Investigation of Sound-Gustatory Synesthesia in a Coffeehouse Setting

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Abstract: Synesthesia is a perceptual phenomenon involving the stimulation of multiple senses. In this work, we determine the presence of sound-gustatory synesthesia by looking at the possible effects of background music on the perceived taste of a coffee-sugar mixture. We asked participants (N = 83) to listen to music while identifying the tastes they perceived drinking a coffee-sugar sample. Our results showed that sweetness was perceived more while listening to the "Slow" music, which is consistent with previous work. The perception of sourness also increased with the tempo of the music, consistent with work associating sourness with pitch. Interestingly, participants also perceived saltiness and sourness even though the ingredients did not contain ingredients with those tastes, which provides further evidence of sound influencing taste perception. This study has shown the presence of sound-gustatory synesthesia in a typical coffeehouse setting, introducing potential applications in psychophysics, food science, and other complex systems research. Our algorithm has also shown how quantitative tools can be used in a qualitative field such as psychological perception. We expect multisensory, interconnected technology in the Internet of Things to spread the experience of synesthesia within a population, with Big Data enabling researchers to detect and measure synesthesia much more accurately.

1 INTRODUCTION

Humans make use of sensory information to determine environmental properties (Hillis, et al., 2002). Synesthesia is the simultaneous perception of two or more stimuli as one experience, even when the external stimulation of the additional perceived sense is absent (Colizoli, et al., 2013; van Campen, 2009). Only around two to four percent of a population have some form of synaesthesia, and its origins are not yet clearly determined (Brang and Ramachandran, 2011). However, with the arrival of multisensory technology and the interconnectedness of Big Data, we expect a proportional increase in the manifestation and detection of synaesthesia.

In particular, flavor perception makes use of multisensory integration of all other human senses (Spence, 2015). Gustatory synaesthesia involves the automatic and consistent experience of tastes that are activated by non-taste related inducers (Colizoli, et al., 2013), such as music (sound-gustatory) and words (lexical-gustatory) (Gallace, at al., 2011; Bankieris and Simner, 2013). In a study by Mesz, Sigman and Trevisan (2012), "Sweetness" is associated with high pitched, consonant, slow, and soft music, "Bitterness" is associated with low pitch and continuous music, "Saltiness" is perceived more when the music have silences between notes, and "Sourness" is with high pitched, dissonant and fast music. Perceptual associations between taste and different aspects of sounds (pitch, timbre, interval, or tempo) can lead to predictions about the effects of musical pieces on gustatory perception (Knöferle and Spence, 2012; Crisinel and Spence, 2009).

Sound-gustatory synesthesia has been initially investigated in terms of how pleasure, associated with sound in the form of music or noise, affects taste as well. With the music used as a component of sound, the experience of drinking beer was rated more enjoyable with music than when in silence (Reinoso Carvalho, et al., 2016). Meanwhile, gelati consumed while listening to liked and neutral music had positive scores, while gelati consumed while listening to disliked music had negative scores (Kantono, et al., 2016). Meanwhile, background noise has been shown to reduce the

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intensity of gustatory cues and increase the intensity of sound-conveyed food attributes (Woods, et al., 2011).

In this work, we investigate sound-gustatory synesthesia in a typical coffeehouse setting, by looking at the possible effects of background music on the perceived taste of coffee-sugar drinks. In particular, we asked participants which particular tastes they perceived upon listening to a type of music. Through this work, we hope to learn more about the interconnectedness of sensory perception within the complex system of the human body. We are also interested in the potential applications of this work to food science and to improving the customer experience in the food and beverage industry. Chefs and related professionals actively apply the latest scientific findings to their own work (Spence, 2015).

2 METHODOLOGY

The researchers downloaded coffeehouse background music (Jazz and Blues Experience, 2016) and used Wondershare Filmora video editor to vary the music speed or tempo (Figure 1). Compared to the original music track ("Normal"), the "Fast" track was 5.000 times faster, and the "Slow" track was 0.230 times slower. Different 60-second segments of the music track were used for the three tracks, to minimize the possibility of participants making conscious associations between the music and the coffee. The participants (N = 83) were composed of college students, senior high students, and some faculty members of the Mapúa University. They were presented with an overview of the nature and purpose of the experiment. The researchers also explained that participation was completely voluntary and will not affect their academic standing. Participants who chose to stay were asked to fill up the questionnaire provided (Figure 2).

