The Effect of Pleasant and Unpleasant Music On Judgments of Learning and Memory Recall

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Abstract

Previous research has suggested that if music is perceived as pleasant, it will evoke a positive mood and if music is perceived as unpleasant or aversive, it will evoke a negative mood. Mood has an effect on memory, as a positive mood enhances cognitive processes, and a negative mood impairs cognitive processes. Research has suggested that Judgments-of-Learning (JOLs) or the predictions of the likelihood of future recall, are generally accurate. According to the Cue-Utilization-Framework (Koriat, 1997), JOLs depend on intrinsic, mnemonic and extrinsic cues. Extrinsic cues include environmental factors such as background music. The purpose of the current study was to investigate the effect of music as a potential extrinsic cue, as perceived as pleasant or unpleasant, on the accuracy of JOLs and memory recall. It is examined whether or not a congruency in music between the learning and testing periods had an effect on the accuracy of JOLs and memory recall. 62 Undergraduate students attending Laurentian University were randomly assigned to one of four conditions including: Pleasant music during learning, negative music during recall, unpleasant music during learning and negative during recall, pleasant music during both and negative music during both. Participants were asked to complete a six-scale mood rating five times throughout the experiment that included items such as cheerful, content, relaxed, irritated, frustrated, and upset. There were two word lists containing 20 words each, and participants were required to progress through a timed PowerPoint where a word would display for 5 seconds and a JOL was made immediately after (in 4 seconds). They were given 5 minutes to recall at the end of each word list. Results did not support the notion that music is an extrinsic cue affecting JOLs as there were no significant differences between conditions. Also, mood dependent memory did not exert an effect on JOLs and Recall, as incongruent conditions had significantly higher mean JOL-Recall than congruent condition (an opposite effect). Overall, JOLs appear to be an accurate predictor of performance.

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The Effect of Pleasant/Unpleasant Music On Judgments of Learning and Memory Recall

Metamemory and JOLs

The term metamemory is used to describe the higher order self-awareness or monitoring of memory functions (Flavell, 1979). Individuals employ the use of metamemory when they monitor and exert control over their memory by examining how well they are performing on tasks requiring the use of memory, and when they implement strategies to improve the accuracy of their memory. An example of this would be a student creating acronyms to remember information when studying for a final exam, as they are able to remember more information this way. Metamemory also describes how an individual explores their thought processes (how they think when using their memory) and mental states (for example, what mood they are in during memory tasks) to actively engage in regulation and control over their memory performance (Schultz & Schultz, 2012). Ultimately, the control over memory is important in that it helps to improve one's memory performance and helps to maximize the potential of one's memory.

Metamemory can be observed experimentally through different metamemory phenomena, including Judgments of Learning (JOL), which are of main focus in my research. JOLs are generally accurate judgments that are made immediately following learning. JOLs predict how likely it is that an individual will remember the information that they learned when they are asked to recall it. Many experiments have shown JOLs to be quite accurate (Mazzoni & Nelson, 1995), meaning that individuals recalled information that they predicted they would likely recall, and they failed to recall information that they predicted they would not likely recall. The accuracy of JOLs is the main objective of JOL research, as accurate JOLs reflect a good metamemory regulation and knowledge.

JOLs are typically made during a period of learning, more specifically immediately after being presented with information for a specific amount of time. In the majority of experimental designs focused on JOLs, participants will be presented with a series of words that are displayed for a fixed amount of time (often a few seconds). JOLs are made following the presentation of the words, and are predicting how likely the participant thinks that they will be able to remember each word when asked to recall the words (Mazzoni & Nelson, 1995). There are a few different types of JOLs that differ with respect to a few key factors. First off, the simplest form of JOLs are called free-recall JOLs, which are predictions made regarding the likelihood that each word from a word list will be recalled purely from memory (with no retrieval cues). Free-recall JOLs are typically made when participants are require to study a word list with no word pairs, and they are generally quite accurate. Secondly, JOLs differ with respect to the timeframe that they are made in. Item-by-item JOLs are the most accurate, and they are made immediately after each stimulus (or word) is presented. This means that the participant will be presented with a word for a fixed amount of time, and then will be required to make a prediction of the likelihood that the word will be recalled. This process continues for each word until an entire word list is completed. Upon completion of the word list, a participant is required to recall as many words from the list as possible, and in no specific order. However, the form of JOL and the timeframe that they are made within are not the only factors affecting JOL accuracy.

Cue-Utilization Framework: JOL Accuracy

In 1997, Koriat investigated the variance of JOL accuracy with respect to three different cues, including: intrinsic, mnemonic and extrinsic cues. In a series of four experiments, using paired-associate JOLs, Koriat (1997) manipulated intrinsic factors (item difficulty), extrinsic factors (word repetition and the length of study time) and mnemonic factors (heuristics). He

concluded that intrinsic factors had more influence on JOL accuracy than extrinsic factors, however extrinsic factors still had a significant effect on JOLs. Koriat only investigated two types of extrinsic cues in his experiments, and no research has been done to investigate the effects of other potential environmental cues-more specifically background music- on JOLs. However, if this framework holds true, it would be expected that JOLs would be moderately sensitive to extrinsic factors. This would mean that JOL accuracy would vary dependent on the type of background music played. With that being said, it is important to look at some research done on the effects of different types of music on memory and mood in order to predict which type of music would have presumably the largest effect on JOLs as an extrinsic factor.

Music, Mood and Memory

The effect of music on people has been of interest to researchers for quite some time. One of the most apparent effects of music is that which it has on mood, as tested by Bieneck and Krahe´ (2012). They hypothesized that participants who rated music as being pleasant would experience a positive mood, and participants who rated music as being unpleasant would experience a negative mood. The experimenters defined the pleasant/unpleasantness of the music by asking the participants to rate the music itself following listening, on 9 factors (exciting, uplifting, activating, lively, relaxing, solemn, peaceful, boring, unpleasant)-where identification of the perception of the music was relied primarily on two factors: uplifting (pleasant) and unpleasant (aversive) (Bieneck & Krahe´, 2012). The experimenters defined mood based on nine items (cheerful, sad, angry, active, aroused, relaxed, irritated, upset, content) which were rated on a Likert scale from 0(not at all) to 6 (very much) taken from Bohner, Hauschildt and Knäuper (1993)-where mood was identified specifically on two items: irritated (negative mood) and cheerful (positive mood). Bieneck and Krahe´ used 56 undergraduate participants, and played

lyric-less pieces of music for the participants. The pleasant music group listened to Peer Gynt Suite by Grieg, Four Seasons by Vivaldi, and 9th Symphony by Dvorak. The aversive music group listened to a song called King Deuce. Bieneck and Krahe´ concluded that the perception of music had an effect on mood, as music that was perceived as pleasant (as rated high on uplifting and low on aversive) induced a positive mood (as rated low on irritated and high on cheerful) whereas music perceived as aversive (as rated low on uplifting and high on aversive) induced a negative mood (as rated high on irritated and low on cheerful). As mood state has an effect on cognition (Gray, 2001), it is of particular interest to examine the effect that different moods have on memory and metamemory.

Another study that looked at the effects of pleasant and unpleasant music on cognitive performance investigated the neurophysiological correlates to auditory stimuli that correspond to music as perceived as pleasant or unpleasant (Barrios, Corsi-Cabrera, del Rio-Portilla, Diaz, Flores-Guitierrez, Fuvila-Humara, and Guevara, 2007). Unpleasant music was defined as music from the french movie *Danton* conducted by J. Prodromides and pleasant music was defined as music by J.S. Bach and G. Mahler's 5th Symphony. The experimenters then used fMRI and EEG data to determine which areas of the brain were activated when both pleasant and unpleasant music was played. It was shown that different brain areas were activated during the different types of music. These results show that the brain is affected by pleasantness of auditory stimuli in different ways. It can be assumed that mood was induced by these pieces of music, as brain regions correlated with a negative mood were activated by unpleasant music, and regions correlated with a positive mood were activated by pleasant music. Overall, research done on the effect of music on mood has suggested that lyric-less music can induce mood, depending on how it was perceived by participants. If participants perceived the music to be unpleasant, it induced a

negative mood. If participants perceived the music to be pleasant, it induced a positive mood. Now, it is important to examine research done on the effects of mood on memory.

