The effects of background music and sound in economic decision making: Evidence from a laboratory experiment

Fujikawa, Takemi and Kobayashi, Yohei

Graduate School of Business, Universiti Sains Malaysia, Advanced Medical and Dental Institute,Universiti Sains Malaysia

6 April 2010

The effects of background music and sound in economic decision making: Evidence from a laboratory experiment

Takemi Fujikawa* Yohei Kobayashi†

June 14, 2010

Abstract

This paper experimentally studies the effects of background music and sound on the preference of the decision makers for rewards in pairwise intertemporal choice tasks and lottery choice tasks. The participants took part in the current experiment, involving four treatments: (1) the familiar music treatment; (2) the unfamiliar music treatment; (3) the noise treatment and (4) the no music treatment. The experimental results confirm that background noise affects human performance in decision making under risk and intertemporal decision making, though the results do not indicate the significant *familiarity* effect that is a change of the preference in the presence of familiar background music and sound.

Keywords: Allais-type preferences; choice under risk; intertemporal choice; the familiarity effect

1 Introduction

This paper shall experimentally investigate the relation between the background music/sound and behavioural preference (i.e., risk and time preference). For investigating risk preference, this paper elicits decision-making preferences in "choice under risk", that is, choices under the followings: (1) low- and high-money payoffs (e.g., a choice between a 80% chance of winning 400 yen and sure 300 yen; a choice between a 80% chance of winning 4000 yen and sure 3000 yen) and; (2) low- and high-probability payoffs (e.g., a choice between a 80% chance of winning 4000 yen and sure 3000 yen; a choice between a 20% chance of winning 4000 yen and a 25% chance of winning 3000 yen). On the other hand, for investigating time preference, this paper elicits decision-making preferences in intertemporal choice, that is, choices under the followings: (1) smaller-sooner and smaller-later money payoffs (e.g., a choice between 800 yen in 7 days and 880 yen in 30 days; a choice between 700 yen in 7 days and 770 yen in 30 days); (2) larger-sooner and larger-later money payoffs (e.g., a choice between present 5000 yen and 5500 yen in 30 days; a choice between present 5000 yen and 5005 yen in 7 days) and; (3) smaller-sooner and larger-longer money payoffs (e.g., a choice between 800 yen in 7 days and 1600 yen in 14 days; a choice between 900 yen in 7 days and 1800 in 14 days).

The goal of the present study is to see if familiar and unfamiliar background music and the white noise sound could affect the behaviour of the participants, who were asked to make decisions in choice under risk and intertemporal choices. The current experiment was conducted to examine the effects of the background music and sound presented to the participants during their choice tasks, involving choice under uncertainty and intertemporal choice. We used three forms of background music and sound (i.e., familiar music, unfamiliar music and noise). We shall show an extensive analysis that was made to answer central questions:

*Graduate School of Business, Universiti Sains Malaysia. Email: takemi@usm.my.

†Advanced Medical and Dental Institute, Universiti Sains Malaysia. Email: kobapie@gmail.com.

- Do familiar and unfamiliar background music and the white noise sound affect human behaviour? Do people change their behaviour in the presence of these background music and sound?

- Do people behave exhibiting the increased or attenuated *familiarity effect* in the presence of familiar background music? Does familiar background music facilitate or detract the familiarity effect when people engage in decision making?

The organisation of this paper is as follows: Section 2 provides a sketchy description of choice under risk and intertemporal choice. Section 3 is devoted to review literature on effects of background music in decision making. In Section 4, we discuss details of the current experiment. Section 5 contains a general discussion of the experimental results. Finally, we conclude.

2 Decision Making under Risk and with Intertemporal Choice

Economists have been analysing, both theoretically and experimentally, "choice under risk" and "intertemporal choice", as the analysis has much to contribute to the study of economics on *rationality*. As we shall show below, this paper aims to investigate behavioural tendencies when people engage in decision making under risk and decision making with intertemporal choice in the presence of particular background music and sound. Our aim is worthwhile, as there should be much discussion on the effect of background music and sound in our daily decision making (e.g., consumer behaviour).

On the one hand, much attention has been focused on choice under risk and its related "Allais-type" behaviour (Allais, 1953) to exemplify deviations from rationality. Since Allais (1953), there have been a number of experiment-based studies, investigating and demonstrating human behaviour in decision making under risk. One of the most elegant studies is Kahneman and Tversky (1979). They performed a choice experiment, where they asked the participants to choose between: (H1) a 80% chance to win \$4 and (L1) a sure gain of \$3. The results revealed that many of the participants preferred a safe option (L1). This preference for a certain payoff is termed as the *certainty effect*. In another experiment, Kahneman and Tversky (1979) asked the participants to choose between (H2) a 20% chance to win \$4 and (L2) a 25% chance to win \$3. Many of the participants preferred (H2). This participants' response is well known as *Allais paradox*.

On the other hand, preferences in intertemporal consumption choice under certainty were in previous studies (e.g. Green, Fristoe and Myerson, 1994; Kirby and Herrenstein, 1995; Millar and Navarick, 1984; Solnick, Kannenberg, Eckerman and Waller, 1980). Frederick and Loewenstein (2002) introduced an example, where people make choice between: (H3) a sure gain of \$101 in 101 days and (L3) a sure gain of \$100 in 100 days. Many would prefer (H3). By decreasing day length, this choice problem could be reduced to the choice problem between: (H4) a sure gain of \$101 tomorrow and (L4) a sure gain of \$100 today. Many people would prefer (L4), though it has a lower objective value. This behavioural tendency is consistent with the existing body of literature (McKerchar, Green, Myerson, Pickford, Hill and Stout, 2009) which supports the assertion that people often choose an option that yields sooner reward even if it has a lower reward when they make a choice between two rewards that differ in delay. Furthermore, Takahashi (2009) demonstrated that subjects often prefer small-sooner rewards to larger-later rewards.

The aforementioned preference reversal phenomena raise an issue relevant to economic theory. It has been examined and reported in the tradition of Samuelson's (Samuelson, 1937) model of discounted utility that explains patterns of intertemporal choice, and Von Neumann-Morganstern expected utility theory (von Neumann and Morgenstern, 1944) that is a rational choice model in economics. Despite these elegant models, recent and previous studies have provided robust evidence for a number of "anomalies" and "violations" in intertemporal choice and decision making under risk. Frederick and Loewenstein (2002) provide historical origins of the discounted utility model and a convincing discussion on the model. We note here that the results and findings are inconsistent, despite many *lab-*

oratory experiments conducted by researchers across countries.

3 Effects of Background Music in Decision Making

Music is a most specialised, peculiar human cultural artefact (Andrade, 2004; Beament, 2001) and powerful stimulus to our behaviour and decision making. One raises a question: Can background music affect our behaviour? There has been much of the controversy pertaining to this question (Brayfield and Crockett, 1955; Jacob, 1968; McGehee and Gardner, 1949; Milliman, 1982; Smith, 1947; Uhrbrock, 1961). Hilliard and Tolin (1979) showed that performance in the presence of familiar background music is higher than that in the presence of unfamiliar music. Corhan and Gounard (1976) premised that vigorous rock music should be associated with better performance than easy-listening music. Music is employed in the background of offices and retail stores to produce certain desired behaviours and decision making among employees and/or customers (Milliman, 1982). Bruner (1990) presumed that music affects human beings in various ways as long as they play music. Having accepted this presumption, previous researchers presented study on behavioural effects on music in decision making.

