavior

Beyond frequency, music tempo is another widely explored feature on music's influences research on consumer behavior. The effect of tempo on consumers' purchase intention and WTP is proven to be significant (Malcman et al., 2024; Pantoja & Borges, 2021). Recent study has offered a new perspective by utilizing tempo as a moderator, particularly by influencing consumers' enjoyment of background music. In particular, fast tempo music increased consumers' affective response to the music itself, which in turn increases their intention to purchase (Liu et al., 2022). Thus, this research aims to explore the role of tempo in the context of sustainable consumption.

While the primary focus of this study is to examine tempo as a moderator, it is crucial to first understand how tempo independently affects consumers' purchase intention and WTP.

2.1.3.1. Music tempo influences sustainable purchase intention

To begin with, the effect of music tempo on purchase intention has been well established since 1990 (Alpert & Alpert, 1990). According to the researchers' summarized review of previous studies by Jain & Bagdare (2011), background music with a fast tempo enables quicker reactions and more active participation in shopping, which accelerates decision-making and enhances purchase intention. Furthermore, the psychological mechanism underlying this phenomenon is explained as fast tempo music can significantly enhance consumers' pleasant mood and make them feel more in tune with the product, thereby reinforcing their intention to purchase (Khan & Pandey, 2023). Furthermore, this mechanism has been verified in a more specific product category by a recent study about food by Pantoja & Borges (2021), concluding that fast tempo background music can lead consumers to expect the displayed food to taste better, which increases purchasing intention.

While the influence paths in the studies vary, they all support that fast tempo

music triggers positive consumer responses and increases purchasing intentions (Jain & Bagdare, 2011; Khan & Pandey, 2023; Pantoja & Borges, 2021). As a result, it's reasonable to assume that fast music tempo also has a positive impact on sustainable products. Consequently, in line with this perspective, the current study advances by examining whether tempo moderates the influence of music frequency on sustainable purchase intentions, leading to the following hypothesis:

H3: Music tempo moderates the effect of music frequency on consumers' purchase intention for sustainable products.

H3a: Fast tempo enhances the positive effects of low (vs. high) frequency music on consumers' purchase intention for sustainable products.

2.1.3.2. Music tempo influences the WTP for sustainable products

Moreover, music tempo also plays a role in encouraging consumers to make payments. For instance, research indicates that for the purchase of daily basic products, consumers appear to pay as soon as possible to end a purchase around fast tempo music rather than delay the purchase, representing a higher willingness to pay at the moment (Kim & Zauberman, 2019). However, a study exploring restaurant consumption found that low tempo increases the duration of consumers' dinner time, which leads to higher spending (Caldwell & Hibbert, 2002). On the other hand, a recent study finds that consumers exposed to fast-tempo music tend to leave a higher percentage of tips, serving as a direct indicator of WTP, as tips depend entirely on consumers' subjective preferences (Malcman et al., 2024).

Consequently, this study takes a further step by investigating whether tempo moderates the effect of music frequency on consumers' WTP for sustainable products, as expressed in the following hypothesis:

H4: Music tempo moderates the effect of music frequency on consumers' WTP for sustainable products.

H4a: Fast music tempo moderates the positive effects of low (vs. high) frequency music on consumers' WTP for sustainable products

2.2. Individual emotions

Emotion is defined as a multi-dimensional psychological reaction state, which is comprised of the interaction of factors, including individual's subjective perception and physiological autonomic responses to the event, and those factors come from personal cognition and behavioral habits (Bagozzi & Pieters, 1998; Borod, 2000). Researchers often classify emotions as positive or negative to discuss their role in driving sustainable consumption (White et al., 2019). Specifically, as summarized by White et al. (2019), positive emotions such as pride, happiness, and hope usually represent the achievement of a goal or a future vision, while negative emotions like anxiety, sadness, and guilt are typically relevant to ethical conflicts and considerations of social responsibility. In addition, arousal is another important emotional dimension that is often discussed, which refers to the intensity of the emotion a consumer feels at a given moment and is indicated by the increase in physiological heartbeat and skin conductivity (Sekeroglu, 2025). A highly aroused state can guide more rational, self-controlled and health-oriented consumption choices (D. Biswas et al., 2019).

2.2.1. Music frequency influences individual emotions

Music frequency affects emotions, which mediate music's influence on consumer behavior (Huang & Labroo, 2020; Lowe et al., 2019; Sekeroglu, 2025).

Lowe et al. (2019) indicates that low frequency background music can cause anxiety among consumers, as people associate low frequency sounds with uncertain and threatening situations by instinct. Additionally, some studies investigate a broader range of emotional states rather than focusing on just one. For instance, Sekeroglu's research (2025) examines arousal. He finds that a higher frequency of surrounding music correlates with stronger consumer emotions such as excitement, while low frequency music makes consumers calm. Furthermore, Huang and Labroo (2020) suggest that the frequency of music can influence consumers' emotional cognitive states, resulting in either positive or negative reactions. Specifically, the bright and airy musical characteristics of high frequency music can stimulate consumers' associations with the moral qualities of kindness and discipline. In general, these emotional responses caused by music frequency serve as a mediating variable, guiding consumers' consumption intentions and final decisions.

2.2.2. Individual emotions and sustainable consumption behavior

Individual emotions play a crucial role in influencing consumers to shift from traditional consumption to sustainable consumption behavior, a process largely determined by the product's emotional value, which is shaped by both the product itself and the environment in which it is placed (Elsantil & Hamza, 2019; White et al., 2019). Therefore, it is possible to expect that individual emotions can act as an underlying mechanism between music frequency and sustainable consumption behavior.

2.2.2.1. Individual emotions influence sustainable purchase intention

Many studies have demonstrated that certain emotions can effectively motivate individual sustainable purchase intentions (Liang & Guo, 2021; Rowe et al., 2019; White et al., 2019).

The study by Liang and Guo (2021) indicates that the emotion of gratitude (vs. unconcerned) enhances consumers' intentions to make sustainable purchases. Specifically, feeling gratitude makes consumers recognize the benefits they have received from others or from nature, fostering a sense of responsibility to give back. This sense of responsibility encourages them to prioritize long-term benefits over immediate gains, making them more likely to choose sustainable consumption options (Liang & Guo, 2021).

Similarly, the same mechanism is mentioned by White et al. (2019). It appears that the emotions of guilt (vs. pride) trigger individuals' moral responsibility, leading to increased sustainable purchase intention. Additionally, the research of White et al. (2019) also expanded on other emotions that don't trigger moral responsibility but promote sustainable consumption, including negative emotions like anxiety, fear and sadness, and positive emotions like joy and optimism. In detail, negative emotions will make consumers more sensitive to environmental issues, leading to a stronger intention to make sustainable purchases, especially when accompanied by clear information about the positive impacts of their actions, which tells consumers about the specific positive impact of their sustainable behavior; on the other hand, positive emotions promote consumers' sustainable consumption intention by enhancing the pleasure of shopping and brand appeal (White et al., 2019).

In addition to the currently perceived emotions, the concept of "anticipated emotions" is also an emphasized object among researchers about sustainable purchase intention. It is a more effective factor in encouraging sustainable consumption intentions than current emotions. Anticipated emotions refer to the emotions an individual expects to experience in the future before taking action, like expecting pride emotion after buying a sustainable product (Bagozzi & Pieters, 1998; White et al., 2019). Subsequent research on this basis found that inducing anticipated pride is more effective than inducing anticipated guilt when it comes to increasing sustainable purchase intentions. In other words, rather than using shame to influence consumer behavior, it is more effective to foster a positive moral self-image among consumers (Rowe et al., 2019).