Memory is mood dependent, which means that memory can be facilitated if the mood during encoding matches the mood during retrieval (Ashbrook & Ellis, 1991). This essentially means that people are more likely to remember information if they are in the same mood when trying to remember as they were in when they memorized the information. When individuals are in the same mood during memorizing and recall, it is referred to as mood-congruence.

The effect of mental state on cognitive processes was further investigated by Gray in 2001 who hypothesized that mood would have an effect on cognition. Participants were exposed to two sets of three 10 minute videos to induce mood (positive, negative and neutral). Mood was tracked using mood ratings before and after viewing the videos, and it was based on the following scales: bored, energetic, sad, angry, happy, anxious, calm, amused. After the mood induction, participants completed a spatial and a verbal memory task. It was concluded that negative mood impaired cognitive processes, while a positive mood enhanced cognitive processes. This means that participants who were in a positive mood completed the tasks with greater accuracy than participants who were in a negative mood. Ultimately, mood can either have an enhancing effect or be detrimental to cognitive processing.

Present Study

Music can induce mood, in that lyric-less that was perceived to be pleasant induced a positive mood, and music perceived to be aversive induced a negative mood (Bieneck & Krahe´, 2012). Mood has an effect on memory, such that positive mood enhances cognitive processes

and negative mood impairs processes (Gray, 2001). Therefore, musically-induced mood should also impact memory and metamemory performance.

As stated in the Koriats (1997) Cue-Utilization Framework, JOLs are generally accurate, however they vary dependent upon intrinsic, mnemonic and extrinsic cues. The manipulation of extrinsic cues has been limited in research, only encompassing study duration and study strategies. This experiment will probe deeper into the possibility that background music as a characteristic of the study environment could be considered an extrinsic factor affecting both JOLs and JOL accuracy.

If an individual perceives the background music as being pleasant, and a positive mood is induced, theoretically, this would have an enhancing effect on memory and more words will be recalled than in the negative music condition (Gray, 2001). If an individual perceives the background music to be aversive, and a negative mood is induced, theoretically, this would have an impairing effect on memory and less items will be recalled than in the pleasant music condition (Gray, 2001). As background music does indeed have an effect on mood (Gray, 2001), and mood can either enhance or impair cognitive processes (Gray, 2001) can the predictive ability of JOL's (estimates of the likelihood of future memory recall) adjust for the effect that a change in mood (either positive or negative) would have?

As memory is mood-dependent (Ashbrook & Ellis, 1993), it is important to investigate possible effects that that mood incongruency or congruency between the study period and recall period may have on memory recall and JOL accuracy. Thus, a mismatch between music played during the learning and test conditions should have a negative effect on memory accuracy, and the negative effect would be the strongest when aversive music is played (Gray, 2001). As true

memory recall conditions (such as tests or examinations in a school setting) do not permit music-listening during retrieval attempts, it is quite important to examine the effects that mood-incongruency or congruency may have on memory accuracy and predictive capacity of JOL's (to take into account mood congruency/incongruency).

Hypotheses

1. A. First off, there was an expected main effect of music condition on JOL sensitivity such that average JOL scores were expected to be different between different music conditions (including: pleasant music played during learning and recall periods; unpleasant music played during learning and recall periods; pleasant music during learning periods, unpleasant music during recall periods; unpleasant music during learning periods, pleasant music during recall periods).

1. B. It was expected that the average JOL scores will be highest in the condition where pleasant music was played during both the learning and the recall period.

2. A. Secondly, there was an expected main effect of music congruency on JOL accuracy, as measured by comparing average JOL to average Recall. As JOLs are generally accurate, and memory is mood dependent, congruent music conditions (pleasant music played during learning and recall periods; unpleasant music played during learning and recall periods) were expected to have more accurate JOLs than incongruent music conditions (pleasant music during learning periods, unpleasant music during recall periods; unpleasant music during learning periods, pleasant music during recall periods).

2. B. It was expected that participants would be the most calibrated (as measured by taking the difference between average Recall and average JOL) in the congruent music conditions (pleasant

music played during learning and recall periods; unpleasant music played during learning and recall periods) in comparison to incongruent music conditions (pleasant music during learning periods, unpleasant music during recall periods; unpleasant music during learning periods, pleasant music during recall periods).

3. Third, it was expected that mood (as measured by the 6 point, 6 item Mood-Rating scale , employed previously by Bieneck & Krahe', 2012) would change throughout the course of the experiment.

Method

Design

This experiment will use a 2 (learning music condition: positive or negative) x 2 (testing music condition: positive or negative) between-subjects design. It is noted that pleasant music is referred to as positive, and unpleasant music is referred to as unpleasant. Some participants will hear the same type of music in both phases (i.e., congruent) while the others will hear different types of music in the two phases (i.e., incongruent). Therefore, participants will be in one of the following four conditions: congruent – positive, congruent – negative, incongruent – positive first, or incongruent – negative first. The two dependent variables in this research are recall performance and JOLs. These can be compared to assess JOL accuracy (as discussed in the results section).

Participants

Participants will be 80 undergraduate students, both male and female, who will be recruited in classrooms and by flyers on campus. The only constraint is participants be fluent English speakers.

Stimuli

Music

All of the music will be played at a comfortable volume of the timed PowerPoint that presented the words. Pleasant music consisted of Four Seasons by Vivaldi, 9th Symphony by Dvorak (Bieneck & Krahe´, 2012) and G. Mahler's 5th Symphony (Barrios et al., 2007).

Unpleasant music included two pieces by J. Prodromides for the film Danton (Barrios et al., 2007).

Words

There were two word lists consisting of 20 words each, and they were created using the Pavio Word Pool Generator. Words in each list were equated for word length (M= 7.675), K-F frequency (M= 21.200), number of syllables (M=2.625), meaningfulness (M=4.373), imagery (M=3.656), and concreteness (M=3.423) (See Appendix I). The exposure order to the two word lists were counterbalanced for all conditions (e.g., half the participants in congruent-positive saw word list 1 first, half saw word list 2 first). These words will be displayed by PowerPoint on a computer screen, and are timed to progress automatically to the next slide after 5 seconds.

Measures

JOLs

The Judgments-of-Learning are made in the same format as Matthew Rhodes had employed in his 2009 study. Participants will be given 4 seconds, immediately following the presentation of each word, to rate on a scale of 0 (not likely at all) to 100 (very likely) the likelihood that they will recall the word in the future (Rhodes, 2009). These JOLs, called item-by-item JOLs, will be recorded in participant booklets, and participants were encouraged to use the entire range of the scale in rating the likelihood that they will recall at a later time (Rhodes, 2009).

Mood Ratings

Mood ratings are conducted five times throughout the study. The ratings employed in this study were previously used in the study by Bieneck and Krahe´ (2012). Participants will record their mood on six scales including cheerful, content, relaxed, irritated, upset, frustrated. Participants were instructed to rate on each scale from 0 (not at all) to 6 (very much) (see Appendix II).

Exit Questionnaire

The exit questionnaire (see Appendix IV) was designed to gather subjective and qualitative information about whether or not the participants perceived the music as being pleasant or aversive. Participants were also asked whether or not they enjoy classical music, and if they listen to music while they study on a regular basis.

Procedure

Participants were given a consent form (see Appendix III) and informed of the experimental schedule. Participants were instructed on how to do the mood rating and JOL. The participants were then given one minute to do the first mood rating. Following the initial mood rating, participants began the first learning portion of the experiment. Participants were shown a word for 5 seconds, and then were given 4 seconds to record their JOL. Participants repeated this for ten words, and then the second mood rating (1 minute in length) was conducted. Participants repeated the memorization-JOL process ten more times in order to complete an entire word list. A distractor task (5 minutes in length) was then administered, and this included naming all of the provinces and territories in Canada as well as their capital cities. If participants finished this, they

were asked to name all of the states and the capital cities. If they somehow finished both tasks, they were asked to name all of the European countries. Participants were then required to recall the word list, and were given 5 minutes to do so. Following recall, participants then did the third mood rating (1 minute in length). After this, the second half of the experiment was commenced. Participants were shown the timed PowerPoint with a word displayed for 5 seconds, and then they were given 4 seconds to record their JOL. Participants repeated this for ten words, and then the fourth mood rating (1 minute in length) was conducted. Participants repeated the memorization-JOL process ten more times in order to complete an entire word list. A distractor task (5 minutes in length) was then administered, and this included naming all of the countries in the world and their capital cities. If participants finished this, they were asked to name all of the oceans and seas. If they somehow finished both tasks, they were asked to name all of the mountains in South, Central and North America. Participants were then required to recall the word list, and were given 5 minutes to do so. Following the completion of the second word list, participants did the fifth mood rating (1 minute in length).