There exists literature pertinent to the effects of music on behaviour and decision making. Iwanaga and Ito (2002) examined the disturbance effect of music on human behaviour in memory tasks. They conducted an experiment in which the participants performed choice tasks in the presence of vocal music, instrumental music, a natural sound and no music. We here note that vocal music contains more verbal information than instrumental music (Iwanaga and Ito, 2002). Iwanaga and Ito (2002) reported that highest disturbance was observed under the vocal music condition. Sundstrom and Sundstrom (1986) showed that music was effective in maintaining both arousal and motivation when the decision makers (DMs) were performing easy decision-making tasks. Wolf and Weiner (1972) asked undergraduates to perform a mental arithmetic task with having them listen to rock music, and showed that their performance in the task was neither decreased nor increased. Hence, the effects of background music in decision making are inconsistent. The kinds of background music varied: classical (Hilliard and Tolin, 1979), folk (Mowsesian and Heyer, 1973), hard rock (Wolf and Weiner, 1972), vocal and instrumental (Salamé and Baddeley, 1982), pop (Iwanaga and Ito, 2002). All of background music in these studies consisted of existing songs (e.g., Mozart, well-known Japanese pop songs, and so on).

3.1 The Familiarity Effect

It must be noted at the outset that, in previous experiments, the "familiarity effect" was likely to be idiosyncratic among individual participants. The familiarity effect is a change of preference in the presence of familiar background music/sound. The previous authors conducted experiments in which the participants were asked to perform the tasks in the presence of background music that was chosen — either biasedly or unbiasedly — from the list of *existing* songs (e.g., Mozart in Rauscher, Shaw and Ky (1993)).

Thus, the previous experiments were conducted with the setting where the songs used as background music during the experiments had been accessible (i.e., purchasable and downloadable). This setting is inadequate since it leads to all sorts of difficulties with experimental controls, in such a way that impression towards particular songs was idiosyncratic among the participants. For example, some of the participants had or had not been familiar with the songs; they had or had not had prior personal images or preconceived opinions of the songs. If (some of) the participants had had prior personal images or preconceived opinions of the songs used as background music during the experiment, it would more or less affect their behaviour. Lack of control with respect to how familiar the songs are may produce results that cannot be interpreted clearly, as different participants may activate different mechanisms to the "same" musical stimulus, with resulting differences in behaviour (Juslin and Västfjäll, 2008). Thus, previous results more or less were biased by the familiarity effect.

The familiarity effect is concerned with *episodic memory* that refers to a process whereby an emotion is induced in a listener, as the music evokes a memory of a particular event in the listener's life (Juslin and Västfjäll, 2008). Music often evokes memories (Gabrielsson, 2001; Juslin, Laukka, Liljeström, Västfjäll and Lundqvist, L.-O., submitted; Sloboda, 1992), and the emotion is associated with the memories. Such a emotion can be rather intense (Juslin and Västfjäll, 2008). Baumgartner (1992) showed that episodic memories evoked by music tend to involve not only social relationships (e.g., past or current romantic partners) but private relationships (e.g., the death of grandfather). Episodic memory can be one of the most frequent and subjectively important sources of emotion in music (Juslin and Liljeström, in press; Sloboda and O'Neill, 2001). Thus, the familiarity effect and its related effect of the episodic memory cannot be neglected.

In the current experiment, the song was used which had not been available to the public before the experiment. The coauthor of the current paper, who is a composer of music, developed and composed the song used as background music for the current experiment that was *neither* downloadable *nor* purchasable. Thus, the current experiment was carried out with the setting, where none of the participants had had an opportunity in listening to and knowing the song before the experiment. This setting conforms to the behavior of the DMs, who have no personal images and/or preconceived opinions of the song.

4 Experiment

The current experiment was conducted at the Kyoto Experimental Economics Laboratory (KEEL) in Japan. On arrival at the KEEL, each participant was assigned a workstation that displayed an experimental screen, and distributed a written instruction that was read aloud. In the instructions, the participants were told that they could have a right to leave the laboratory before the experiment started, if they did not wish to participate in the experiment. The participants were also told that they were given an opportunity to ask questions individually before and during the experiment. At the conclusion of the experiment, they were paid individually and privately according to their response to choice problems, the detailed procedures of which shall be described below. The participants received no initial (showing up) fee. Decision task completion took no longer 90 minutes, and an average payoff was 3735 yen (about 40 US dollars at the time of the experiment) per participant.

4.1 Participants

The participants in the current experiment were 42 undergraduates from various faculties at Kyoto Sangyo University, of whom were 6 women and 36 men. These participants had a mean age of 20.73 years ($SD = 2.8$, range= $18 - 34$ years).

4.2 Apparatus

The experiment included four treatments:

- Treatment 1 in which the participants made decisions in the presence of *familiar* background music;
- Treatment 2 in which the participants made decisions in the presence of *unfamiliar* background music;
- Treatment 3 in which the participants made decisions in the presence of noise (white noise);
- Treatment 4 in which the participants made decisions without the presence of any background music/sound.

The background music/sound was played in each treatment through personal headphones that were connected with each workstation. As the order of the four treatments was randomised, each participant took part in the four treatments in a different order. For example, the order of the treatments performed by some participants was Treatment 2, 1, 3 and 4; while the order by the other participants was Treatment 3, 4, 1 and 2. She/he started with the first treatment and participated in the second treatment. On completion of the first treatment, she/he was advised by the automatically-generated message on the computer screen that the first treatment had been completed, and a 10-minutes break was given before starting the second treatment. During the 10-minutes break, she/he participated in a questionnaire shown on the computer screen and used a mouse to respond to a set of questions. During the break, she/he was allowed to remove the headphone.

In each treatment, each participant was asked to respond to 30 random samples of pairwise choice problems taken by a computer programme from 120 choice problems, consisting of the following three types:

- Type A: Choice under risk (i.e., a choice between a p_1 chance of winning x_1 yen today and a p_2 chance of winning x_2 yen today ($p_1, p_2 \in (0,1], p_1x_1 > p_2x_2$);

- Type B: Intertemporal choice (i.e., a choice between sure y_1 yen in t_1 days and sure y_2 yen in t_2 days ($y_1 > y_2 > 0$ and $t_1 > t_2 \geq 0$);

- Type C: Self-evident choice (i.e., a choice between a q_1 chance of winning z_1 yen today and a q_2 chance of winning z_2 yen today ($q_1, q_2 \in [0,1), q_1 \leq q_2, 0 < z_1 \leq z_2$); a choice between sure z_3 yen today and sure z_4 yen today ($z_3 > z_4 > 0$))

Appendix 1 presents the payoff structure of the 120 choice problems, of which 60 are Type A problems; 40 are Type B problems and; 20 are Type C problems. Some choice problems shared the same payoff structure. For example, two Type A problems (Problem 2 and 8) involved a choice between 80% chance of winning 4000 yen and sure payoff of 3000 yen. Yet, the participants were presented with these problems in different paradigms: Problem 2 was presented with a "probability-based" paradigm (that is shown in Figure 1), while Problem 8 with a "description-based" paradigm (that is shown in Figure 2).

That is, in each treatment, each participant was given 30 choice problems that were randomly selected for her/him by the computer programme from the pool of 120 choice problems. The participants participated in all of the four treatments. The order of the treatments was, however, counterbalanced to avoid the "order effect" that is concerned with an indication that the order in which items are presented can affect the strength of the decision maker's belief (Zhang, Johnson and Wan, 1998).

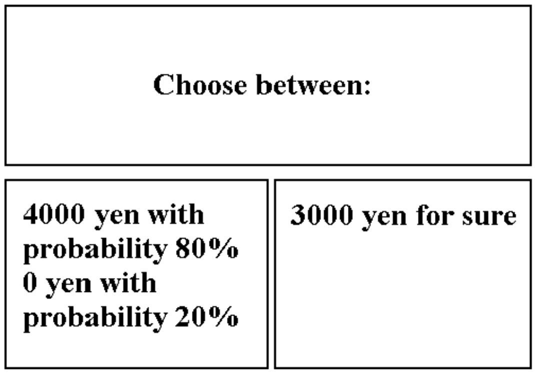

Figure 1: Experimental screen for a probability-based paradigm. The upper of the display shows the choice problem. The lower shows options available to the participants. They were asked to choose (click) either of the two options.