In summary, individual emotions significantly impact sustainable purchase intentions (Liang & Guo, 2021; Rowe et al., 2019; White et al., 2019), and these emotions can be adjusted by music frequency (Huang & Labroo, 2020; Lowe et al., 2019; Sekeroglu, 2025). Consequently, the following hypothesis is proposed:

H5: Individual emotions mediate the effects of music frequency on purchase intention for sustainable products

2.2.2.2. Individual emotions influence the WTP for sustainable products

Individual emotions influence not only the intention level but also extend to the behavioral level, affecting more practical sustainable consumption behaviors such as willingness to pay (Becerril-Castrillejo & Muñoz-Gallego, 2022; Elsantil & Hamza, 2019; Maier & Wilken, 2014).

For example, a study points out that positive emotions, such as pride and empathy, facilitate behaviors that benefit others, resulting in a greater WTP for sustainable products, whereas negative emotion has a limited impact on whether consumers pay for sustainability (Elsantil & Hamza, 2019). However, Maier and Wilken (2014) have identified the disincentive of negative emotion to WTP for sustainable products, stating that when experiencing stress, consumers tend to focus more on specific product attributes, such as price and tangible value. This shift in attention can lead to a preference for products that may not be sustainable, resulting in low WTP for

sustainable products, as the value of sustainable products is not always apparent through these attributes (Maier & Wilken, 2014). Although positive emotions can promote WTP for sustainable products, repeated exposure to similar emotions may lead to emotional burnout, which in turn reduces consumers' response to product value and their willingness to pay (Becerril-Castrillejo & Muñoz-Gallego, 2022).

Meanwhile, considering that consumers' emotions can be modified by the frequency of background music (Huang & Labroo, 2020; Lowe et al., 2019; Sekeroglu, 2025), the following hypothesis is made:

H6: Individual emotions mediate the effects of music frequency on WTP for sustainable products

2.2.2.3. Emotional Dimensions Selected for Measurement

In summary, individual emotions that can influence sustainable consumption behavior include positive emotions such as pride, gratitude, joy, and optimism, as well as negative emotions like guilt, fear, and sadness. Therefore, this dissertation focuses on these emotions as the core dimensions of the survey, framing them as expected emotional reactions following consumers' experiences with their consumption choices. The aim is to explore whether variations in music frequency can stimulate these emotional responses and further influence consumers' sustainable intention and their payment willingness.

2.3. Product perception

Consumers' perceptions of products are the key determinants of their consumption behavior. Their perceptions of a product shape their attitudes toward it and their subjective assessment of their ability to consume it, thereby influencing their purchase intention and even actual behavior (Ajzen, 1985).

2.3.1. Music frequency influences product perception

Music frequency influences consumers' perception of products, and this perception acts as a mediator in research discussing the relationship between music and consumer behavior (Lowe & Haws, 2017; Melzner & Raghubir, 2023). Study shows consumers perceive products placed in the background music of low frequency to be larger than they actually are. It is because, in life, larger objects typically emit

lower frequency sounds compared to smaller ones, for example, large bells tend to produce lower frequencies than smaller tinkling bells (Lowe & Haws, 2017). The conclusion of Wang et al. (2020) aligns with that of Lower and Haws (2017), adding that the music frequency only made the product appear larger when paired with a bright color, and this association did not occur when the color low saturation (Wang et al., 2020). Namely, the induced product perception by music frequency serves as a mediator influencing consumers' intention and final purchase (Lowe & Haws, 2017; Sunaga, 2018).

2.3.2. Product perceptions and sustainable consumption behavior

In the context of sustainable consumption behavior, consumers' perceptions of products remain crucial for promoting purchase intentions and their willingness to pay (Jebarajakirthy et al., 2024). Typically, perceptions for sustainable products are often based on following different dimensions of perceived product value: firstly, functional value relates to the product's quality and efficiency, which consumers often use as a benchmark to determine whether the product contributes positively to the environment; secondly, the social value is associated with the social status that comes from purchasing the product; thirdly, the experimental value is connected to the feelings of delight and satisfaction consumers experience while shopping; lastly, the epistemic value is derived from the new knowledge and freshness obtained from consumption (Yuan et al., 2022).

2.3.2.1. Product perceptions influence sustainable purchase intention

It has been proved that specific product perceptions foster consumers' sustainable intentions (Jebarajakirthy et al., 2024; König & Maier, 2024; Lee & Kim, 2024).

Specificlly, Jebarajakirthy et al. (2024) find that consumers' perspectives on the product's sustainable attributes are associated with their intention to purchase, as consumers prefer to buy products that have a positive environmental impact. Furthermore, König & Maier (2024) highlight that sustainability perceptions grow when consumers feel a psychological link with a product, especially if they see it as relevant to their own lives. Moreover, the youthful perception that products provide to

consumers also increases their intention to consume sustainably (Lee & Kim, 2024). This is because the concept of sustainable consumption is relatively new to the general public and tends to relate more to younger generations. Therefore, people are more inclined to buy sustainable products if the product or shopping experience makes them perceive themselves as younger (Lee & Kim, 2024).

As mentioned before, music frequency can influence consumers' perceptions of products (Lowe & Haws, 2017; Melzner & Raghubir, 2023; Wang et al., 2020). Therefore, this study proposes that:

H7: Product perceptions mediate the effect of music frequency on purchase intention for sustainable products

2.3.2.2. Product perceptions influence the WTP for sustainable products

When it comes to the willingness to pay for sustainable products, researchers propose that consumers' perceptions of a product are the key factor.

It is believed that product's functional, emotional, social, and epistemic values collectively enhance consumers' transaction utility by reducing the gap between the perceived value and the price, making they feel that purchasing sustainable products is worthwhile (Sheth et al., 1991) and subsequently influences their purchasing decisions (Yuan et al., 2022). In addition, Paparoidamis and Tran (2019) emphasize the importance of consumers' perceived trade-offs in influencing their WTP. They note that consumers frequently compare the environmental features of products against traditional ones in terms of functionality or price. When consumers perceive that those sustainable attributes require minimal sacrifices, they are more likely to accept them and are willing to pay a higher price (Papadas et al., 2024).

Since music frequency influences consumers' product perception (Papadas et al., 2024; Sheth et al., 1991; Yuan et al., 2022). In line with this, the study hypothesizes that:

H8: Product perceptions mediate the effect of music frequency on WTP for sustainable products.

2.4. Proposed conceptional model

Based on previously mentioned studies, researchers expressed that

sustainable consumption behaviors are impacted by consumers' individual emotions and product perceptions (White et al., 2019; Yuan et al., 2022). Furthermore, music characteristics such as frequency can influence personal emotions and product perceptions (Lowe et al., 2019; Lowe & Haws, 2017). Additionally, music tempo has a moderating effect on how music affects consumers' purchasing behavior (Liu et al., 2022).

As a result, this dissertation proposes that music frequency can affect consumers' sustainable purchase intention and WTP for sustainable consumption. This relationship is mediated by individual emotions and perceptions of the product. Additionally, music tempo is proposed to moderate the strength of music frequency influences on sustainable consumption. The proposed conceptual model presented in Figure 1 illustrates the hypothetical relationships among all the discussed variables, while Table 1 summarizes all proposed hypotheses.