After the completion of the experiment, participants completed the exit questionnaire (see Appendix IV) and then given a debriefing form (Appendix V) which asked them for their identification number and email if they wish to receive the results of the study. Participants were asked if they had any questions in regards to the experiment and they were told that if they had any further questions or concerns they could contact my supervisor, Dr. Heather Mong. If the participant was allowed to attain course credit for their participation, the necessary paperwork was signed and they were thanked for their participation.

Results

All analyses were conducted using SPSS for Windows 20.0, using an alpha of .05 for each statistical decision (unless specified otherwise). Descriptive statistics were computed for different variables including JOLs themselves, JOL and Recall, and Mood Ratings. For JOL and JOL-Recall data analyses, assumptions of normality and sphericity were met. For Mood rating analysis, data was not spherical, so a MANOVA was used for analysis. One participant was excluded from the analyses on the premise that they were an extreme outlier in various tests.

JOL Sensitivity

The sensitivity of JOLs must be examined to identify any factors that may have significant effects on JOLs between participants. These different factors were analyzed using a Repeated-Measures ANOVA, and include Half of the Experiment, List Order and Combination x List Order.

Half of the Experiment

The Within-Subjects effect of half on JOL scores (between 0 and 100) was analyzed. Results showed that there was a significant effect of half (either first or second) on JOLs ($F_{(1,53)}$= 44.559, p<.05 η_p^2= .457). The overall mean JOL dropped from the first half (M=26.504, SD=15.573) to the second half of the experiment (M=18.922, SD=13.238). Results are displayed in Figure 1.

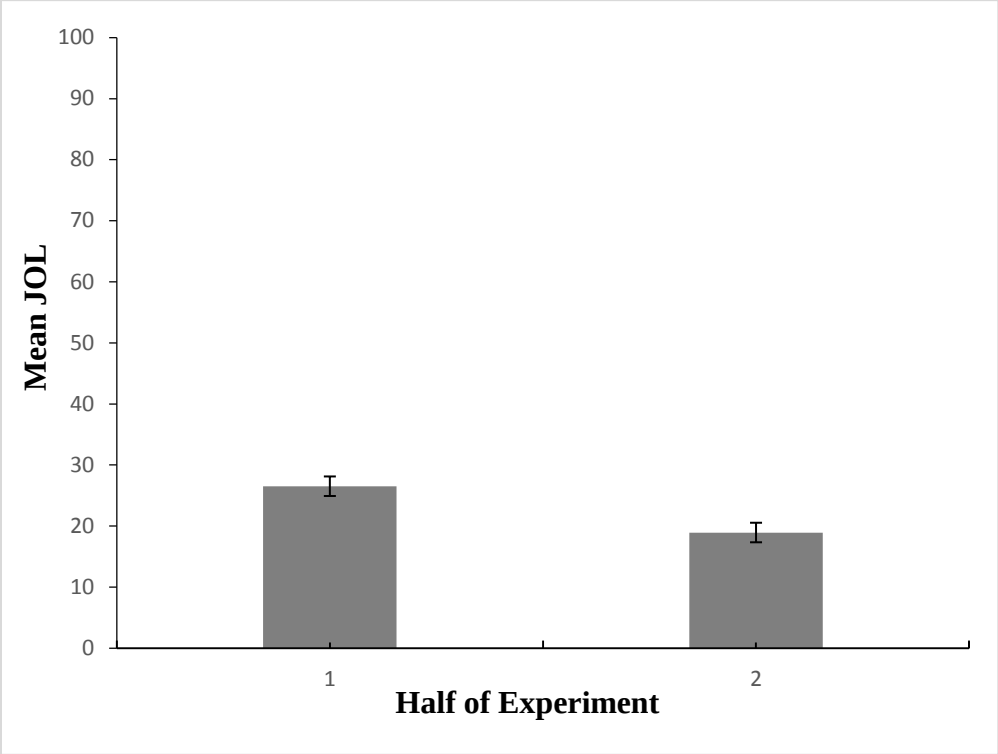

Figure 1. Mean JOL across all conditions for each half of the experiment. Mean JOLs are measured on a scale of 0-100. The First Half=1, and the Second Half=2. Error bars represent the standard error of the mean.

List Order

The Between-Subjects effect of List Order on JOL scores (between 0 and 100) was analyzed. As the word lists were counterbalanced, half of the participants saw List # 1 and then List # 2, and the other half saw List # 2 and then List # 1. Results showed that there was a significant effect of List Order (Order 1=List #1 then List # 2 and Order 2=List # 2, then List # 1) on JOLs ($F_{(1,53)}$= 5.457, p<.05, η_p^2 =.093). The mean JOL for List Order 1 (M=18.929, SD=4.544) was significantly higher than mean JOL for List Order 2 (M=26.498, SD=4.647). Results are displayed in Figure 2.

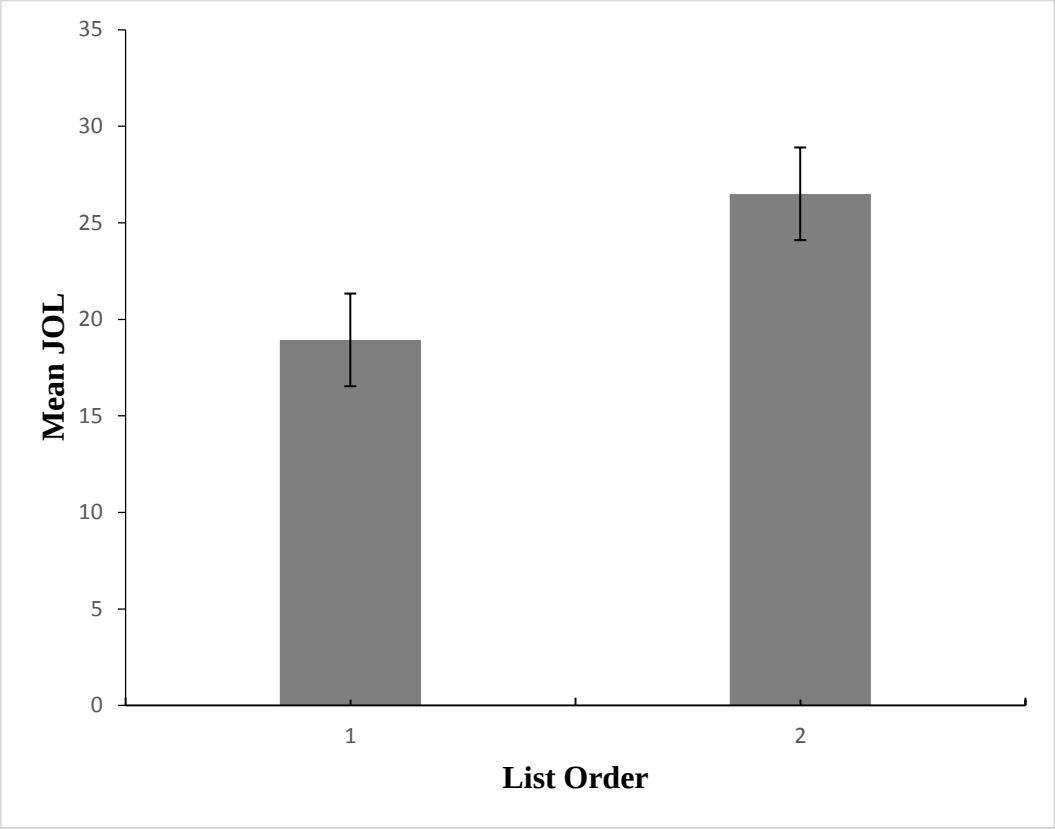

Figure 2. Mean JOL across all conditions for each List Order. Mean JOLs are measured on a scale of 0-100. List Order 1=List #1 then List # 2 and List Order 2=List # 2, then List # 1. Error bars represent the standard error of the mean.