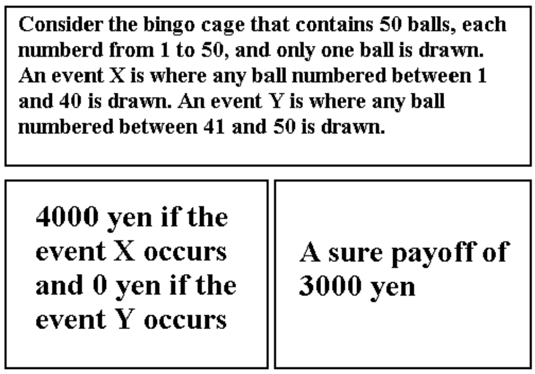

Figure 2: Experimental screen for a description-based paradigm.

In each treatment, the participants' task was to make a selection between two options in the choice problem given at each round t ($t = 1, \ldots, 30$). As shown in Figure 1 and 2, each of the problems was presented in their computer screen at each round t. They were asked to respond to each problem by choosing (clicking) one of two options (i.e., a left button and right button in the lower panel of Figure 1 and 2) by using a computer mouse. Each problem was the independent one-shot problem and arranged randomly. The order of the problems and options was counterbalanced randomly across the participants.

On completion of each treatment — except for Treatment 4 —, the participants were asked to fill in a questionnaire developed to clarify the participants' understanding on music preference, familiarity of the background music/sound played during the treatment and consciousness about the music/sound.

4.3 Treatment 1: A Familiar Music Treatment

4.3.1 Stimuli

The musical piece used in Treatment 1 as background music was a popular song in Japan: An opening song of *Doraemon* — famous TV Japanimation — that was arranged by the coauthor of the current paper, and used only for the experiment.[1] In the treatment, only instrumental selections (e.g., piano) were employed. Hence, as stated in Milliman (1982), no concern had to be given to female versus male vocalist, popular versus less popular artists, etc.

The song was arranged to piano solo score and performed by a virtual grand piano — the software synthesiser *Ivory Grand Pianos* standardised by VSTi that emulates "Boseudofer 290 Imperial Grand". No other particular artificial instruments were used, except of other equipments for auditory correction (i.e., the equaliser, reverb and mastering effects). The music tempo was fixed as 120 beats per minute (bpm) and loop was arranged for continuous experiment. (Note that 1 loop is 1 minute.) The sound pressure of the 2 MIX source was normalised as -15 dB and its range is $-\infty$ dB to -0.1 dB (no clip). The format of sound source was 16 bits/44.1 kHz CD quality wave format without any compression. The average of note tone was C4; the highest note was G5 and; the lowest note was B2 (as chromatic scale). The density of notes was 250 notes per minute. Average velocity of note was 100 (highest: 127, lowest: 64). The volume of the music was maintained at a constant level with the headphones. The volume among each participant was all the same and fixed to proper loudness through the treatment continuously. Results of the questionnaires revealed that no participants expressed discomfort or distaste for the music played during the treatment.

[1] A succinct description of *Doraemon* is found in Iyer (2006).

4.3.2 Results

An overall proportion of risky choices (P_{risky}) was 0.5. The P_{risky} of individual participants is available in Appendix 2. Figure 3 presents numbers of risky and safe choices of individual participants in the treatment. We can see from the figure the existence of heterogeneity among the participants in behavioural tendencies in the treatment. For example, P_{risky} of some participants (e.g., Participant 7) was 100 percent; while P_{risky} of other participants (e.g., Participant 1) was nearly 10 percent. Figure 7 presents the distribution of the individual P_{risky} in the treatment ($SD = 0.27$). The P_{risky} of individual 60 Type A problems is available in Appendix 4. Figure 5 presents numbers of risky and safe choices of individual problems in the treatment. Figure 9 presents the distribution of P_{risky} of the individual problems ($SD = 0.23$).

An overall proportion of sooner choices (P_{sooner}) was 0.6. The P_{sooner} of individual participants is available in Appendix 3. Figure 4 presents numbers of sooner and later choices of individual participants in the treatment. We can see from the figure the existence of heterogeneity among the participants in behavioural tendencies in the treatment. For example, some participants (e.g., Participant 36) chose only sooner options, while others (e.g., Participant 3) chose only later options. Figure 8 presents the distribution of the individual P_{sooner} in the treatment ($SD = 0.32$). The P_{sooner} of individual 40 Type B problems is available in Appendix 5. Figure 6 presents numbers of sooner and later choices of individual problems in the treatment. Figure 10 presents the distribution of P_{sooner} of the individual problems ($SD = 0.26$).

An overall proportion of rational choices made among Type C problems was 1. We posit in this paper that, given a choice between a q_1 chance of winning z_1 yen today and a q_2 chance of winning z_2 yen today ($q_1, q_2 \in [0, 1), q_1 \leq q_2, 0 < z_1 < z_2$), it is rational for people to choose a q_1 chance of winning z_1 yen today. We also posit that, given a choice between sure z_3 yen today and sure z_4 yen today ($z_3 > z_4 > 0$), it is rational for people to choose sure z_3 yen today.

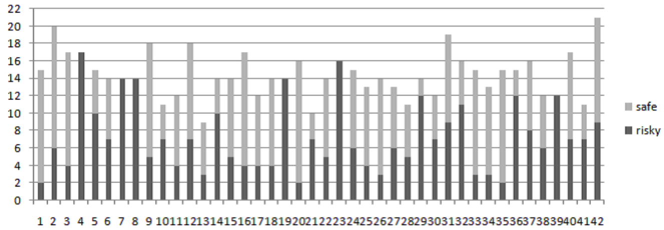

Figure 3: Numbers of risky and safe choices of individual participants in Treatment 1. For example, Participant 20 was presented with 16 Type A choice problems, and chose risky options in 2 problems and safe options in 14 problems.

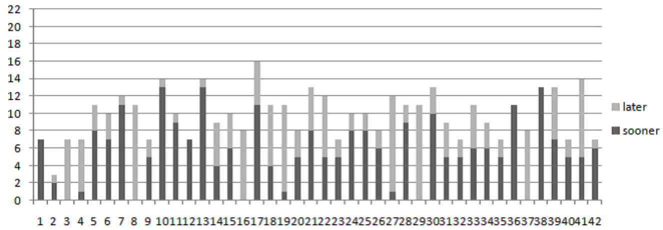

Figure 4: Numbers of sooner and later choices of individual participants in Treatment 1. For example, Participant 38 was presented with 13 Type B choice problems, and chose sooner options in all of the 13 problems.

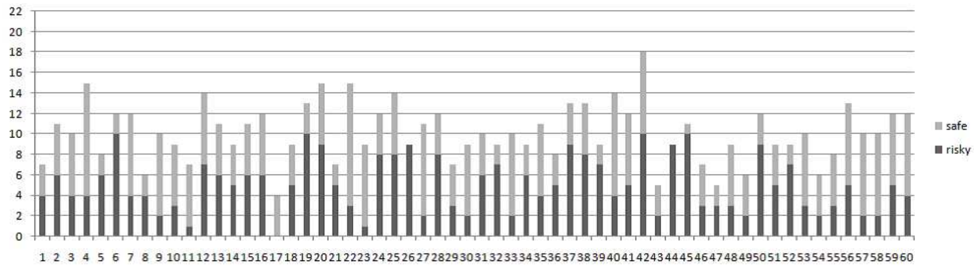

Figure 5: Numbers of risky and safe choices in individual 60 Type A questions in Treatment 1. For example, Problem 16 was performed by 12 participants, and 6 of them chose risky options and the rest 6 chose safe options.

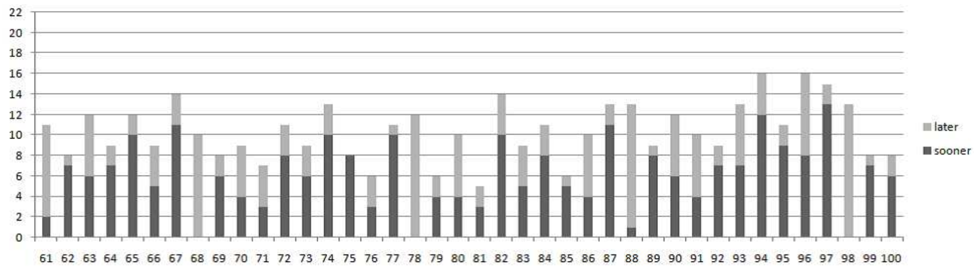

Figure 6: Numbers of sooner and later choices in individual 40 Type B questions in Treatment 1. For example, Problem 77 was performed by 11 participants, and 10 of them chose sooner options and 1 chose later options.