Figure 1

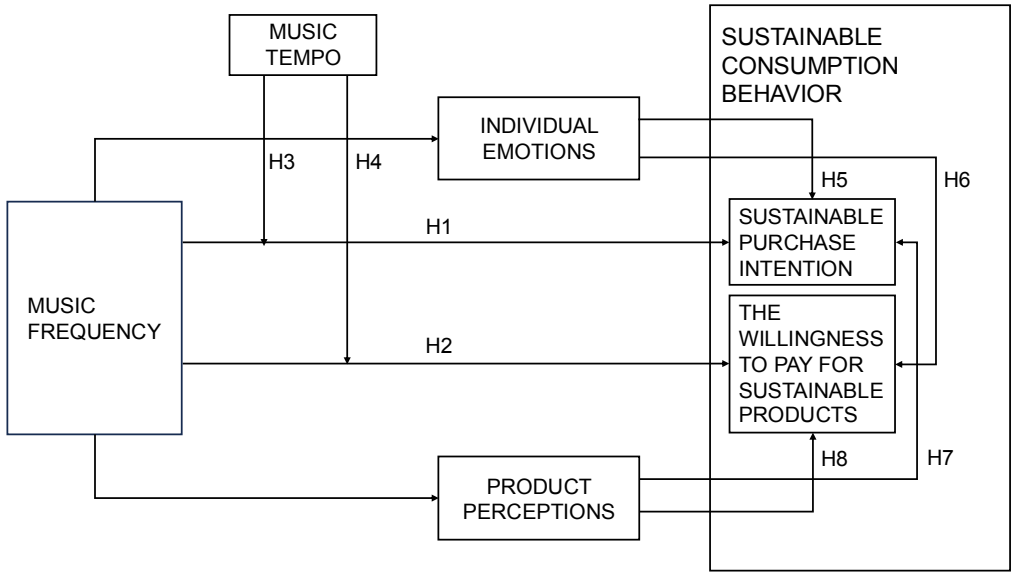

Table 1 Summary of hypothesizes

H1	Low (vs. high) music frequency increases consumers' purchase intention for sustainable products
H2	High (vs. low) music frequency increases the WTP for sustainable products
H3	Music tempo moderates the effect of music frequency on consumers' purchase intention for sustainable products.

H3a	Fast tempo enhances the positive effects of low (vs. high) frequency music on consumers' purchase intention for sustainable products
H4	Music tempo moderates the effect of music frequency on consumers' WTP for sustainable products.
H4a	Fast music tempo moderates the positive effects of low (vs. high) frequency music on consumers' WTP for sustainable products.
H5	Individual emotions mediate the effects of music frequency on purchase intention for sustainable products.
H6	Individual emotions mediate the effects of music frequency on WTP for sustainable products.
H7	Product perceptions mediate the effect of music frequency on purchase intention for sustainable products
H8	Product perceptions mediate the effect of music frequency on WTP for sustainable products.

3. Methodology

3.1. Research Philosophy

To address the research question and achieve its objectives, this study uses a deductive approach based on positivism, a philosophical stance that belongs to empiricism, which assumes that objective facts in society can be observed and measured (Bryman & Bell, 2015). Positivist research is the process of arriving at conclusions through logical analysis and reasoning (Bryman & Bell, 2015). Adopting the deductive approach, this study proposes and examines hypotheses based on established consumer psychology theories, aiming to explain sustainable consumption behavior influenced by certain music features (Collis & Hussey, 2014).

3.2. Research design

3.2.1. Research method and manipulation

To begin with, the current research is an experimental study conducted with a mono-quantitative method. Specifically, according to Saunders et al., (2023), experimental research is usually used to study the causal relationship of variables while controlling for other variables. A mono-quantitative method involves using statistical probability data to test the proposed hypotheses (Saunders et al., 2023). In particular, this experimental research was developed to investigate the causal effects of musical characteristics and consumer sustainable behavior.

Therefore, an experiment was conducted through an online questionnaire containing a video-based task. The study design is a 2 (music frequency: high vs. low) x 2 (music tempo: fast vs. slow) between-subjects. Participants were randomly assigned to one of four conditions for data collection. Each condition presents the same 30-second video of a shopping experience in the Bio area of a supermarket, accompanied by background music that varies in frequency and tempo. Specifically, the music in this study was directly adapted from Study 2 of Huang and Labroo (2020), where two rock tracks were altered to create high frequency and low frequency versions, while all other musical elements remained unchanged. The original files were obtained and used as the basis for further editing. In addition, following the approach of Malcman et al. (2024), the tempo was adjusted using Audacity software to create a

fast version (+4.2% BPM) and a slow version (−15% BPM) for each frequency condition. Other musical features, such as melody and timbre, were maintained consistently across versions.

3.2.2. Questionnaire and Measurements

The questionnaire on the Qualtrics platform is available in English, Portuguese, and Chinese to help participants better understand it. Before the questionnaire was published, a pre-test involving 20 participants verified the validity of the experimental operation. Subsequently, the questionnaire was registered on the AsPredicted platform with the reference number #224120.

The whole questionnaire contained five blocks. Participants began with block one, where they were initially informed about the research's purpose, duration, and confidentiality, and were assured that their participation was completely voluntary. After confirming their adult status, they automatically entered block two and were randomly assigned to one of four experimental conditions to watch the corresponding shopping scenario videos. Following this, in block three, participants answered questions related to the dependent, mediating, and independent variables of the research. After that, participants were required to answer manipulation test questions in block four to ensure they accurately recognized the changes in the music throughout the experiment. Finally in block five, they answered questions about demographics, including age and nationality.

Regarding the measurement, in block three, participants answered questions that evaluated the study's dependent variables: purchase intention and willingness to pay for a certain sustainable product displayed in the video. All dimensions are assessed using a 7-point Likert scale ranging from 1 (“strongly disagree”) to 7 (“strongly agree”).

The purchase intention was measured utilizing four dimensions adapted from Chandran and Morwitz (2005). These dimensions evaluated the likelihood, probability, certainty, and perceived chance of purchasing the product. Furthermore, willingness to pay was evaluated through three statements inspired by Wei et al. (2023), which assess participants’ openness to paying a premium for sustainable products. These

statements represent a range from a moderate willingness to spend extra to full acceptance of increased prices for sustainability.

After that, the two mediating variables of the study, individual emotions and product perceptions were measured. Individual emotions were assessed in a semantic differential scale where participants had to select a position on a 7-point scale between opposing emotional terms. The scale is based on the research conducted by Huang and Labroo (2020), which originally focuses on arousal, power, and mood dimensions . However, this dissertation incorporates six emotion pairs that previous research has demonstrated to influence sustainable consumption behavior: gratitude (vs. unconcerned) (Liang & Guo, 2021), guilt (vs. pride), anxiety (vs. secure), sadness (vs. joyful) and optimism (vs. pessimistic) (White et al., 2019).

Moreover, product perceptions were assessed based on Yuan et al. (2022) and Lee & Kim (2024). The assessment covers dimensions of perceived product value that can impact consumers' sustainable consumption, including sustainable attribute, functional value, experiential value, epistemic value, social value, and youthful brand image. And each dimension is featured with three descriptions that capture consumers' evaluations of the product evaluated in a 7-point Likert scale. Please see appendix A for the summary of the sources and adaptations of the experimental stimuli and measurement scales used in this study.

In block four, the control variables and manipulation check scales, including participants' perceptions of the music (Huang & Labroo, 2020), purchase frequency and brand familiarity (in 7-point Likert scale), as well as gender, age, nationality and education level (as categorical variables), were utilised from Huang & Labroo (2020) and Yuan et al. (2022). Additionally, sustainable concern was a control variable, due to its relevance in sustainability research. It was measured with three modified items from the GREEN scale (Haws et al., 2014): concern for environmental issues, efforts to buy eco-friendly products, and attempts to reduce personal environmental impact. Apart from these eight control variables, the survey encompasses three questions(Q18-Q20) designed to evaluate participants' compliance with the experimental procedure, specifically regarding their completion of the video viewing and whether they were able

to hear the accompanying music clearly. These items were used for data cleaning before analysis, removing responses that did not meet minimum criteria like early video termination or audio issues (See Appendix B).