Combination and List Order

The Between-Subjects effect of both Combination and List Order on JOL scores (between 0 and 100) was analyzed. Combination refers to the type of combination of music that participants heard during Learning Periods and Recall. Again, as the word lists were counterbalanced, half of the participants saw List # 1 and then List # 2, and the other half saw List # 2 and then List # 1. Results showed that there was a significant interaction between Combination (Positive, Positive; Positive, Negative; Negative, Positive; Negative, Negative) and List Order (Order 1=List #1 then List # 2 and Order 2=List # 2, then List # 1) on JOLs ($F_{(3,53)}$=3.918, p<.05, η_p^2= =.182). A post-hoc analysis-the Bonferroni correction for multiple comparisons-was conducted, with a new alpha of .0125 (.05/4). It revealed that the only

significant difference between List Orders was in the Negative, Positive combination, $t(13)=3.899$, $p<.0125$. Results are displayed in Figure 3.

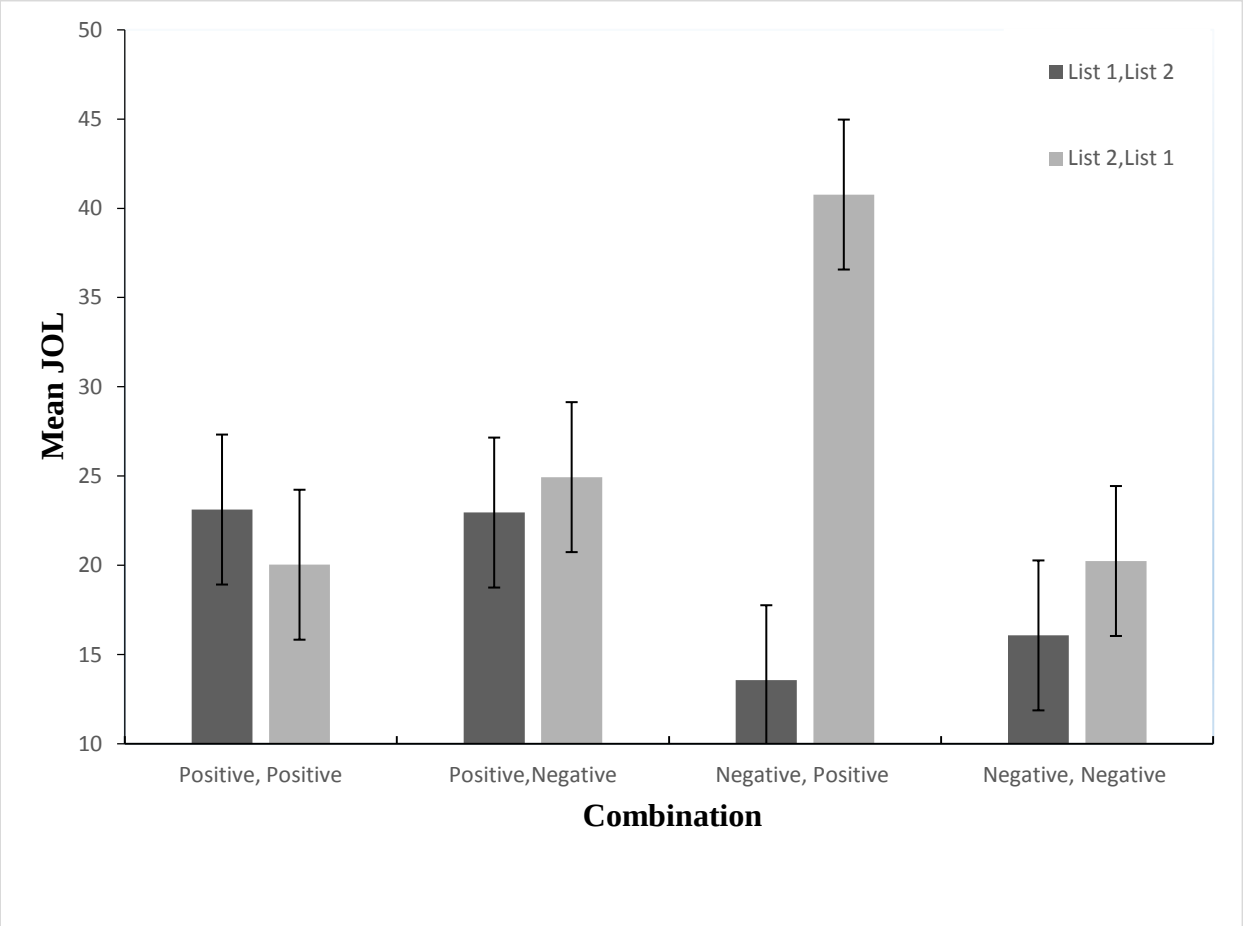

Figure 3. Mean JOL across all conditions for each List Order and Combination. Mean JOLs are measured on a scale of 0-100. Combinations refer to music played during Learning Period, Recall Period, including Positive, Positive; Positive, Negative; Negative, Positive; Negative, Negative. List Order 1=List #1 then List # 2 and List Order 2=List # 2, then List # 1. Error bars represent the standard error of the mean.

JOL and Recall

Mean JOL was calculated for each participant as an average score (from 0-100) and mean Recall was determined by calculating the percent of total words correctly recalled from Word List 1 and Word List 2. The comparison between JOLs and Recall were analyzed by combining

JOL and Recall scores. This pairwise comparison for each participant was done by averaging both mean JOL and mean Recall scores, resulting in one value per participant. Different factors affecting JOL and Recall performance were analyzed using a Repeated-Measures ANOVA.

Half of the Experiment

The Within-Subjects effect of half on JOLs and Recall was examined by first combining JOL and Recall scores by averaging mean JOL and mean Recall, resulting in one value per participant. Results showed that there was a significant effect of half (either first or second half) on mean JOL-Recall across conditions ($F_{(1,5)}$=4.932, p <.05, η_p^2=.085). The mean JOL-Recall was significantly higher in the first half (*M*=25.877, *SD*=13.399) in comparison to the second half (*M*=23.512, *SD*=11.881). Results are presented in Figure 4.

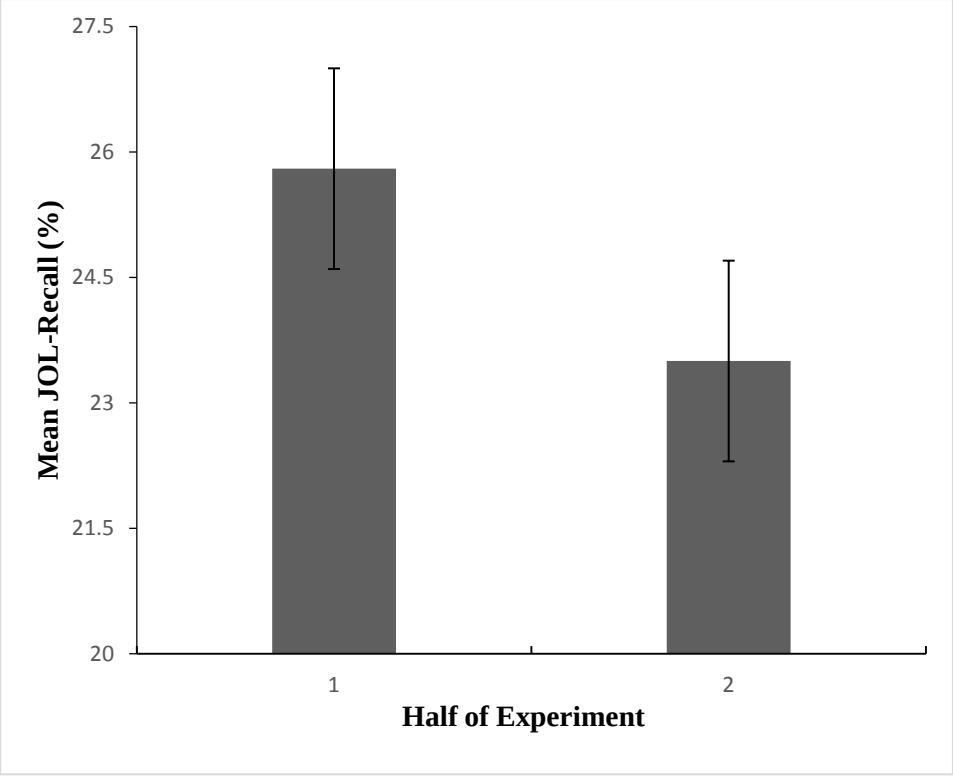

Figure 4. Mean JOL across all conditions for each List Order. Mean JOL-Recall is a percentage. The First Half=1, and the Second Half=2. Error bars represent the standard error of the mean.