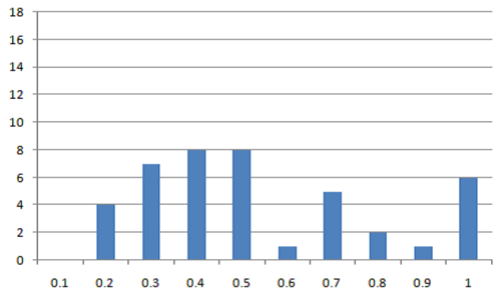

Figure 7: The distribution of P_{risky} of the individual participants in Treatment 1. For example, we observed 6 out of 42 participants (i.e., Participant 4, 7, 8, 19, 23 and 39), whose P_{risky} was more than 0.9.

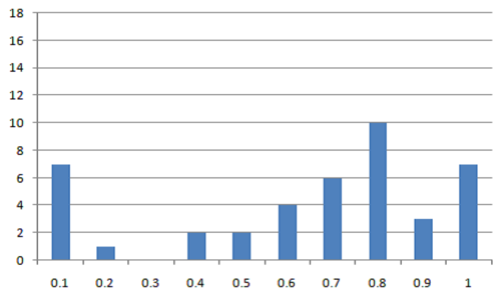

Figure 8: The distribution of P_{sooner} of the individual participants in Treatment 1. For example, we observed 2 out of 42 participants (i.e., Participant 18 and 41), whose P_{sooner} is such that $0.3 < P_{sooner} \leq 0.4$.

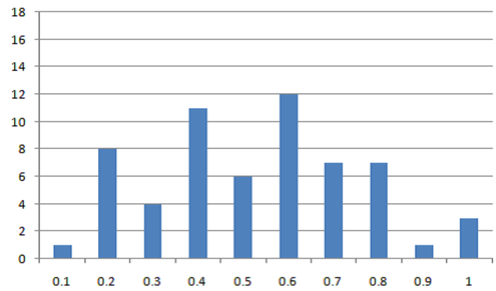

Figure 9: The distribution of P_{risky} of the individual Type A problems in Treatment 1. For example, 1 out of 60 Type A problems (i.e., Problem 6) was observed, where $0.8 < P_{risky} \leq 0.9$.

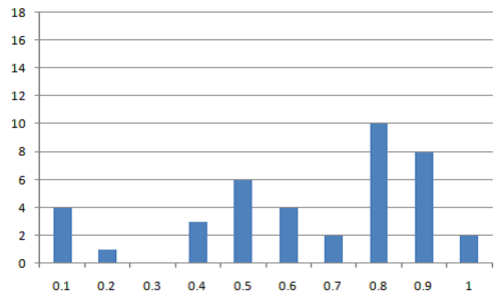

Figure 10: The distribution of P_{sooner} of the individual Type B problems in Treatment 1. For example, 1 out of 40 Type B problems (i.e., Problem 61) was observed, where $0.1 < P_{sooner} \leq 0.2$.

4.3.3 Questionnaire Analysis

On completion of the treatment, the participants were asked to fill in a questionnaire developed to clarify the participants' understanding on music preference, familiarity of the background music played during the treatment and consciousness about the music. The questionnaire contained questions that were: (1) Was the music played during this treatment familiar to you? (2) How much attention did you pay to the music during this treatment? (3) Do you like the music? (4) Do you think your decision-making behaviour was influenced by the music?

Results of the questionnaires revealed the followings: First, self-reported familiarity level of the music on a 11-point scale (0=*not familiar with*; 10=*very much familiar with*) was extremely high ($Min = 9, Max = 10, M = 9.90, SD = 0.37$). Second, self-reported attention level (i.e., how much attention paid to the music while making decisions) on a 11-point scale (0=*no attention at all*; 10=*very much attention*) was high ($Min = 0, Max = 10, M = 7.47, SD = 2.97$). Third, self-reported music liking on a 11-point scale (0=*dislike very much*; 10=*like very much*) was high ($Min = 0, Max = 10, M = 7.76, SD = 2.56$). Fourth, self-reported influence of the music on decision-making behaviour (i.e., to what extent the participants' decision-making behaviour was influenced by the music) on a 11-point scale (0=*to no extent*; 10=*to a very large extent*) was low ($Min = 0, Max = 10, M = 3.00, SD = 3.14$).

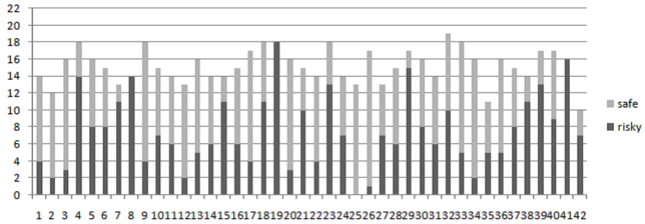

Figure 11: Numbers of risky and safe choices of individual 42 participants in Treatment 2. For example, Participant 19 was presented with 18 Type A choice problems, and chose only risky options in all of the 18 problems.

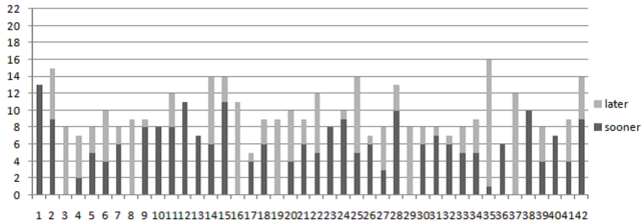

Figure 12: Numbers of sooner and later choices of individual 42 participants in Treatment 2. For example, Participant 12 was presented with 11 Type B choice problems, and chose only sooner options in all of the 11 problems.

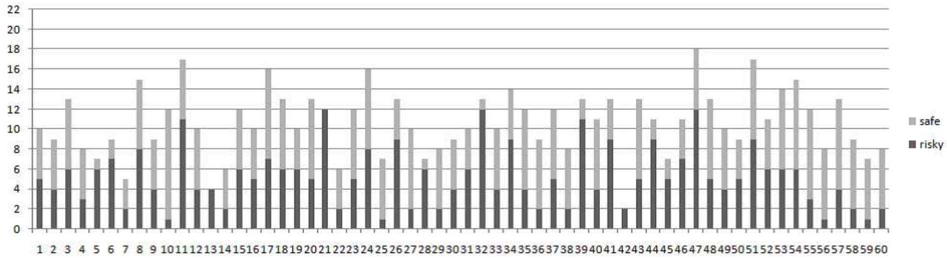

Figure 13: Numbers of risky and safe choices in individual 60 Type A problems in Treatment 2. For example, Problem 24 was performed by 16 participants, and 8 of them chose risky options and the rest 8 chose safe options.

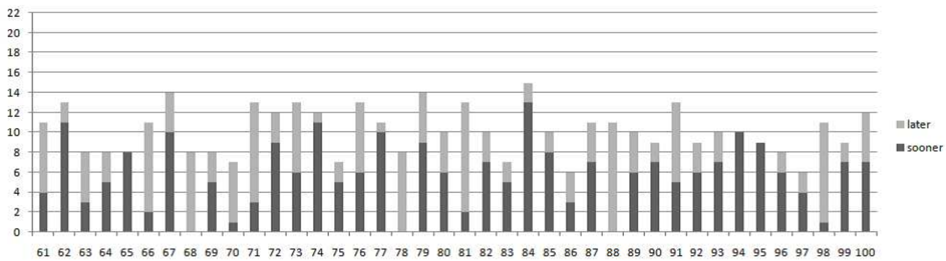

Figure 14: Numbers of sooner and later choices of individual 40 Type B problems in Treatment 2. For example, Problem 95 was performed by 10 participants, and all of them chose only sooner options.