3.3. Sample and procedure

The sample for this study was obtained through convenience sampling, which is a non-beneficial sampling method, meaning that all participants come from the population that the researcher can easily access (Saunders et al., 2023). The questionnaire was distributed randomly in both online and offline environments (gyms and cafés). Additionally, the sample targets consumers in Portugal who are over 18 years old. Besides, the target sample size was calculated using G-Power software, which indicated that the sample for this study should comprise approximately 210 responses (Faul et al., 2007). Given that there are four conditions, around 50 participants in each condition could provide sufficient data for statistical analysis.

3.4. Data analyses

The data were processed using SPSS. Data cleaning was carried out before analysis to verify the accuracy of variable coding. Specifically, incomplete questionnaires were removed. Besides, responses from participants who stayed on the video screen in block two for at least 15 seconds were considered valid for the final analysis, as this ensured exposure to half of the stimulus analysis. Furthermore, descriptive statistics (means and standard deviations) for each major variable are used to describe the basic characteristics of the sample. Moreover, Cronbach's Alpha was calculated to test the internal consistency of each scale. Individual emotions were excluded from this analysis, as they cover five distinct dimensions, each measured by a unique distinct item.

To examine the main effects of music frequency on the dependent variable (purchase intention and WTP), statistical tests will be implemented using analysis of variance (One-way ANOVA). Additionally, Two-way ANOVA will be conducted to assess possible interaction effects between music frequency and tempo. Furthermore, this study adopts the PROCESS Macro tool with 5,000 bootstrap resamples to create bias-corrected 95% confidence intervals for testing the mediating effects of emotions

and product perception on the relationship between music frequency and sustainable consumption behavior.

Moreover, to ensure that individual characteristics did not affect the main effect of music frequency on consumers' purchase intention and WTP for sustainable products, the study applied one-way ANOVA for Likert scale and the Chi-square test for categorical items.

4. Results Analysis

4.1. Sample description

The questionnaire has obtained 461 responses. Since it was impossible to fully control participants' viewing behavior of the 30-second video in the questionnaire (because it was self-administered), only 200 valid samples with a viewing time of more than 15 seconds were considered for analysis. In addition, the 200 valid responses were distributed across the 4 experimental conditions in the survey, with each condition including 44-55 participants.

The valid sample contains 60.5% of females and 39.5% of males. The age range is from 20 to 55 years old (M = 33, SD = 6.96), with a concentration between 24 and 37 years old (76.5%). In terms of educational level, 85% of the participants hold a bachelor's degree or higher, indicating a relatively high overall educational background. Furthermore, the sample covers nine nationalities. Portuguese nationality represents the largest share at 50.5%, with Brazilian nationality following at 16.0%. Other nationalities include Spain, the United Kingdom, Italy, and others.

4.2. Reliability analysis

The Cronbach's Alpha reliability analysis was conducted on all variables measured by the Likert scale to test the internal consistency of each scale. Results (See Appendix D) show that these scales have good internal consistency and can support the following analysis and interpretation. Additionally, the reliability analysis does not take into account variables of individual emotions, as these were measured using five separate scales, each representing a distinct emotion, making Cronbach’s alpha analysis inapplicable.

4.3. Manipulation check

To ensure the effectiveness of the experimental manipulation, this study performed manipulation checks using two separate one-way ANOVA.

For music frequency, the analysis examined whether participants could distinguish background music frequency on a 7-point scale (1 - low to 7 - high) between low and high conditions. The results showed a significant difference ($F(1, 198) = 5.161$, $p = .024$) with participants exposed to high frequency music reported higher perceived

frequency (M = 4.95, SD = 2.01) than those in the low-frequency condition (M = 4.27, SD = 2.23). Similarly, for music tempo, participants in fast tempo music condition (M = 5.08, SD = 2.01) perceived faster tempo compared to the slow tempo group (M = 4.42, SD = 2.23), revealing a significant difference (F(1, 198) = 4.872, p = .028), confirming the effective manipulation of tempo. Collectively, these findings verify the effectiveness of both music frequency and tempo manipulations.

4.4. Control variables analysis

To examine control variables across music frequency conditions, one-way ANOVA was applied to control variables measured on Likert scales, including sustainable concern (p = 0.056; M_low = 4.65, SD = 1.57; M_high = 4.21, SD = 1.67), wine purchase frequency (p = 0.856; M_low = 4.11 SD = 1.48; M_high = 4.07, SD = 1.51), brand familiarity (p = 0.659; M_low = 3.74 SD = 2.08; M_high = 3.62, SD = 1.96), and age (p = 0.651; M_low = 32.42 SD = 6.53; M_high =33.11, SD =7.36). In addition, chi-square tests were also used for categorical variables, including gender (p = 0.396), nationality (p = 0.338), and education level (p = 0.155). The results showed no significant differences (p > 0.05) among all control variables under different music frequency conditions. This indicates that the influence of music frequency (low/high) on consumer behavior will not be explained by these variables.

4.5. Analysis of the main effects

This study performed a one-way ANOVA to test Hypotheses 1 and 2, to verify how music frequency influences consumers' sustainable consumption behaviors, including purchase intention and willingness to pay.

For purchase intention, the results revealed no significant difference between groups, F(1, 198) = 0.519, p = 0.472 > 0.05. The mean scores of the low frequency group (M = 4.13, SD = 1.68) and the high frequency group (M = 3.96, SD = 1.59) were also relatively close. In terms of WTP, the results showed no significant difference as well, F(1, 198) = 0.232, p = 0.631 > 0.05. The gap in mean scores between the low frequency group (M = 4.03, SD = 1.88) and the high frequency group (M = 3.92, SD = 1.55) was small.

Therefore, H1 and H2 are not supported.

4.6. Analysis of the moderating effects

To investigate whether music tempo moderates the effect of music frequency on consumers' sustainable consumption behavior, a two-way ANOVA is used to analyze the two dependent variables of this research separately.

Results indicate that the interaction between music frequency and tempo is not statistically significant on purchase intention of sustainable products ($F(1, 196) = 0.577$, $p = 0.449$, $p > 0.05$). Additionally, there was no significant difference in the means of the four experimental groups (See Appendix E). These results suggest that music tempo does not moderate the effect of music frequency on consumers' purchase intention for sustainable products. Consequently, H3 and H3a are not supported.

Additionally, the interaction between music frequency and tempo was found to be not significant when evaluating consumers' willingness to pay for sustainable products ($F(1, 196) = 0.025$, $p = 0.875$, $p > 0.05$). The differences among the means of the four experimental groups were all less than 1 (See Appendix E). Consequently, music tempo does not moderate the effect of music frequency on consumers' WTP for sustainable products. Thus, H4 and H4a are not valid.

4.7. Analysis of the mediating effects

Although the main effect shows no significant results, music frequency may still influence consumers' sustainable behavior through an indirect path. Therefore, this study further analyzed the mediating effect between individual emotions and product perceptions to verify H5 to H8.

As stated in the methodology section, the variable of 'individual emotions' is represented by five dimensions: Guilt-Pride, Unconcerned-Gratitude, Sad-Joyful, Pessimistic-Optimistic and Secure-Anxious. And the variable of product perceptions is formed of six dimensions: Sustainable Attributes, Functional Value, Experiential Value, Epistemic Value, Social Value and Youthful Image.

All mediating effects were independently tested using the PROCESS macro (Model 4, with 5,000 bootstrapped samples and a 95% confidence interval). The independent variables included music frequency (0 = low frequency, 1 = high frequency), the dependent variables were consumers' purchase intention for

sustainable products or WTP for sustainable products, and the mediating variables consisted of those various dimensions.