JOL and Recall

The Within-Subjects measures of mean JOL and mean Recall were compared across conditions. Results showed that there was a significant difference between mean JOL and mean Recall for all participants, ($F_{(1,53)}$=6.054, p<.05, $\eta_p^2 = .103$). The mean JOL (*M*=22.713, *SD*=3.25) was significantly lower than mean Recall (*M*=26.676, *SD*=2.937). Results are displayed in Figure 5.

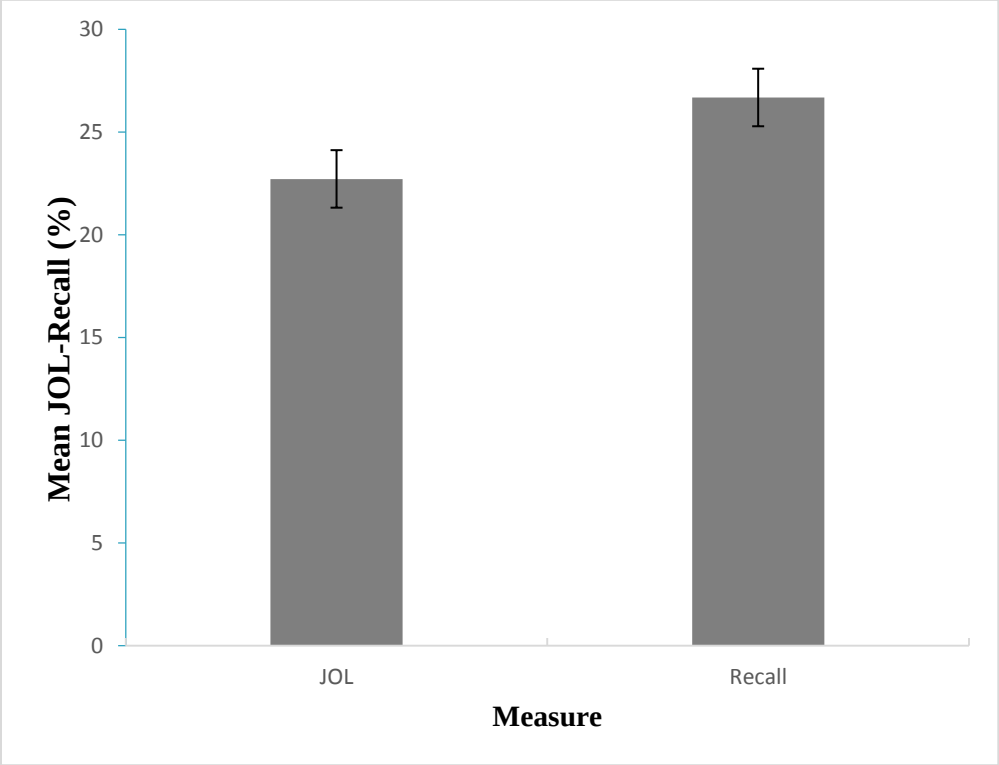

Figure 5. Mean JOL and Mean Recall for all participants throughout the experiment. Error bars represent the standard error of the mean.

Congruency

The Between-Subjects effect of congruency on JOLs and Recall was examined by first combining JOL and Recall scores by averaging mean JOL and mean Recall, resulting in one

value per participant. Results showed that there were a significant effect of congruency (Congruent conditions heard the same music during learning and recall, and incongruent conditions heard different music during learning and recall) on mean JOL-Recall across conditions ($F_{(1,60)}$ =4.460, p<.05, η2=.069). The mean JOL-Recall for incongruent conditions (*M*=22.032, *SD*=3.814*)* was significantly higher than the mean JOL-Recall for congruent conditions (*M*=27.820, *SD*=3.393*)*. Results are displayed in Figure 6.

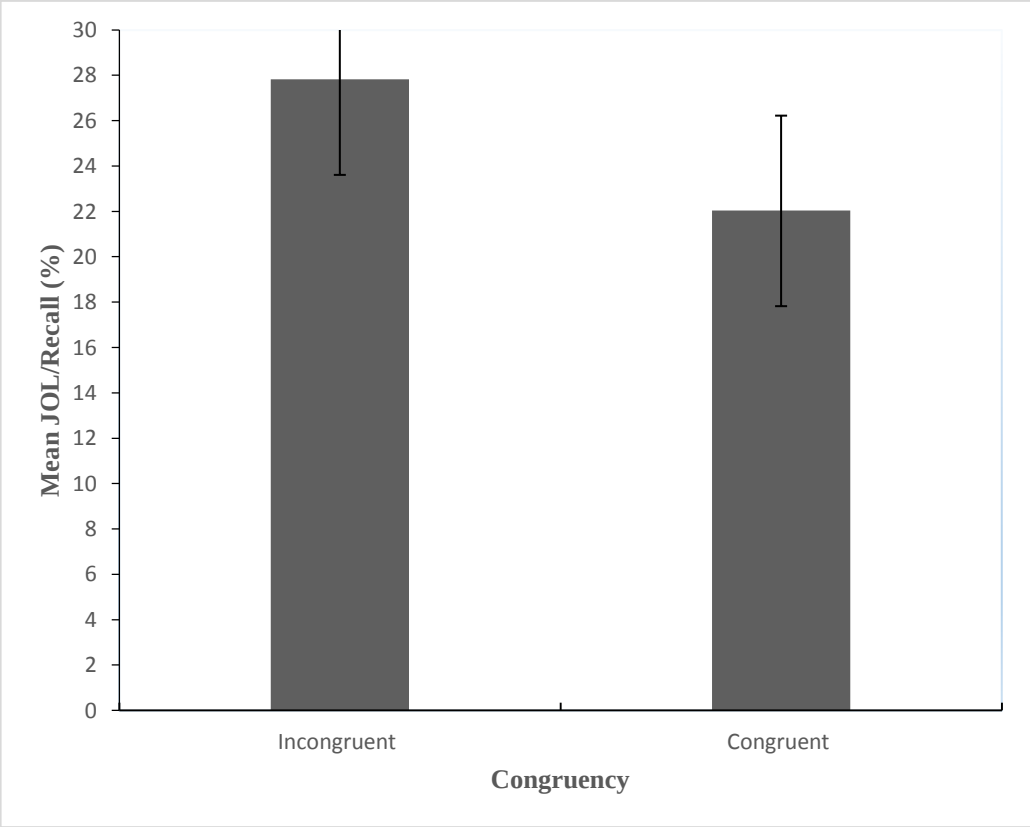

Figure 6. Mean JOL-Recall (percentage) for congruent (Congruent conditions= Positive, Positive; Negative, Negative) and incongruent (Incongruent conditions= Positive, Negative; Negative). Error bars represent the standard error of the mean.

Combination

The Between-Subjects effect of Combination on JOLs and Recall was examined by first combining JOL and Recall scores by averaging mean JOL and mean Recall, resulting in one value per participant. Results showed that there were no significant effect of Combination (Positive, Positive; Positive, Negative; Negative, Positive; Negative, Negative) on mean JOL-Recall across conditions ($F_{(3,53)}$=1.478, p>.05, η_p^2 =.369). There were no significant differences between Combinations.