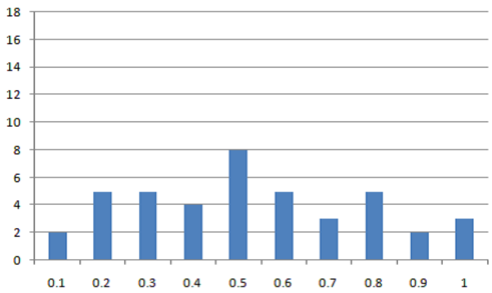

Figure 15: The distribution of P_{risky} of the individual participants in Treatment 2. For example, we observed 2 out of 42 participants, whose P_{risky} was less than 0.1.

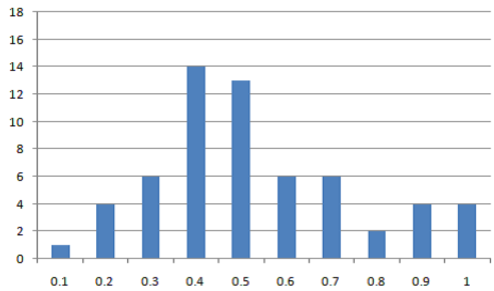

Figure 17: The distribution of P_{risky} of the individual Type A problems in Treatment 2. For example, 1 out of 60 Type A problems was observed, where P_{risky} was less than 0.1.

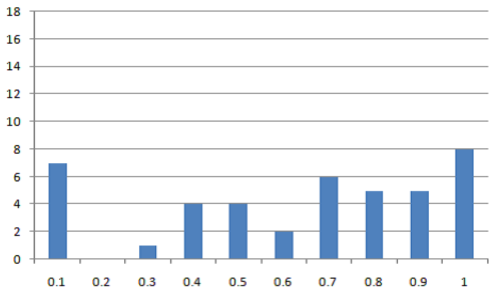

Figure 16: The distribution of P_{sooner} of the individual participants in Treatment 2. For example, we observed 8 out of 42 participants were observed, whose P_{sooner} was more than 0.9.

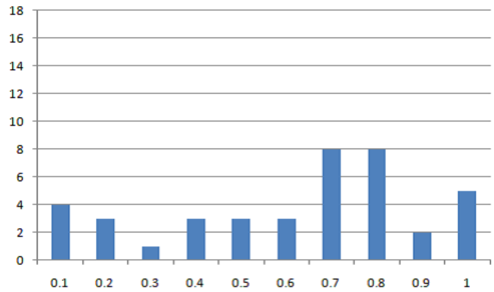

Figure 18: The distribution of P_{sooner} of the individual Type B problems in Treatment 2. For example, 1 out of 40 Type B problems was observed, where $0.2 < P_{sooner} \leq 0.3$.

4.4 Treatment 2: An Unfamiliar Music Treatment

4.4.1 Stimuli

The musical piece used in Treatment 2 as background music was a new song composed and arranged by the coauthor of the current paper, and used only for the experiment. In the treatment, only instrumental selections (e.g., piano) were employed. The song was arranged to piano solo score and performed by a virtual grand piano — the software synthesiser *Ivory Grand Pianos* standardised by VSTi that emulates "Boseudofer 290 Imperial Grand". No other particular artificial instruments were used, except for equipments for auditory correction (i.e., the equaliser, reverb and mastering effects). The music tempo was fixed as 120 bpm and loop was arranged for continuous experiment. Note that 1 loop is 1 minute and 4 seconds. The sound pressure of the 2 MIX source was normalised as -15 dB and its range is $-\infty$ dB to -0.1 dB (no clip). The format of sound source was 16 bits/44.1 kHz CD quality wave format without any compression. The average of note tone was D4; the highest note was F5 and; the lowest note was E1 (as chromatic scale). The density of notes was 250 notes per minute. Average velocity of note was 100 (highest: 127, lowest: 64). The volume of the music was maintained at a constant level with the headphones. The volume among each participant was all the same and fixed to proper loudness through the treatment continuously. Results of the questionnaires revealed that no participants expressed discomfort or distaste for the music played during the treatment.

4.4.2 Results

An overall P_{risky} was 0.49. The P_{risky} of individual participants is available in Appendix 2. Figure 11 presents numbers of risky and safe choices of individual participants in the treatment. We can see from the figure the existence of heterogeneity among the participants in behavioural tendencies in the treatment. For example, P_{risky} of some participants (e.g., Participant 19) was 100 percent; while P_{risky} of other participants (e.g., Participant 26) was less than 10 percent. Figure 15 presents the distribution of the individual P_{risky} in the treatment ($SD = 0.26$). The P_{risky} of individual 60 Type A problems is available in Appendix 4. Figure 13 presents numbers of risky and safe choices of individual problems in the treatment. Figure 17 presents the distribution of P_{risky} of the individual problems ($SD = 0.23$).

An overall P_{sooner} was 0.57. The P_{sooner} of individual participants is available in Appendix 3. Figure 12 presents numbers of sooner and later choices of individual participants in the treatment. We can see from the figure the existence of heterogeneity among the participants in behavioural tendencies in the treatment. For example, some participants (e.g., Participant 1) chose only sooner options, while others (e.g., Participant 16) chose only later options. Figure 16 presents the distribution of the individual P_{sooner} in the treatment ($SD = 0.34$). The P_{sooner} of individual 40 Type B problems is available in Appendix 5. Figure 14 presents numbers of sooner and later choices of individual problems in the treatment. Figure 18 presents the distribution of P_{sooner} of the individual problems ($SD = 0.29$). An overall proportion of rational choices made among Type C problems was 1.

4.4.3 Questionnaire Analysis

On completion of the treatment, the participants were asked to fill in a questionnaire that contained the same set of questions as Treatment 1.

Results of the questionnaire revealed the followings: First, self-reported familiarity level of the music on a 11-point scale (0=*not familiar with*; 10=*very much familiar with*) was extremely low ($Min = 0, Max = 6, M = 0.88, SD = 1.46$). Second, self-reported attention level on a 11-point scale (0=*no attention at all*; 10=*very much attention*) was moderate ($Min = 0, Max = 10, M = 5.79, SD = 3.03$). Third, self-reported music liking on a 11-point scale (0=*dislike very much*; 10=*like very much*) was high ($Min = 1, Max = 10, M = 7.40, SD = 1.79$). Fourth, self-reported influence of the music on decision-making behaviour on a 11-point scale (0=*to no extent*; 10=*to a very large extent*) was low ($Min = 0, Max = 10, M = 2.98, SD = 3.09$).

4.5 Treatment 3: Noise Treatment

4.5.1 Stimuli

The background sound used in Treatment 3 was "Gaussian white noise". The format of sound source was 16bits/44.1kHz CD quality wave format without any compression, thus the power of spectrum pattern was evenly at the range from 0 Hz to 22.1 kHz. The sound pressure was normalised as -20 dB, thus the wave form was slightly different from ideal wave form. An amplitude over bit range was cut off. The sound pressure was lower than the other music treatments. This is because the perception of this stimulus was higher than other musical stimulus and we feel more loudness under the same sound pressure. To avoid the participants' uncomfortableness, the level of the sound pressure of this stimulus was decreased, so that the participants would feel the stimulus was as loud as the stimulus used in the other two treatments. The sound pattern was evenly static across the treatment. No musical pieces were used in the treatment except white noise. The volume among each participant was all the same and fixed to proper loudness across the treatment. Results of the questionnaires revealed that no participants expressed discomfort or distaste for the noise played during the treatment.