4.7.1. The mediating effect of individual emotions

Results for individual emotions show that, except for Unconcerned-Gratitude (BootLLCI = -0.5751, BootULCI = -0.0268), the Bootstrap confidence intervals for the other four dimensions span 0, indicating no significant mediating effect (See Appendix E). In path analysis, the effect of music frequency on Unconcerned-Gratitude was significant (β = -0.5905, p = 0.0299). This means that high frequency music reduces consumers' gratitude mood. In addition, the gratitude emotion has a positive influence on the purchase intention for sustainable products (β = 0.5159, p < 0.001).

Similarly, a significant mediating effect was observed when testing the consumers' WTP for sustainable products (Unconcerned-Gratitude, BootLLCI = -0.5775, BootULCI = -0.0312). And the path is simmilar, high frequency music reduces consumers' gratitude mood (β = -0.5905, p = 0.0299). The gratitude emotion positively impacts consumers' WTP for sustainable products (β = 0.5073, p < 0.001).

Notably, even when the five emotional dimensions were combined into a single overall variable to assess the mediating effect, the result remained significant (See Appendix F). Additionally, the direct effect of music frequency on consumers' purchase intention for sustainable products (β = 0.1541, p = 0.4148, 95% CI = [–0.2178, 0.5261]) and WTP for sustainable products (β = 0.1843, p = 0.3782, 95% CI = [–0.2273, 0.5960]) were not statistically significant, confirming the absence of a direct effect, further illustrating the strong mediating effect of the individual emotion of gratitude.

Thus, H5 and H6 are supported in the context of gratitude emotion. Namely, low music frequency promotes consumers' purchase intention (H5) and WTP (H6) for sustainable products by evoking gratitude emotion.

4.7.2. The mediating effect of product perceptions

The findings on product perceptions indicate that only the 'Youthful Image' dimension (BootLLCI = -0.6429, BootULCI = -0.1294) has a significant mediating effect, while the other five dimensions' Bootstrap intervals all cross zero and are not significant (See Appendix E). Results of the path analysis indicate that high frequency music

reduces consumers' perception of a product's ‘Youthful Image’ (β = -0.6462, *p* = 0.0028), while ‘Youthful Image’ positively affects consumers' purchase intention for sustainable products (β = 0.5873, *p* < 0.001).

In terms of consumers’ WTP for sustainable products, “Youthful Image” also shows a significant mediating effect (BootLLCI = -0.6196, BootULCI = -0.1258). High frequency music reduces consumers' perception of a product's ‘Youthful Image’ (β = -0.6462, *p* = 0.0028), while ‘Youthful Image’ can increase consumers' WTP for sustainable products (β = 0.5571, *p* < 0.001).

Besides, the product perception of “youthful image" continues to have a significant mediating effect when aggregating the six product perception dimensions into a single variable, highlighting the youthful image as a strong mediator (See Appendix F). In addition, the direct effect of music frequency on consumers’ purchase intention for sustainable products (β = 0.254, p = 0.8729, 95% CI = [–0.2873, 0.3381]) and WTP for sustainable products (β = 0.0360, p = 0.8452, 95% CI = [–0.3276, 0.3997]) were not statistically significant, confirming no direct effect, further highlights the significant mediating effect of product perception of youthful image. Accordingly, H7 and H8 are supported in terms of the youthful image. Thus, low frequency music can increase consumers' purchase intention (H7) and WTP (H8) for sustainable products by improving the perception of the product's youthful image.

5. Discussions and Conclusions

The objective of this dissertation was to explore the influence of music frequency on sustainable consumption. The primary objective of this study is to explore whether music frequency affects consumers' sustainable consumption behavior, including purchase intention and WTP for sustainable products. Although existing studies have pointed out that low frequency music can enhance consumers' intention for abstract products that offer a sense security (Lowe et al., 2019) and have long-term value (Sunaga, 2018), the present study found no significant difference in the purchase intention for sustainable products when comparing low frequency and high frequency music. Furthermore, literature suggests that high frequency music can enhance consumers' willingness to pay (Sekeroglu, 2025), however this research did not find a comparable significant effect either.

These findings may be related with various factors. For instance, the existing literature on the impact of music frequency mostly focuses on traditional products (Sekeroglu, 2025; Sunaga, 2018), whereas this study focuses on sustainable products. Moreover, the manipulation was conducted through a video scenario rather than a real purchase task, which may not adequately incentivize specific individual emotions and product perceptions in the experimental setting, thereby constraining the development of the expected psychological path. However, on the other hand, as mentioned in the methodology chapter, the manipulation design in this study closely follows validated approaches used in previous research. Specifically, the original music tracks were sourced from Huang and Labroo (2020), and the tempo modifications were made strictly in line with the parameters suggested by Malcman et al. (2024). Besides, external factors like the type of product used in the experiment (a sustainable wine) and participants' characteristics, including their sensitivity to music or cultural background, may have had a greater impact than the manipulation setting in constraining the activation of specific individual emotions and product perceptions.

The second specific objective of this study was to investigate whether music tempo moderates the effect of music frequency on sustainable consumption behavior. Research indicates that music tempo can influence consumers' purchase intentions

(Khan & Pandey, 2023) and their willingness to pay (Kim & Zauberman, 2019). Furthermore, music tempo is also believed to play a moderating role between music preference and purchase intention (Liu et al., 2022). However, this study found no significant moderating effect of music tempo on the relationship between music frequency and sustainable consumption behavior among consumers. In other words, music tempo does not significantly influence how music frequency affects consumers' purchase intentions and WTP for sustainable products. The likely explanation for this is that the primary focus of this study is on music frequency, so the musical stimuli were directly adapted from tracks utilized in prior research examining the impact of frequency on consumer behavior (Huang & Labroo, 2020). Although the tempo was adjusted, the musical pieces may not have provided sufficient tempo cues to bring out the expected consumer responses. Participants may have had trouble consciously or subconsciously noticing the tempo change, reducing its moderating effect.

This study's third specific objective was to investigate whether individual emotions can explain the influence of music frequency on consumers' sustainable consumption behavior. When analyzing the mediating role of individual emotions, this study reveals that low frequency music can effectively evoke gratitude as an individual emotion, subsequently promoting their purchase intention and WTP for sustainable products. Our finding is in line with Sekeroglu's statement (2025), which suggests that variations in music frequency can have a significant impact on individual emotions. Furthermore, our current finding not only supports the idea that gratitude can enhance purchase intention for sustainable products (Liang & Guo, 2021), but also broadens the research by demonstrating that gratitude can increase consumers' willingness to pay. Therefore, this study highlights the mediating effect of individual emotion of gratitude on the relationship between music frequency and sustainable consumption behavior.

The final objective of the present research was to examine how product perceptions can explain the influence of music frequency on sustainable consumption behavior. Existing studies suggested that variations in music frequency can influence customers' perceptions of a product (Lowe & Haws, 2017) and that certain product

perceptions increase consumers' purchase intentions (Jebarajakirthy et al., 2024) and their willingness to pay (Yuan et al., 2022). This research partly supports and integrates these perspectives, showing that when consumers are exposed to low frequency music, they develop a more youthful image of the sustainable product, and this perception is positively correlated with their purchase intention and WTP. This finding aligns with the viewpoint expressed by Lee & Kim (2024), which suggests that a youthful image of products helps enhance consumers' sustainable consumption. In conclusion, this research confirms that the "youthful image", as a product perception, mediates the relationship between music frequency and sustainable consumption behavior.