Measure x Combination

The Within-Subjects effect of Combination on JOLs and Recall was examined by comparing mean JOLs and mean Recall for each participant, between combinations. Results showed that there were no significant effects of Combination (Positive, Positive; Positive, Negative; Negative, Positive; Negative, Negative) on the difference between JOLs and Recall across conditions ($F_{(3,53)}$ = .451, p>.05,η_p^2=.025). A post-hoc analysis-the Bonferroni correction for multiple comparisons-was conducted, with a new alpha of .0125 (.05/4). These t-tests revealed that differences were non-significant.

JOLs and Recall: Calibration

Calibration: Combination

The Within-Subjects comparison of half on JOLs and Recall was examined by calculating each participant's calibration. Calibration scores are the difference between mean Recall and mean JOL for each participant. Results showed that there are no significant differences in calibration between combinations, ($F_{(3,53)}$ = .451, p>.05, , η_p^2=.025).

Mood Ratings

Mauchly's test indicated that the assumption of sphericity assumption of sphericity had been violated for mood ratings ($X^2_{(9)}$ =.770, *p*=.145), so a MANOVA was used analyze data for various factors.

Time

In order to analyze, all ratings on each scale (6 scales: Cheerful, Content, Relaxed, Irritated, Frustrated, Upset) were averaged for each Mood Rating (#1- #5). Each scale had one value per Mood Rating. Results showed significant change with respect to time, ($F_{(4,50)}$=3.852, p<.05, η_p^2 =.278). Results are displayed in Figure 7.

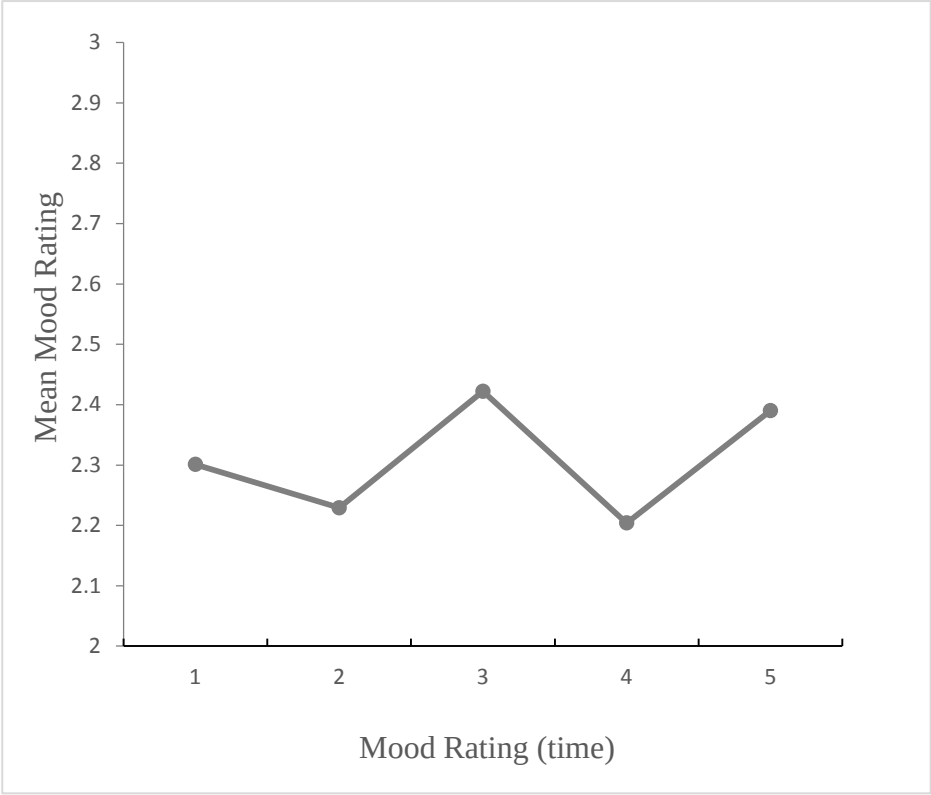

Figure 7. Mean mood ratings (mean of 6 scales: Cheerful, Content, Relaxed, Irritated, Frustrated, Upset) with respect to time. Time is represented by the Mood Rating (#1-#5).

Time x Mood x Combination

Each scale was analyzed with respect to time, by taking an average of each scale (6 scales: Cheerful, Content, Relaxed, Irritated, Frustrated, Upset) for each Mood Rating (#1-#5). There was significant change in rating for each scale as the experiment progressed, ($F_{(20,34)}$=4.893, p<.05, η_p^2 =.475). Results are displayed in Figure 8.

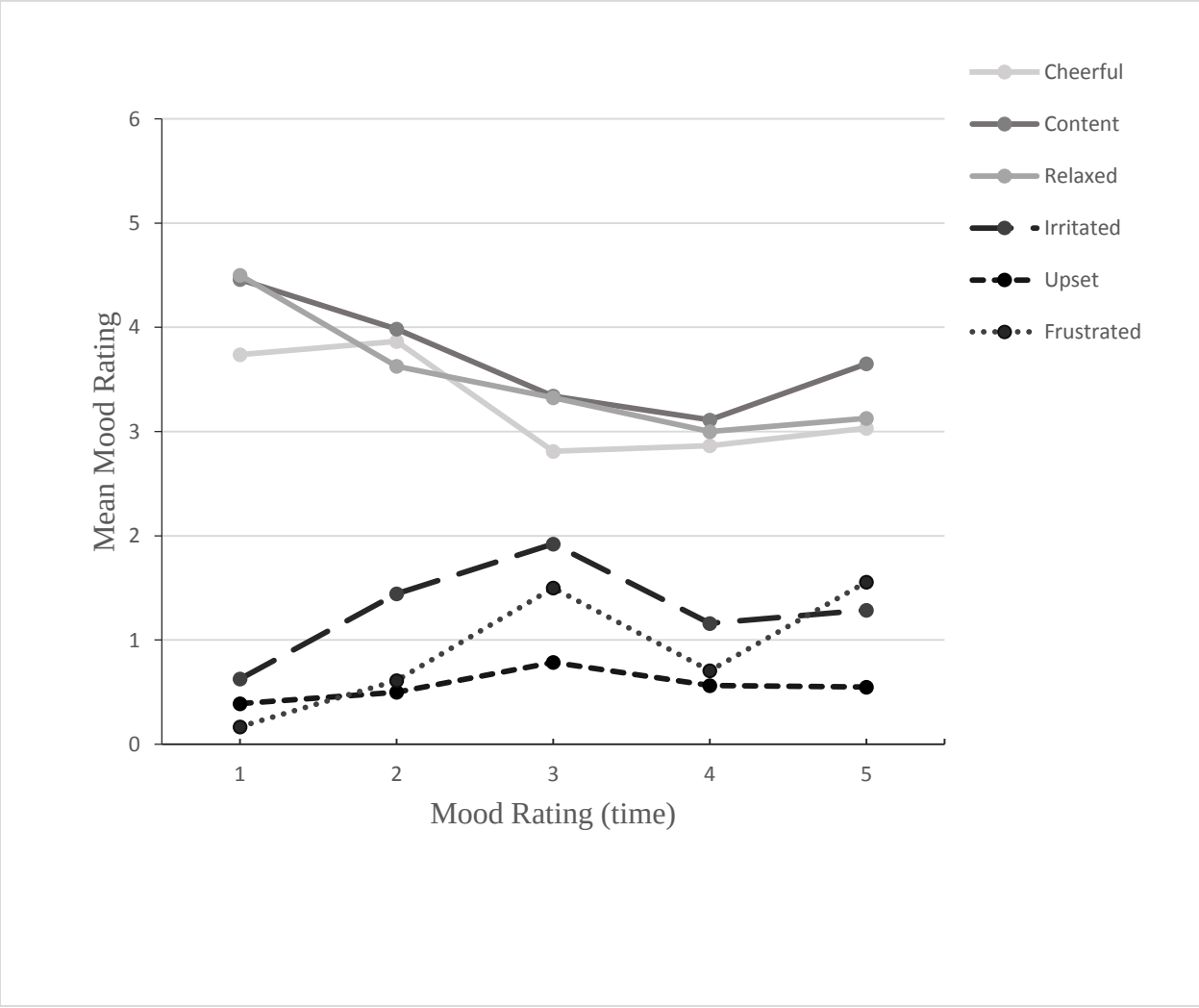

Figure 8. Mean change on each Mood Scale (Cheerful, Content, Relaxed, Frustrated, Irritated, Upset) with respect to time (Mood Rating #1-#5).