4.5.2 Results

An overall P_{risky} was 0.54. The P_{risky} of individual participants is available in Appendix 2. Figure 19 presents numbers of risky and safe choices of individual participants in the treatment. We can see from the figure the existence of heterogeneity among the participants in behavioural tendencies in the treatment. For ex-

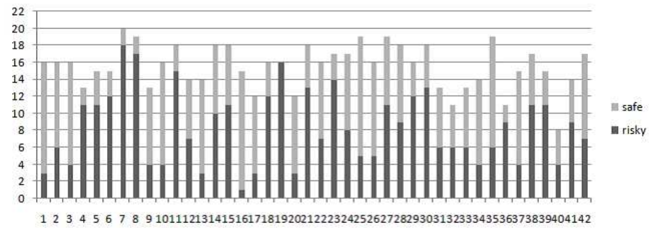

Figure 19: Numbers of risky and safe choices in Treatment 3. For example, Participant 16 was presented with 15 Type A choice problems, and chose risky options in 1 problem and safe options in 14 problems.

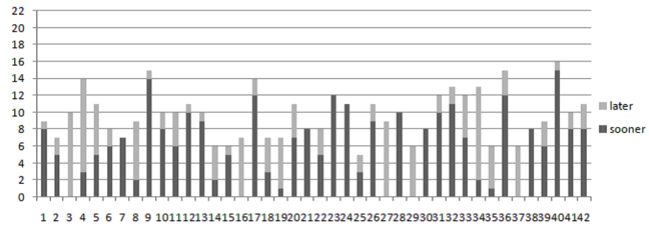

Figure 20: Numbers of sooner and later choices of individual participants in Treatment 3. For example, Participant 9 was presented with 15 Type B choice problems, and chose sooner options in 14 problems and later options in 1 problem.

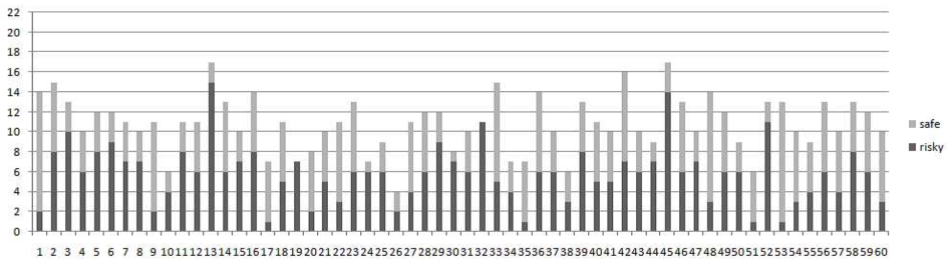

Figure 21: Numbers of risky and safe choices in individual 60 Type A problems in Treatment 3. For example, Problem 1 was performed by 14 participants and 2 of them chose risky options and 12 chose safe options.

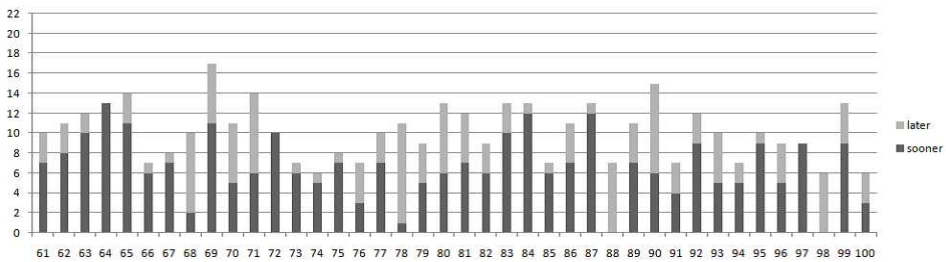

Figure 22: Numbers of sooner and later choices in individual 40 Type B problems in Treatment 3. For example, Problem 69 was performed by 17 participants, and 11 of them chose sooner options and 6 chose later options.

ample, P_{risky} of some participants (e.g., Participant 16) was extremely low; while P_{risky} of other participants (e.g., Participant 7) was high. Figure 23 presents the distribution of the individual P_{risky} in the treatment ($SD = 0.24$). The P_{risky} of individual 60 Type A problems is available in Appendix 4. Figure 21 presents numbers of risky and safe choices of individual problems in the treatment. Figure 25 presents the distribution of P_{risky} of the individual problems ($SD = 0.22$).

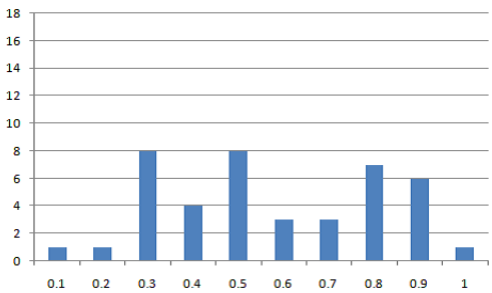

Figure 23: The distribution of P_{risky} of the individual participants in Treatment 3. For example, we observed 3 participants, whose P_{risky} is such that $0.5 < P_{risky} \leq 0.6$.

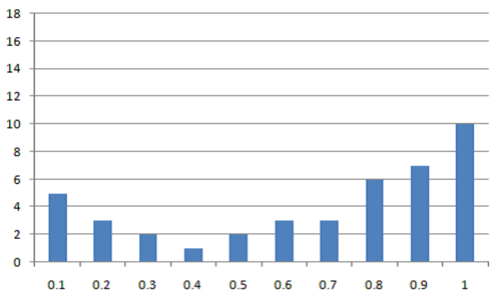

Figure 24: The distribution of P_{sooner} of the individual participants in Treatment 3. For example, we observed 3 participants, whose P_{risky} is such that $0.1 < P_{risky} \leq 0.2$.

An overall P_{sooner} was 0.65. The P_{sooner} of individual participants is available in Appendix 3. Figure 24 presents numbers of sooner and later choices of individual participants in the treatment. We can see from the figure the existence of heterogeneity among the participants in behavioural tendencies in the treatment. For example, some participants (e.g., Participant 23) chose only sooner options, while others

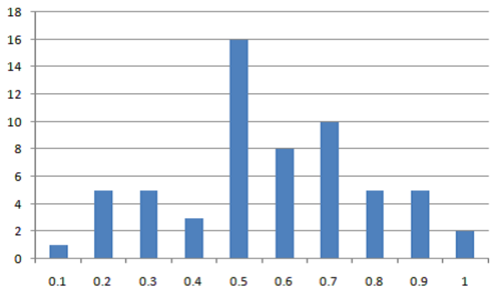

Figure 25: The distribution of P_{risky} of the individual Type A problems in Treatment 3. For example, 3 out of 60 Type A problems were observed, where $0.2 < P_{risky} \leq 0.3$.

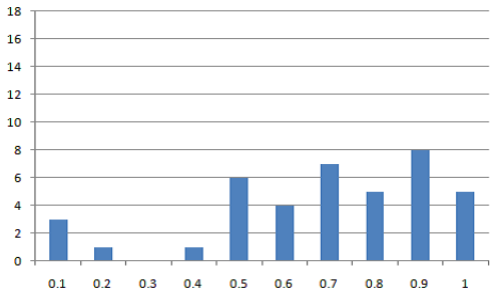

Figure 26: The distribution of P_{sooner} of the individual Type B problems in Treatment 3. For example, 1 out of 40 Type B problems was observed, where $0.1 < P_{sooner} \leq 0.2$.

(e.g., Participant 3) chose only later options. Figure 24 presents the distribution of the individual P_{sooner} in the treatment ($SD = 0.34$). The P_{sooner} of individual 40 Type B problems is available in Appendix 5. Figure 22 presents numbers of sooner and later choices of individual problems in the treatment. Figure 26 presents the distribution of P_{sooner} of the individual problems ($SD = 0.26$).

4.5.3 Questionnaire Analysis

On completion of the treatment, the participants were asked to fill in a questionnaire that contained questions: (1) How much attention did you pay to background sound during this treatment? (2) Do you like the sound presented during this treatment? (3) Do you think your decision-making behaviour was influenced by the sound? The questionnaire aimed to clarify the participants' perception of the noise, as

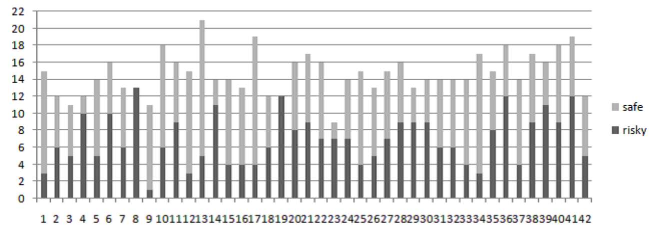

Figure 27: Numbers of risky and safe choices in Treatment 4. For example, Participant 13 was presented with 21 Type A choice problems, and chose risky options in 5 problem and safe options in 16 problems.