5.1. Implications

Theoretically, this study extends research on musical influence in servicescapes on consumer behavior to sustainable consumption, focusing on two specific music features: frequency and tempo. In addition, by introducing ‘individual emotions’ and ‘product perceptions’ as mediators, it clarifies how music frequency affects sustainable consumption behaviors. It shows that the gratitude emotion and youthful product image amplify low frequency music positive impact on consumers’ purchase intention and WTP for sustainable products.

Managerially, this study offers guidance for sustainable brands in designing their servicescapes. Low frequency music can be used to create in-store music environments that promote consumers’ purchase intentions and WTP in a subconscious and cost-effective manner. A relevant example was observed in the supermarket of El Cort Inglês, where background music was played in the area of sustainable products. This arrangement of music may provide greater emotional engagement and perceived product value.

5.2. Research limitations and future research

The current study has several limitations. First, the data is gathered through an online survey experiment, which has limited control over auditory stimuli. Music frequency and tempo are subtle characteristics that may not be consciously recognized(Jain & Bagdare, 2011), especially in uncontrolled environments, potentially

explaining participants' limited ability to identify and react to them. Therefore, future research may benefit from laboratory or controlled field experiments for effective stimulus presentation.

Secondly, the sample in this study might not fully represent the broader consumer population. Most participants were recruited online from the researcher's social networks as it was a convenience sample. Their behavior and focus might vary from the typical audience for sustainable brands. Thus, future studies should aim for a more diverse or representative population.

Thirdly, this study examines the impact of music frequency on consumer behavior using a single type of sustainable product, bio wine, without exploring multiple sustainable product categories, such as sustainable personal care products, to assess the reliability of the observed effects across various product types. Furthermore, the study does not include traditional products as a control group. Future studies could cover a wider range of sustainable product categories, with each one paired with a similar non-sustainable product as a control group. This would help determine whether the effects observed are specific to sustainable products or relevant to various product categories.

Lastly, this study focused only on two key music features, frequency and tempo, without considering other potentially relevant auditory variables such as music volume or individual music preferences. These factors may collectively influence consumers' sustainable consumption concerning music frequency and tempo. Further research could explore these aspects to gain a deeper understanding of music's overall influence on sustainable consumption behavior.

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Appendix

Appendix A - Summary of metrics and scales from similar research and adoption (experimental variables)

Name of variable	Source	Scale	Adapted scale 【questions in my survey】	
Music Frequency	Huang & Labroo, 2020	Study 1 • Scene: fieldwork set in the campus food court • Music genre: Music with no lyrics (category unspecified) • Processing method: • high-pitched: Adjust the frequency upward by 50% • low-pitched: Adjust the frequency down by 50% Study 2 • Scene: listen to audio (headphone) • music genre: Rock music • Processing method: • High-pitched： Adjust frequency up 50% • Normal-pitched ： original audio • Low-pitched ： Adjust frequency down 50% Study 3 • Scene: listen to audio (headphone) • Genre of music: Expanded into three genres • Metal • Jazz • Rock • Processing method: High and low frequency versions of each music (Pitch adjusted ±50%) • Objective: To test whether musical frequency effects remain stable across musical styles Study 4 • Scene: listen to audio (headphone) • Music genre: Another unnamed instrumental music • Processing method: Still use ±50% high-frequency/low-frequency processing Study 5 • Scene: ask to complete task • music genre: Classical music • Pitch manipulation: Also ±50% processing • Added the "Moral Awakening" text task as a moderating variable	Use the same music stimuli that adopted by Huang & Labroo(2020) in their study 2, creating a video with the backgroud music: • Music1--High frequency version • Music2--Low frequency version	Four video versions were created by mixing high/low frequencies with fast/slow tempos, each featuring different background music： • High frequency, slow tempo: https://www.dropbox.com/scl/fi/qj0jmgbsq33o0eicgt1yj/High-Slow169.MP4?rlkey=dcu2bgj2v87652vzftje4t8f3&st=wv429ck4&dl=0 • Low frequency, fast tempo: https://www.dropbox.com/scl/fi/icck4u46l5qlhfhrqhht6/Low-Fast169.MP4?rlkey=z03259zwhqs2spep2y5990yab&st=ya00i96h&dl=0 • High frequency, fast tempo: https://www.dropbox.com/scl/fi/fv1tu3mouwqiuqzvax4au/High-fast169.MP4?rlkey=sxevxc3on58zcozy78v1y5f5v&st=4g4llxml&dl=0 • Low frequency, slow tempo: https://www.dropbox.com/scl/fi/fok0c8d8epy99193tqqbl/Low-slow169.MP4?rlkey=3v1rhp8v1w1firh9f4x7fa95l&st=likshdc4&dl=0
Music Tempo	Malcman et al., 2024	Choose songs - Club Dance “Gyoza” to form two version: • Original tempo:126 BPM • Fast version: 131.28 BPM （+4.2%） • Slow version: 94.55 BPM （-25%）	Edit the M1 and M2(original tempo:129) with Audacity audio editing software • The fast tempo version:134.4 BP （+4.2%） • The slow tempo : 109.65 BPM （-15%） • Keep melody, tone, timbre, harmony and other features consistent, adjusting only the rhythm (each participant listen to one version of the music at random)	

Name of variable	Source	Scale	Adapted scale 【questions in my survey】
Individual Emotions	Huang & Labroo, 2020	9-point scale • Measuring arousal • 1relaxed---7stimulated • 1sluggish---7frenzied • 1depressed---7upbeat • 1drowsy---7energetic • 1calm---7aroused • Measurding feelings of power • 1powerless---7powerful • Measuring mood • 1sad--7happy	Please express your current feelings by selecting a point between the two opposing words. • 1Guilt---7Pride • 1Unconcerned---7Gratitude • 1Sad---7Joyful • 1Pessimistic---7Optimistic • 1Secure---7Anxious
Product Perceptions	Yuan et al., 2022	Measuring ecological value • The environmental performance of green products meets my expectations • I purchase green products because they have more environmental concern than others • I purchase green products because they have more environmental benefits than others	Measuring Sustainable attributes： • This product's environmental performance aligns with my expectations. • I choose this product because it shows more environmental concern compared to others. • I choose this product for its greater environmental benefits over alternatives
		Measuring functional value • Green products are very reliable • Green products provide good performance • Green products have an acceptable standard of quality	Measuring Functional value • This product is dependable. • This product has good quality. • I will be satisfied with the product's quality and taste.
		Measuring experiential value • Buying green products totally absorbs me • Others' enthusiasm for buying green products is catching and uplifting • Buying green products entertains me	Measuring Experiential value • I'm passionate about green products • Others' willingness to buy this sustainable wine is inspiring • buying this sustainable wine makes me happy
		Measuring epistemic value • I am bored with nongreen products • I am curious about green products • I like to experience things that are new and different	Measuring epistemic value • I am bored with normal wine • I am curious about the difference between sustainable wine and regular wine • I prefer to explore different and innovative items
		Measuring symbolic value • With green products, I can express my environmental concerns • With green products, I can demonstrate to myself and my friends that I care about environmental conservation • With green products, my friends perceive me to be concerned about the environment	Measuring social value • I can share my environmental concerns with this sustainable wine in my home • By choosing this sustainable wine, I can show myself and my friends that I care about conservation. • With this sustainable wine in my home, my friends see me as someone who cares about the environment.
			Measuring youthful image - I believe this product has a youthful brand image. - The product appears stylish and full of energy. - The product targets to young audience.