Discussion

JOL Sensitivity

Results from tests examining factors affecting JOLs revealed that combination does not have a significant effect on JOL scores. Combination refers to the type of music heard during the Learning period and during the Recall period, where two groups had music congruency (Positive music during learning, Positive music during recall; Negative music during learning, Negative music during recall), and two groups had music incongruency (Positive music during learning, Negative music during recall; Negative music during learning, Positive music during recall). JOLs are not significantly sensitive to the combination of music heard, thus this does not support the Hypothesis 1A and B. To have been supported, there would have been significant sensitivity of JOLs to combination, which post-hoc tests would have been able to identify which combination had the greatest effect.

Overall, JOLs dropped significantly in the second half of the experiment. As word lists were counterbalanced, this was not necessarily due to List Order, (as half of the participants saw Word List #1, then Word List # 2 and the other half of the participants saw Word List # 2, then Word List # 1). One explanation for this would be that participants judged themselves in a stricter manner in the second half of the experiment after gaining experience in the first half. The present study did not include practice slides so that participants would become comfortable with the fast pace of the experiment, and perhaps the first half of the experiment served as practice.

Also, List Order proved to have a significant effect on JOLs. As List Order 1(Word List #1, then Word List # 2) had significantly lower JOLs than List Order 2 (Word List # 2, then Word List # 1). One explanation for this would be that perhaps Word List 2 was slightly more

memorable than Word List 1, and perhaps this increased the confidence of participants in their judgments. Upon scoring data, it was evident many words from Word List 2 were recalled by a great number of participants. For example, the word "abdomen" was recalled by 62% of participants (whereas many other words were recalled by less than 50% of participants).

It was also revealed that there was an interaction between List Order and Combination and that significance lied specifically in the Negative-Positive combination. In this combination, participants who experienced List Order 1 had significantly lower mean JOLs than those who experienced List Order 2. One explanation for this effect could be perhaps an issue of power. The negative-positive combination had a sample size of 13 people, whereas the other three combinations had either 16 or 17. Another possible explanation could be due to group effects, as there were varying numbers of participants among different sessions. Although it is a possibility that participants who heard Negative music during Learning and Positive music during Recall were so affected by this combination that they had discrepancies in JOLs, however this warrants further investigation.

JOL-Recall and Calibration

The results of analyses investigating the effect of different factors on both JOL and Recall suggests that there is no significant effect of combination on calibration. Calibration, which describes the difference between mean JOL and mean Recall scores, is more accurate as it approaches zero. As the difference in calibration scores between combinations proved to be insignificant, it can be assumed that music combination did not affect the accuracy of JOLs. This does not support the hypothesis that participants will be more calibrated in the Pleasant-Congruent condition (Hypothesis 2.A). However, according to Rhodes and Tauber (2010), this

indicates that the JOL is a fairly good predictor of performance overall. In regards to the Cue-Utilization Framework (Koriat, 1997), perhaps background music does not fall under the category of an extrinsic factors. Once again, the insignificant results here could perhaps be an issue of power.

Overall, participants were more calibrated in the second half of the experiment. As previously mentioned, an explanation for this could be that participants used the first half of the experiment as practice. Upon progressing through the first half, participants would be able to see what they were capable of in terms of the number of words they could recall. In the exit questionnaire, participants expressed their frustration upon completing the first half of the experiment, as they were not able to remember as many words as they thought. This supports the notion that participants were more aware of their own abilities in the second half of the experiment-perhaps a result of learning! Once again, it would be of great interest to incorporate practice trials before the experiment commenced to ensure that participants were aware of their potential.

The results of tests examining the effect of congruency on JOLs and Recall did not support Hypothesis 2.B., as JOLs and Recall were significantly higher in incongruent conditions as opposed to congruent conditions-which is interesting. As previously mentioned, Ashbrook and Ellis (1991) suggested that memory was mood dependent, and that memory can be facilitated more accurately if conditions during encoding match conditions during retrieval. Results of the present study do not demonstrate mood-dependent memory. Again, results here could perhaps be an issue of power, or simply that participants were unaffected by the music.

Mood Ratings

Results addressing the Mood Ratings did support the Hypothesis 3, which predicted an overall change in mood throughout the experiment. This change in mood was reflected in significant changes in time (Mood Rating Number) on each of the 6-scales (Cheerful, Content, Relaxed, Irritated, Frustrated, Upset).

Implications of the Present Study

Overall, this study failed to demonstrate that lyric-less classical music, either pleasant or unpleasant, had an effect on JOLs and JOL accuracy. Also, it was not demonstrated that congruency or incongruency between the type of music played during learning and recall had an effect on JOLs and JOL accuracy. Despite this, results helped to support the notion that JOLs are an overall good predictor of future performance, as per Tauber and Rhodes (2010), as participants in all combinations were overall well calibrated. With regards to the Cue-Utilization Framework (Koriat, 1997), results do not support the postulation that potentially mood-inducing background music can be considered an extrinsic factor. Although according to Koriat (1997), extrinsic factors do have less influence than intrinsic factors, they still do have an effect. Perhaps this study employed too small of a sample size to exhibit this effect, or perhaps background music really has no effect on JOLs and JOL accuracy. Future research could examine a larger sample size, and add in a neutral music condition or control for comparison.

As participants were tested in a group setting, and the sample size in this research was quite small (with a total of 62 participants), the number of participants in each group session could have affected performance. Some group sessions had as many as 9 individuals, and some sessions had as little as 2 individuals. This inconsistency, as well as the fact that participants may not test better in group settings could have had a detrimental effect on scores. Future research should employ individual testing to control for any of these effects.

Another suggestion for future research would be employing different measures to track mood. As previously mentioned, a 6 point Likert-Scale (0 being not at all 6 being very much) on was used to track mood on 6 different factors (Cheerful, Content, Relaxed, Irritated, Frustrated,

and Upset) throughout this experiment. Likert-Scales are highly subjective and are not an efficient way to objectively measure mood. With greater resources, physiological measures such as EEGs that could be used to track mood more objectively throughout this experiment would be of greater interest.

The results from this research also point out the downside to using previously normed music and Word Lists. In music in the study by Bieneck and Krahe´ (2012) was rated prior to the experiment by getting participants to rate the music on a six point scale (0 being not at all,6 being very much) on 9 different factors: Exciting, Uplifting, Activating, Lively, relaxing, Solemn, Peaceful, Boring, and Unpleasant. The music employed in the present study assumed that the perceived pleasant or unpleasantness of the music as used by Bieneck and Krahe´ (2012) would hold the same value in the present research. However, it would have been of great value to have participants in this research norm the music themselves prior to conducting this experiment to ensure that it was perceived as pleasant and unpleasant accordingly. Also, as previously mentioned, the word lists used in this experiment had controlled for various factors (as per the Paivio-Word Pool Generator) including: word length (M= 7.675), K-F frequency (M= 21.200), number of syllables (M=2.625), meaningfulness (M=4.373), imagery (M=3.656), and concreteness (M=3.423). With that being said, many of the words are not quite that common in modern-day language (for example: thistledown, derelict, temerity, etc.), thus they may not have been as memorable. Despite controlling for various factors, different words hold different emotional connotations that differs among individuals, so perhaps this in conjunction with the fact that many words from the list seemed outdated contributed to the differential effects observed in List Order effects. Perhaps re-norming Word Lists with the sample participants would be beneficial in future research.

Although the present study doesn't support all of the aforementioned hypotheses, the results are certainly not significant enough to disprove any possible effects that pleasant or unpleasant music could have on JOLs and JOL accuracy. A few key changes made to this research design could help uncover any underlying effects, and the direction of future research could help to identify any other important cues affecting JOLs that could aid in educational and professional settings.