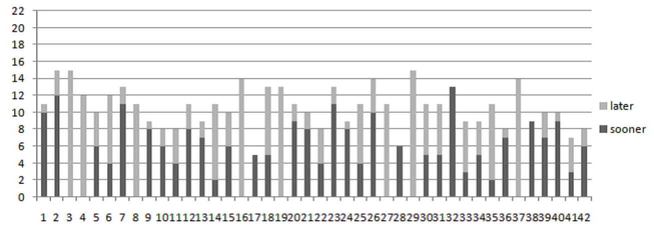

Figure 28: Numbers of sooner and later choices of individual participants in Treatment 4. For example, Participant 26 was presented with 14 Type B choice problems, and chose sooner options in 10 problems and later options in 4 problems.

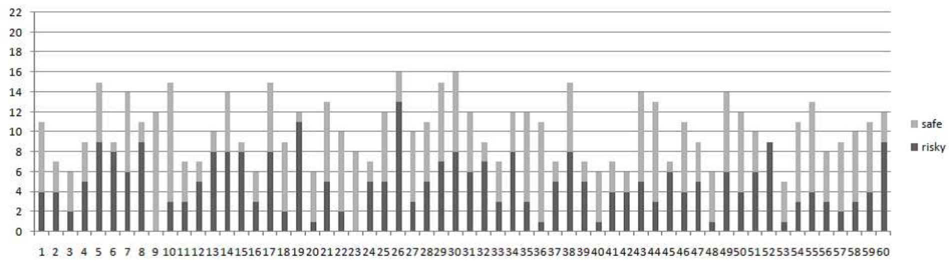

Figure 29: Numbers of risky and safe choices in individual 60 Type A problems in Treatment 4. For example, Problem 19 was performed by 12 participants and 11 of them chose risky options and 1 chose safe options.

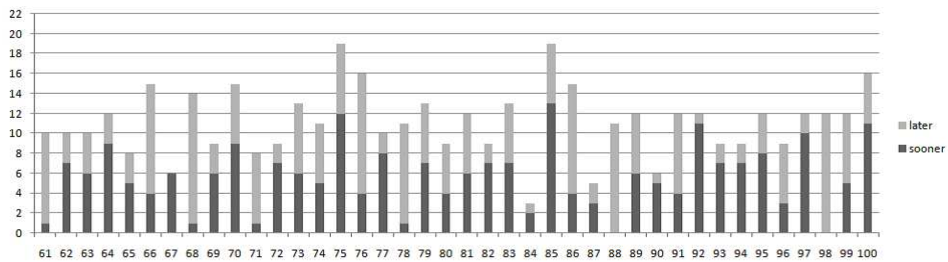

Figure 30: Numbers of sooner and later choices in individual 40 Type B problems in Treatment 4. For example, Problem 85 was performed by 19 participants, and 13 of them chose sooner options and 6 chose later options.

compared to perception of background music in Treatment 1 and 2.

Results of the questionnaire revealed the followings: First, self-reported attention level on a 11-point scale (0=*no attention at all*; 10=*very much attention*) was moderate ($Min = 0, Max = 10, M = 6.21, SD = 3.77$). Second, self-reported sound liking on a 11-point scale (0=*dislike very much*; 10=*like very much*) was extremely low ($Min = 0, Max = 8, M = 1.88, SD = 2.01$). Third, self-reported influence of the sound on decision-making behaviour on a 11-point scale (0=*to no extent*; 10=*to a very large extent*) was low ($Min = 0, Max = 10, M = 2.85, SD = 3.18$).

4.6 Treatment 4: No Music Treatment

4.6.1 Stimuli

No background music/sound was used in Treatment 4. The participants were asked to engage in choice tasks in the presence *neither* of background music *nor* of background sound.

4.6.2 Results

An overall P_{risky} was 0.48. The P_{risky} of individual participants is available in Appendix 2. Figure 27 presents numbers of risky and safe choices of individual participants in the treatment. We can see from the figure the existence of heterogeneity among the participants in behavioural tendencies in the treatment. For example, P_{risky} of some participants (e.g., Participant 9) was extremely low; while P_{risky} of other participants (e.g., Participant 8) was high. Figure 31 presents the distribution of the individual P_{risky} in the treatment ($SD = 0.21$). The P_{risky} of individual 60 Type A problems is available in Appendix 4. Figure 29 presents numbers of risky and safe choices of individual problems in the treatment. Figure 33 presents the distribution of P_{risky} of the individual problems ($SD = 0.24$).

An overall P_{sooner} was 0.6. The P_{sooner} of individual participants is available in Appendix 3. Figure 28 presents numbers of sooner and later choices of individual participants in the treatment. We can see from the figure the existence of heterogeneity among the participants in behavioural tendencies in the treatment. For example, some participants (e.g., Participant 32) chose only sooner options, while others (e.g., Participant 37) chose only later options. Figure 32 presents the distribution of the individual P_{sooner} in the treatment ($SD = 0.34$). The P_{sooner} of individual 40 Type B problems is available in Appendix 5. Figure 30 presents numbers of sooner and later choices of individual problems in the treatment. Figure 34 presents the distribution of P_{sooner} of the individual problems ($SD = 0.26$).

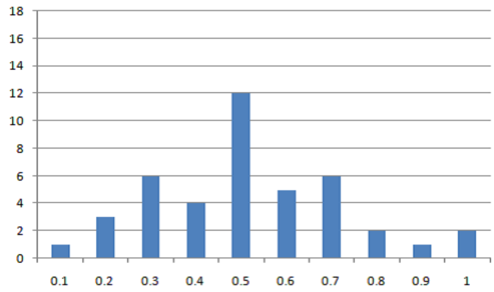

Figure 31: The distribution of P_{risky} of the individual participants in Treatment 4. For example, we observed 2 participants, whose P_{risky} is such that $0.7 < P_{risky} \leq 0.8$.

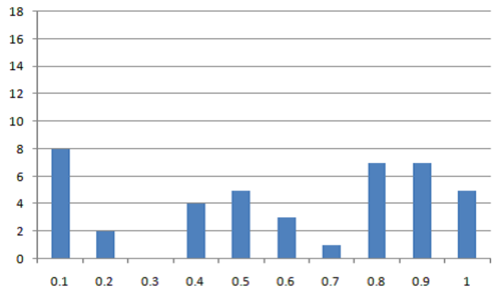

Figure 32: The distribution of P_{sooner} of the individual participants in Treatment 4. For example, we observed 1 participant, whose P_{risky} is such that $0.6 < P_{risky} \leq 0.7$.

4.6.3 Questionnaire Analysis

No questionnaire was given to the participant in this treatment.

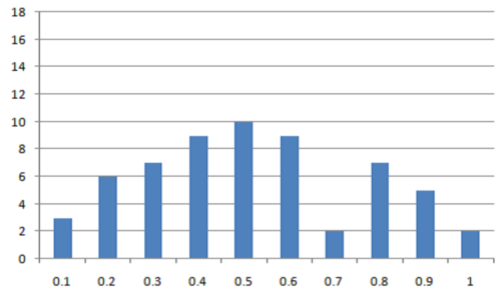

Figure 33: The distribution of P_{risky} of the individual Type A problems in Treatment 4. For example, 2 out of 60 Type A problems were observed, where $0.6 < P_{risky} \leq 0.7$.