Name of variable	Source	Scale	Adapted scale 【questions in my survey】
Purchase Intention	Chandran & Morwitz, 2005	7-point scale • How likely are you to buy the product on offer (highly unlikely to highly likely), • How probable it is that you will purchase the product on offer (highly improbable to highly probable), • How certain it is that you will purchase this product (highly uncertain to highly certain), and • What chance there is that you will buy this product (no chance at all to very good chance).”	Please share your level of agreement with the following statements regarding your intention to buy this product: • I'm likely to buy this product(1---7) • The possibility of me purchisng this product is high(1---7) • I'm pretty sure I'll buy this product(1---7) • There is a good chance that I will buy this product(1---7)
WTP for Sustainable Products	Wei et al. (2023)	7-point scale • I am willing to pay more money to buy environment-friendly products. • I am willing to pay more money to buy products with sustainable packaging (e.g., compostable, glass, aluminum…). • I am willing to pay more money to buy eco-friendly products. • I am willing to spend more money to buy bulk products. • I believe it is acceptable to spend extra money on bulk products. • I believe it is acceptable to spend extra money on products with sustainable packaging (e.g. compostable, glass, aluminum…).	Please share your level of agreement with the following statements regarding your intention to buy this product: • I am open to spending more for this sustainable product(1---7) • I am willing to pay a premium for this product(1---7) • I completely agree to pay a higher price for this product(1---7)

Appendix B - Summary of metrics and scales from similar research and adoption (control variables)

Name of variable	Source	Scale	Adapted scale 【questions in my survey】
Participants' Perceptions of the Music	Huang & Labroo, 2020	9-point scale • How would you rate the music?" •Low pitched--high pitched, •Discomforting--comforting • Slow tempo--fast tempo • Unpleasant-- pleasant	8-point scale • How would you rate the music? • Low frequency(low-pitched)--High(high-pitched) • Slow tempo--fast tempo
Purchase frequency	Yuan et al., 2022	Categorical variables • Everyday • Always • Sometimes • Seldom	Categorical variables • How frequently you usually purchase wine? • Never • Less tha once a year • A few times a year • Once a month • A few times a month • Once a week • Sever a times a week
Brand familiarity	Yuan et al., 2022	7-point scale • How would you rate the product?	7-point scale How familiar are you with the showen wine brand "Coelheiros"? (1 = Not at all familiar to 7 = Very familiar)
Gender	Yuan et al., 2022	Categorical variables • Female • Male	Categorical variables • What is your gender? • Female • Male
Age	Yuan et al., 2022	Categorical variables • Up to 17 • 18–24 • 25–29 • 30–39 • 40–49 • Over 49	Open-ended •What is your age? (ex. 24)

Name of variable	Source	Scale	Adapted scale 【questions in my survey】
Nationality	Yuan et al., 2022	Categorical variables •U.S •China •Canada •Europe	Categorical variables •What is your nationality? •Portuguese •Brazilian •British •Italian •Chines •Others
Education level	Yuan et al., 2022	Categorical variables • High school • Undergraduate • Postgraduate • Others	What is your highest level of education? • High school or below • Undergraduate • Master
Sustainable Concern	Haws et al., 2014	7-point scale •It is important to me that the products I use do not harm the environment. •I consider the potential environmental impact of my actions when making many of my decisions. •My purchase habits are affected by my concern for our environment. •I am concerned about wasting the resources of our planet. •I would describe myself as environmentally responsible. •I am willing to be inconvenienced in order to take actions that are more environmentally friendly.	7-point scale •Please indicate your agreement with the following statements about your environmental concern •I am concerned about I am concerned about environmental issues. •I make an effort to buy environmentally friendly products. •I try to reduce my personal impact I try to reduce my personal impact on the environment.

Appendix C - Questionnaire

English

Q1. Dear participant,

This questionnaire is part of the final master work of Management and Industrial Strategy major at ISEG (Lisbon School of Economics & Management).
The purpose of this questionnaire is to understand consumers' purchasing behavior.

Your participation is entirely voluntary. There are no right or wrong answers, and all results will be used for academic purposes.

This questionnaire takes about 5 minutes to complete.

Thank you very much for your participation.
Sincerely,
Linmiao(Claire) Yue

Q2. Do you confirm that you are at least 18 years old and have volunteered to participate in this survey being able to desist from responding at any time?

- ○ No
- ○ Yes

Imagine you are planning a home gathering with your friends. To prepare for it, you go to the supermarket to purchase some food and beverages. The video below simulates what you might experience during this shopping trip, so please try to immerse yourself in the environment. Pay attention not only to the background music playing in the store but also to the other surrounding elements.

Please click on the image below to watch the video. Make sure that you have the speakers on.
📌 The video will open in a new browser tab. After watching, please return to this tab to continue answering the questions.

Q8. This organic wine is one of the products that you saw during your shopping. Please carefully consider all the information before proceeding with the questionnaire.

Product information:
Name: Coelheiros Branco 2024
Type: White wine
Region: Alentejo, Portugal
Grape varieties: Arinto × Antão Vaz
Sustainability: Organic and vegan
Tasting profile: Fresh, vibrant, with citrus and green apple notes

Please share your level of agreement with the following statements regarding your intention to buy this product. Considering the scale 1 = Strongly disagree to 7 = Strongly agree.

	1- Strongly disagree	2	3	4	5	6	7- Strongly agree
I'm likely to buy this wine.	○	○	○	○	○	○	○
The possibility of me purchasing this wine is high.	○	○	○	○	○	○	○
I'm pretty sure I'll buy this wine.	○	○	○	○	○	○	○
There is a good chance that I will buy this wine.	○	○	○	○	○	○	○

Q9. Please share your level of agreement with the following statements regarding your willingness to pay for this product. Considering the scale 1 = Strongly disagree to 7 = Strongly agree.

	1- Strongly disagree	2	3	4	5	6	7- Strongly agree
I am open to spending more for this sustainable wine.	○	○	○	○	○	○	○
I am willing to pay a premium price for this wine.	○	○	○	○	○	○	○
I completely agree to pay a higher price for this wine.	○	○	○	○	○	○	○

Q10. Please indicate how you are feeling now, after the shopping experience task proposed, by selecting a point between the two opposing words. A rating of 1 means you feel much more like the word on the left, and 7 means you feel much more like the word on the right.

Pride	○	○	○	○	○	○	○	Guilt
Unconcerned	○	○	○	○	○	○	○	Gratitude
Sad	○	○	○	○	○	○	○	Joyful
Pessimistic	○	○	○	○	○	○	○	Optimistic
Secure	○	○	○	○	○	○	○	Anxious

Q11. Please rate how much you agree with the following statement about the product's sustainability attributes considering the scale 1 = Strongly disagree to 7 = Strongly agree.

	1- Strongly disagree	2	3	4	5	6	7- Strongly agree
This product's environmental performance aligns with my expectations.	○	○	○	○	○	○	○
I would choose this product because it shows more environmental concern compared to others.	○	○	○	○	○	○	○
I would choose this product for its greater environmental benefits over alternatives.	○	○	○	○	○	○	○

Q12. Please rate how much you agree with the following statement about the product's perceived functional value. Considering the scale 1 = Strongly disagree to 7 = Strongly agree.

	1- Strongly disagree	2	3	4	5	6	7- Strongly agree
This product is dependable.	○	○	○	○	○	○	○
This product has good quality.	○	○	○	○	○	○	○
I will be satisfied with the product's quality and taste.	○	○	○	○	○	○	○

Q13. Please rate how much you agree with the following statement about the product's perceived experiential value. Considering the scale 1 = Strongly disagree to 7 = Strongly agree.

	1- Strongly disagree	2	3	4	5	6	7- Strongly agree
I'm passionate about green products like this.	○	○	○	○	○	○	○
Others' willingness to buy this product is inspiring.	○	○	○	○	○	○	○
Buying this product makes me happy.	○	○	○	○	○	○	○

Q14. Please rate how much you agree with the following statement about the product's perceived social value. Considering the scale 1 = Strongly disagree to 7 = Strongly agree.