At the start of each trial, participants were asked to sip some water to cleanse the palate. A music track was then played for 1 minute. During this time, participants were asked to taste a new 5.00-cc coffee-sugar sample and report their perceived tastes on their questionnaire. The participants may select more than one taste per trial; alternately, they may answer "None".

Trials "A", "B" and "C" made use of the "Normal", "Fast", and "Slow" tracks respectively. Participants were given 3 samples marked "A", "B", and "C", but these samples involved the same mixture (equal parts coffee and sugar dissolved in warm water), to limit the variability in the experiment. All experiments were performed in a classroom within one day, with around 15 to 30 participants for each batch.

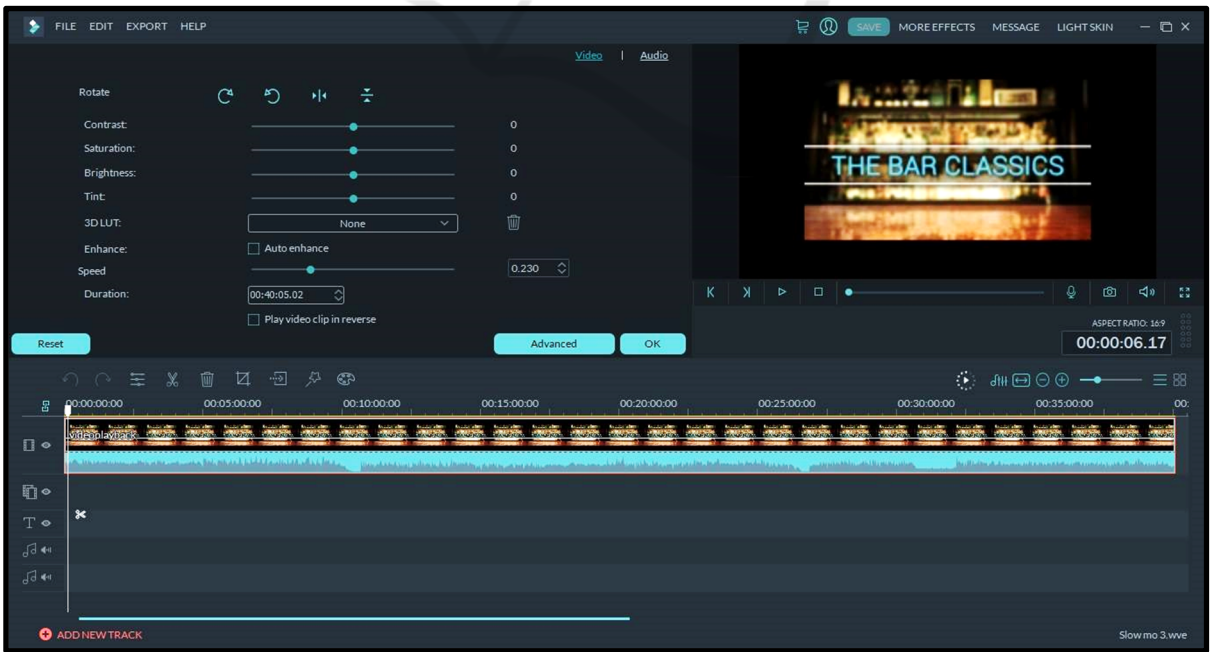
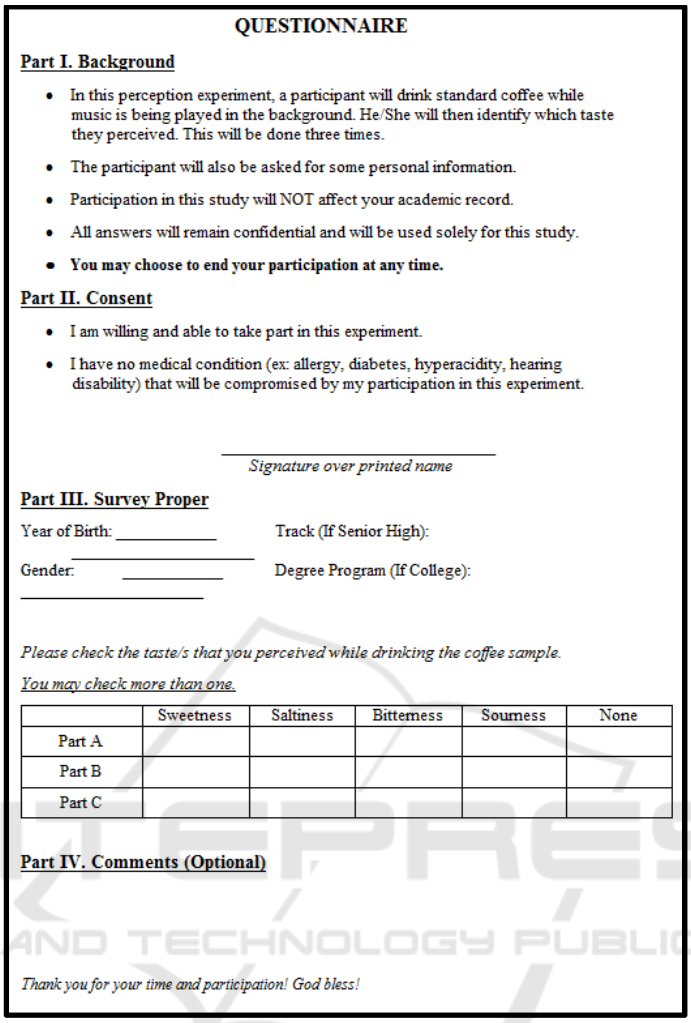