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Appendix I

frequency	syllables	letters	**word**	imagery	concreteness	meaningfulness
29	2	5	**Folly**	2.93	2.63	4.4
2	4	8	**Delirium**	4.8	2.79	5
1	2	9	**Limelight**	4.83	3.06	4.72
1	3	8	**Pacifism**	3.9	2.06	3.8
1	2	7	**Buffoon**	4.33	4.63	4.5
19	2	8	**Nonsense**	3.07	1.9	4.12
1	3	8	**Copybook**	4.6	6.62	3.61
6	2	7	**Phantom**	5.03	2.5	5
8	1	4	**Bard**	4.9	5.03	4.8
7	2	7	**Leaflet**	5.47	6.62	4.92
50	3	8	**Quantity**	3.47	3.32	4.17
50	2	8	**Instance**	2	2.87	4.04
29	1	4	**Hint**	2.57	3.35	3.72
10	3	8	**illusion**	3.53	2.03	4.67
3	2	7	**concept**	1.93	1.97	3.76
50	5	11	**opportunity**	3.03	2.63	4.08
100	3	7	**opinion**	3.23	2.29	4.96
2	3	8	**jeopardy**	3.03	2	3.48
27	2	5	**maker**	3.57	4.46	5
100	2	4	**Idea**	2.2	1.42	4.88

Word List # 1

Word List # 2

frequency	syllables	letters	**word**	imagery	concreteness	meaningfulness
1	4	9	**criterion**	1.83	1.93	3
7	3	7	**abdomen**	6	6.83	4.75
3	3	10	**inducement**	2.93	2.34	3.68
2	2	6	**Upkeep**	3.07	2.5	4.76
8	2	7	**outcome**	2.4	2.8	4.24
1	2	8	**steerage**	3	4.29	4.65
1	2	6	**Savant**	3.07	3.02	3.88
1	3	9	**hierarchy**	5.13	2.73	4.48
50	3	10	**confidence**	3.4	1.52	4.17
50	3	10	**convention**	5.07	5.38	4.92
26	2	4	**Item**	3.67	5.27	4.96
1	4	8	**temerity**	2.33	2.19	2.04
1	3	8	**Derelict**	4.6	5.66	4.52
1	3	11	**thistledown**	3.83	6.14	4.76
100	1	5	**Month**	4.37	3.2	4.58
19	3	9	**formation**	3.87	3.76	4.92
22	3	10	**permission**	2.87	4.43	4.68
4	3	8	**ensemble**	4.63	5.45	4.8

19	5	13	**determination**	3.57	1.66	4.64
35	2	8	**kindness**	4.2	1.63	4.84

Appendix II: Mood Ratings

Mood Rating Number 1:

Cheerful: 0 (not at all)……..…..6 (very much)

Content: 0 (not at all)……..6 (very much)

Relaxed: 0 (not at all)…….…….6 (very much)

Irritated: 0 (not at all)……..6 (very much)

Upset: 0 (not at all)……..….6 (very much)

Frustrated: 0 (not at all)……..…..6 (very much)

Mood Rating Number 2:

Cheerful: 0 (not at all)……..…..6 (very much)

Content: 0 (not at all)……..6 (very much)

Relaxed: 0 (not at all)…….…….6 (very much)

Irritated: 0 (not at all)…….6 (very much)

Upset: 0 (not at all)……6 (very much)

Frustrated: 0 (not at all)……..…..6 (very much)

Mood Rating Number 3:

Cheerful: 0 (not at all)……..…..6 (very much)

Content: 0 (not at all)……..6 (very much)

Relaxed: 0 (not at all)…….…….6 (very much)

Irritated: 0 (not at all)…….6 (very much)

Upset: 0 (not at all)……6 (very much)

Frustrated: 0 (not at all)……..…..6 (very much)

Mood Rating Number 4:

Cheerful: 0 (not at all)……..…..6 (very much)

Content: 0 (not at all)……..6 (very much)

Relaxed: 0 (not at all)…….……6 (very much)

Irritated: 0 (not at all)…….6 (very much)

Upset: 0 (not at all)…….6 (very much)

Frustrated: 0 (not at all)……..…..6 (very much)

Appendix III

LAURENTIAN UNIVERSITY

INFORMED CONSENT TO PARTICIPATE IN A RESEARCH PROJECT

Title of project: Effect of Music on JOLs and Memory

Name of supervisor: Heather Mong, Ph.D.

Contact for questions/problems: Heather Mong, ext. 4248 hmong@laurentian.ca

Purpose of the research: The purpose of the research is to investigate the effects of music on Judgments of Learning and memory recall. The experiment is not a test of skill of any individual. The experiment will be conducted in a single session lasting one hour or less.

Procedures/methods to be used: The experiment will be conducted on projector. After reading a set of instructions, you will be shown a series of words on the screen. You will be asked to make simple judgments following each word, predicting how well you think you will remember the word. You also will be required to complete two distractor tasks (including naming things) and mood tests. All responses will be recorded in a booklet given you to you prior to commencement of the experiment.

Risks inherent in the procedure: There are no known risks involved in participation in this project. It is not possible to identify all potential risks in an experimental procedure, but reasonable safeguards have been taken to minimize both the known and the potential, but unknown risks.

Benefits: You will be able to learn about research methodology and current research being conducted in a relatively new branch of cognitive psychology called metacognition.

Confidentiality: Participants will remain completely anonymous. At no time will your data be linked with your name.

Participation: You must be at least 18 years old to participate. Your participation in this research is voluntary. If you decide to participate in this study, you may withdraw your consent and stop participating at any time without penalty or loss of benefits to which you are otherwise entitled.

Your signature acknowledges that you have read the information stated above and willingly sign this consent form. Your signature also acknowledges that you have received, on the date signed, a copy of this document.

_____

Participant name (printed)

_____ _____

Participant signature *Date*

Investigator signature *Date*

Appendix IV

ID#:_____

1) Did you enjoy the music played in the background while doing this experiment?

Yes__ No__

2) Please rate the music on the following scales (please circle one).

Exciting: 0 (not at all)……..…..6 (very much)

Uplifting: 0 (not at all)……...6 (very much)

Activating: 0 (not at all)…….…....6 (very much)

Lively: 0 (not at all)…….....6 (very much)

Relaxing: 0 (not at all)……...6 (very much)

Solemn: 0 (not at all)……..……...6 (very much)

Peaceful: 0 (not at all)……..…..6 (very much)

Boring: 0 (not at all)…….....6 (very much)

Unpleasant: 0 (not at all)……....6 (very much)

3) Do you enjoy classical music? Yes__ No__

4) How often do you listen to music when you study?

All of the time____

Most of the time ____

Sometimes___

Occasionally___

Rarely___

Never___

5) List the reasons why you listen to music/ don't listen to music when studying?

6) Did you feel as if your mood changed throughout the experiment? Please explain

Appendix V

Music, Memory and Judgments of Learning Experiment

Debriefing Form

As stated in the consent form, the purpose of this study is to examine the differential effects of music on memory and Judgments-of-Learning. Prior research suggests that if music is perceived as pleasant, it will evoke a positive mood and if music is perceived as unpleasant or aversive, it will evoke a negative mood. Mood had a significant effect on memory, as a positive mood enhances cognitive processes, and a negative mood impairs cognitive processes. Research has proven that Judgments-of-Learning (JOL's) or the predictions of the likelihood of future recall, are generally accurate. Cue-Utilization-Framework (Koriat, 1997) states that JOL's depend on intrinsic, mnemonic and extrinsic cues. As extrinsic cues are environmental conditions, and background music was manipulated in this experiment, it was expected that pleasant music would have an enhancing effect on memory recall, and unpleasant music would impair memory- both of which would be accounted for in terms of JOL accuracy. Listening to music that may induce a different mood during the learning period than during the recall period would account for mood incongruency. Which is also thought to have an effect on memory accuracy.

This is a relatively new area of study, and no research has been done to investigate the effect of music, mood and extrinsic properties that may affect JOL accuracy. However, a great deal of interesting JOL research has been done by a cognitive psychologist from Colorado State University named Matthew Rhodes. If you would like more information on this topic, you can contact myself or Dr. Heather Mong.

Note that your data will be identified using an arbitrary participant number. At no time will your name be connected with your data.

If you have any questions or concerns about this research, or would like to discuss the results after the experiment has been completed, please contact myself (ax_tompkins@laurentian.ca) or Dr. Mong (hmong@laurentian.ca).