	1- Strongly disagree	2	3	4	5	6	7- Strongly agree
I can share my environmental concerns with this sustainable wine in my home.	○	○	○	○	○	○	○
By choosing this, I can show myself and my friends that I care about conservation.	○	○	○	○	○	○	○
With this sustainable wine, my friends see me as someone who cares about the environment.	○	○	○	○	○	○	○

Q15. Please rate how much you agree with the following statement about the product's perceived epistemic value. Considering the scale 1 = Strongly disagree to 7 = Strongly agree.

	1- Strongly disagree	2	3	4	5	6	7- Strongly agree
I am bored with normal wine.	○	○	○	○	○	○	○
I am curious about the difference between sustainable wine and regular wine.	○	○	○	○	○	○	○
I prefer to explore different and innovative wines.	○	○	○	○	○	○	○

Q16. Please rate how much you agree with the following statement about the product's perceived youthful image. Considering the scale 1 = Strongly disagree to 7 = Strongly agree.

	1- Strongly disagree	2	3	4	5	6	7- Strongly agree
I believe this wine has a youthful brand image.	○	○	○	○	○	○	○
The wine appears stylish and full of energy.	○	○	○	○	○	○	○
The wine targets to young audience.	○	○	○	○	○	○	○

Q17. How would you rate the background music of the previous video?

Low frequency (low-pitched)	○	○	○	○	○	○	○	High frequency (high-pitched)
Slow tempo	○	○	○	○	○	○	○	Fast tempo

Q18. Did you clearly hear the music during the task?

- ○ No, I could barely hear it.
- ○ A little unclear.
- ○ Yes, very clearly.

Q19. Do you recognize the background music used in the video? Please choose one of the following options:

- ◯ Yes, it is "New Echo" by ACE
- ◯ Yes, it is "Triangle" by Imagine Dragon
- ◯ I don't know

Q20. Have you watched the entire video that just shown?

- ◯ Yes
- ◯ I watched most of it
- ◯ No, I didn't watch it

Q21. Please indicate your agreement with the following statements about your environmental concern, using the scale 1 = Strongly disagree to 7 = Strongly agree.

	1 = Strongly disagree	2	3	4	5	6	7 = Strongly agree
I am concerned about environmental issues.	◯	◯	◯	◯	◯	◯	◯
I make an effort to buy environmentally friendly products.	◯	◯	◯	◯	◯	◯	◯
I try to reduce my personal impact on the environment.	◯	◯	◯	◯	◯	◯	◯

Q22. How frequently you usually purchase wine?

Never	Less than once a year	A few times a year	Once a month	A few times a month	Once a week	Several times a week or more
◯	◯	◯	◯	◯	◯	◯

Q23. How familiar are you with the showen wine brand "Coelheiros"?
Please answer using the scale 1 = Not at all familiar to 7 = Very familiar.

	1 = Not at all familiar	2	3	4	5	6	7 = Very familiar
Familiarity	◯	◯	◯	◯	◯	◯	◯

Q24. What is your gender?

- ◯ Male
- ◯ Female

Q25. What is your age? (ex. 24)

Q26. What is your nationality?

Q27. What is your highest level of education?

- ◯ High school or below
- ◯ Bachelor's degree
- ◯ Master's degree or above

Appendix D - Reliability Analysis

Reliability Statistics		
	Cronbach's Alpha	N of Items
Purchase Intention	0.904	4
Willingness To Pay	0.888	3
Product Preception- Sustainability Attributes	0.844	3
Product Preception- Functional Value	0.800	3
Product Preception- Experiential Value	0.883	3
Product Preception- Social Value	0.876	3
Product Preception- Epistemic Value	0.795	3
Product Preception- Youthful Image	0.852	3

Appendix E - Descriptive Statistics for Moderating Effect Analysis

Dependent Variable: Purchase intention			
Music Frequency	Music Tempo	Mean	SD
Low	Low	4.17	1.70
	High	4.08	1.67
High	Low	3.84	1.52
	High	4.11	1.68
Dependent Variable: WTP			
Music Frequency	Music Tempo	Mean	SD
Low	Low	3.77	1.89
	High	4.29	1.84
High	Low	3.72	1.48
	High	4.16	1.61

Appendix F - Mediating effect analysis (PROCESS macro)

PROCESS macro-Model 4				
X =Music frequency				
Y	M	BootLLCI	BootULCI	Hypothesis
Purchase Intention	Individual emotions_Guilt:Pride	-0.0330	0.1304	5
	Individual emotions_Sad:Joyful	-0.3392	0.0597	
	Individual emotions_Pessimistic :Optimistic	-0.4147	0.0510	
	Individual emotions_Secure:Anxious	-0.0703	0.0830	
WTP	Individual emotions_Guilt:Pride	-0.0297	0.1296	6
	Individual emotions_Sad:Joyful	-0.3076	0.0549	
	Individual emotions_Pessimistic :Optimistic	-0.3463	0.0364	
	Individual emotions_Secure:Anxious	-0.0755	0.0873	
Purchase Intention	Product Perceptions-Sustainable attributes	-0.3033	0.3104	7
	ProductPreception_FunctionalValue	-0.4666	0.0973	
	ProductPerception_Experiential value	-0.5682	0.0466	
	Product Perceptions-social value	-0.4827	0.1200	
	Product Perceptions-epistemic value	-0.2952	0.2904	
WTP	Product Perceptions-Sustainable attributes	-0.2756	0.3099	8
	ProductPreception_FunctionalValue	-0.4633	0.1001	
	ProductPerception_Experiential value	-0.5441	0.0346	
	Product Perceptions-social value	-0.4638	0.1132	
	Product Perceptions-epistemic value	-0.2730	0.2830	

Appendix G - Mediating effect analysis of combined dimensions

PROCESS macro-Model 4				
X =Music frequency				
Y	M	BootLLCI	BootULCI	Hypothesis
Purchase Intention	Individual emotions_Guilt:Pride	-0.0904	0.0671	5
	Individual emotions_Unconcerned:Gratitude	-0.4825	-0.0258	
	Individual emotions_Sad:Joyful	-0.0754	0.0701	
	Individual emotions_Pessimistic :Optimistic	-0.2310	0.0180	
	Individual emotions_Secure:Anxious	-0.0374	0.0450	
WTP	Individual emotions_Guilt:Pride	-0.0909	0.0745	6
	Individual emotions_Unconcerned:Gratitude	-0.5114	-0.0255	
	Individual emotions_Sad:Joyful	-0.0960	0.0526	
	Individual emotions_Pessimistic :Optimistic	-0.1458	0.0464	
	Individual emotions_Secure:Anxious	-0.0412	0.0582	
Purchase Intention	Product Perceptions-Sustainable attributes	-0.0944	0.1077	7
	ProductPreception_FunctionalValue	-0.1243	0.0299	
	ProductPerception_Experiential value	-0.2502	0.0208	
	Product Perceptions-social value	-0.1551	0.0366	
	Product Perceptions-epistemic value	-0.0989	0.1098	
	Product Perceptions-Youthful image	-0.1802	-0.0398	
WTP	Product Perceptions-Sustainable attributes	-0.1316	0.1394	8
	ProductPreception_FunctionalValue	-0.1811	0.0314	
	ProductPerception_Experiential value	-0.2161	0.0276	
	Product Perceptions-social value	-0.1335	0.0397	
	Product Perceptions-epistemic value	-0.0900	0.0899	
	Product Perceptions-Youthful image	-0.1638	-0.0243	