Figure 1: Screenshot of the video editor used.



QUESTIONNAIRE

Part I. Background

- In this perception experiment, a participant will drink standard coffee while music is being played in the background. He/She will then identify which taste they perceived. This will be done three times.
- The participant will also be asked for some personal information.
- Participation in this study will NOT affect your academic record.
- All answers will remain confidential and will be used solely for this study.
- **You may choose to end your participation at any time.**

Part II. Consent

- I am willing and able to take part in this experiment.
- I have no medical condition (ex: allergy, diabetes, hyperacidity, hearing disability) that will be compromised by my participation in this experiment.

_____
Signature over printed name

Part III. Survey Proper

Year of Birth: _____ Track (If Senior High): _____

Gender: _____ Degree Program (If College): _____

Please check the taste/s that you perceived while drinking the coffee sample.

You may check more than one.

	Sweetness	Saltiness	Bitterness	Sourness	None
Part A					
Part B					
Part C					

Part IV. Comments (Optional)

Thank you for your time and participation! God bless!

Figure 2: The questionnaire used in the experiment.

3 RESULTS AND DISCUSSION

Overall, Bitterness and Sweetness were the dominant perceived tastes, as expected from samples containing bitter coffee and sweet sugar (Figure 3). The tallied answers for each trial exceeded 100% as participants may select more than one answer.

A significantly large majority (53.33%) perceived Sweetness for the "Slow" trial, while Bitterness was dominant taste for the "Normal" (56.93%) and "Fast" (43.05%) trials. The results are consistent with previous studies associating sweetness with slow music (Mesz, et al., 2012), presumably influencing participants to sense "Sweetness" in a predominantly bitter drink. We note that Mesz, Sigman and Trevisan (2012) also associated bitterness with low pitch, which are not necessarily in contrast with our results, as the speed of a music track may be increased without necessarily increasing its pitch.

Interestingly, a notable portion of responses perceived Sourness and Saltiness even though the samples did not contain sour nor salty components; while a significant minority also selected "None" for the perceived taste. Such results are evidence of taste perception as opposed to objective taste.

Lastly, the perception of Sourness increased with the speed of the background music: from 9.17% to 18.98% to 24.50%, for "Slow" to "Normal" to "Fast" music, respectively. This is consistent with previous work associating sourness and pitch (Mesz, 2012), when we consider that pitch is proportional to speed.

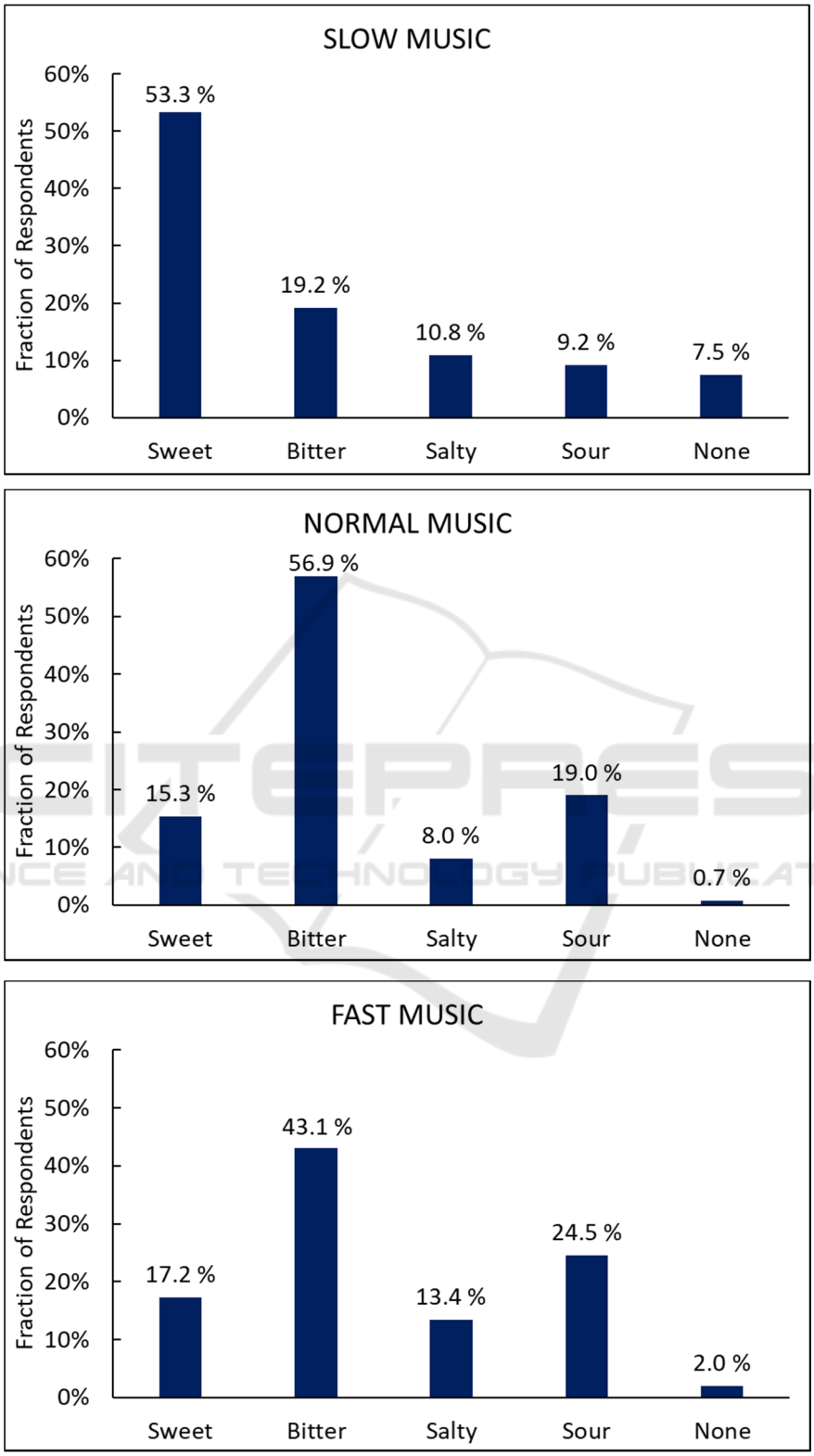


Figure 3: The tastes perceived by the respondents listening to music played at three different speeds

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4 CONCLUSIONS

This initial work has demonstrated the presence of sound-gustatory synesthesia in a typical coffeehouse setting. We have seen that the speed of the music being heard may alter the perception of the coffee being tasted. In particular, majority of the participants detected Sweetness when Slow music was played, and Bitterness when Normal and Fast music were played. Participants also perceived Sourness and Saltiness, and the perception of Sourness increased with the speed of the music track, even when sour and salty components were not present in their drinks.

We can improve the study by including baseline measurements for taste (water) and sound (no music). Stafford, Fernandes, and Agobiani (2012) have shown that the presence of music altered taste perception, serving as a "distraction" in the same way as shadow multitasking.

To extend the previous sound-gustatory synesthesia research, we can also have participants ask if they inherently "like" or "dislike" the drink and the music tested, to investigate associations between hedonic and sensory perception of coffee. Lastly, we can also look for possible effects of respondent traits such as gender and age.

We expect multisensory, interconnected technology in the Internet of Things to spread the experience of synesthesia within a population, with Big Data enabling researchers to detect and measure synesthesia much more accurately.

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