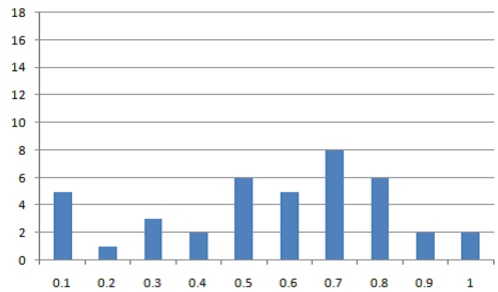

Figure 34: The distribution of P_{sooner} of the individual Type B problems in Treatment 4. For example, 2 out of 40 Type B problems was observed, where $0.8 < P_{sooner} \leq 0.9$.

Consider the bingo cage that contains 50 balls, each numbered from 1 to 50, and only one ball is drawn. An event X is where any ball numbered between 1 and 40 is drawn. An event Y is where any ball numbered between 41 and 50 is drawn.	Sure 3000 yen
Choose between # 4000 yen with probability 80% and; # Sure 3000 yen	4000 yen with probability 80%
Choose between # Sure 2000 yen today and; # Sure 2100 yen in one week	Sure 2000 yen today
Choose between # 400 yen with probability 80% and; # Sure 300 yen	400 yen with probability 80%
Choose between # Sure 1000 yen today and; # Sure 1050 yen in one week	Sure 1050 yen in one week

Figure 35: An example of five choice problems randomly selected by computer programmes and the participant's choices. The left column shows selected five choice problems and the right shows options chosen by her/him.

4.7 Payments to Participants

In the experiment, each participant engaged in four treatments, in each of which she/he responded to 30 pairwise choice problems. Thus, she/he responded to a total of 120 choice problems. Among all of 120 choice problems, only one choice problem was determined for which she/he was paid. The determination was made by the following steps:
Step 1: Once each participant completed all decision tasks in the last treatment, computer programmes randomly selected five out of 120 choice problems she/he had responded in the experiment. The selected five choice problems and options she/he had chosen were displayed on her/his computer screen, as shown in Figure 35.
Step 2: She/he was asked to choose one of the five problems. The experimenter announced that she/he could be paid for this one problem.
Step 3: This step was split into the following two different steps (i.e., Step 3-1 and 3-2), depending on a type of the choice problem chosen by her/him in Step 2 and the option of the problem chosen by her/him during the experiment.

Step 3-1: This step applied if the choice problem chosen in Step 2 involved a choice between a risky option (i.e., an option yielding an uncertain payoff) and a safe option (i.e., an option yielding a sure payoff), regardless of whether the choice problem was concerned with choice under risk or intertemporal choice.

If she/he had chosen the safe option, her/his payoff was immediately determined. Then, she/he was asked to remain seated until payment was ready. For example, if the choice problem chosen in Step 2 was to choose between a risky option that could yield 4000 yen with probability of 80% and a safe option that could yield a sure payoff of 3000 yen (i.e., the choice problems shown in the first and third raws in Figure 35), and she/he had chosen the safe option, her/his award amount was immediately determined. Then, she/he was informed that she/he could be given 3000 yen shortly.

On the other hand, if she/he had chosen the risky option, she/he was presented with an empty bingo cage and a set of numbered balls. Then, she/he was asked to put these numbered balls into the empty bingo cage, and draw one ball from the bingo cage. An outcome of the risky option was determined, according to the ball drawn. The composition of the bingo cage varied, depending on the choice problem and option she/he had chosen. The preparation of the bingo cage and balls was done in view of her/him, staff at KEEL and other participants.

For example, if she/he had chosen the risky option in the abovementioned choice problem, the experimenter prepared the empty bingo cage and balls numbered 1 through 50, and asked her/him to put these 50 balls into the empty bingo cage. Then, she/he was asked to choose and write down any ten numbers from 1 to 50 on a blackboard at the laboratory. Before asking her/him to draw one ball from the bingo cage, containing 50 balls, the experimenter informed her/him that she/he could be given 4000 yen if any of the balls that carried numbers you chose and wrote down on the blackboard was *not* drawn, and no money, otherwise.

Step 3-2: This step applied if the choice problem she/he chose in Step 2 involved an incentive scheme that payments could be made in the future (e.g., one week after the experiment). We employed Japanese practice of using "registered mail for cash" to send her/him a cash payoff, if she/he was to receive deferred payments. Postage costs were borne by the experimenter. For example, if the choice problem was to choose between "a sure payoff of 1000 yen today" and "a sure payoff of 1050 yen in one week", and her/his choice was the latter, then 1050 yen was received by registered mail one week after the experiment.

5 General Discussion

5.1 Behavioural Tendencies in the Presence of Background Noise

A perusal of previous studies renders to what extent background noise affects the decision makers' performance. Some (e.g., Ellermeier and Hellbrück, 1998; Jones, Miles and Page, 1990; Abikoff, Courtney, Szeibel and Koplewicz, 1996; Salamé and Baddeley, 1987) showed that background noise does not affect cognitive performance. Others, however, provided an account for noise-induced improvement (e.g., Usher and Feingold, 2000; Söderlund and Smart, 2007; Baker and Holding, 1993; Zentall and Shaw, 1980) and noise-induced deterioration in cognitive performance (e.g., Schlittmeier and Hellbrück, 2009; Cassidy and MacDonald, 2007; Hygge, Evans and Bullinger, 2002; Ylias and Heaven, 2003).

The results of the current experiment confirm that background noise affects performance in decision making under risk and intertemporal decision making.

On the one hand, we observed increased proclivity towards risk-taking behaviour in Type A problems in the presence of background noise, compared to the other background music/sound. Figure 36 shows an overall P_{risky} in each treatment. We found a significant difference in the participants' performance in the presence of noise (i.e., in Treatment 3), compared to silence (i.e., in Treatment 4), when they made choice under risk. An overall P_{risky} in Treatment 3 and that in Treatment 4 were 0.54 and 0.48, respectively. The difference between these two proportions was statistically significant ($\chi^2(1) = 5.21, p < 0.05$), though there is no statistical difference among hole four treatments ($\chi^2(3) = 5.43, p > 0.05$).

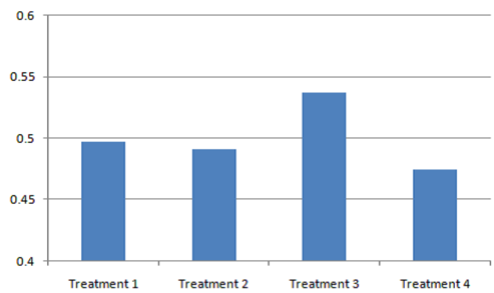

Figure 36: An overall P_{risky} in each treatment

On the other hand, the current results indicate a behavioural tendency that the sooner options were more opted by the participants in Treatment 3 (i.e., in the presence of back-

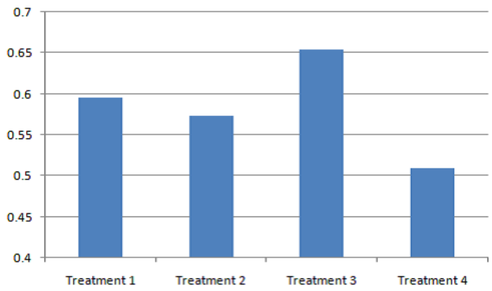

Figure 37: An overall P_{sooner} in each treatment

ground noise), compared to the other three treatments. Figure 37 that shows an overall P_{sooner} in each treatment. A significant difference was observed in the participants' performance in the presence of noise, compared to silence, when they made choice between a sooner option and later option. An overall P_{sooner} was statistically different across all of the four treatments ($\chi^2(3) = 19.18, p < 0.001$). Much attention is given here to a comparison of an overall P_{sooner} in Treatment 3 and that in Treatment 4: P_{sooner} in the former treatment and the latter were 0.65 and 0.51, respectively. The difference between these two proportions was statistically significant ($\chi^2(1) = 18.66, p < 0.001$), though there was no statistical difference between: (1) P_{sooner} in Treatment 1 and 3 ($\chi^2(1) = 3.58, p > 0.1$) and; (2) P_{sooner} in Treatment 1 and 4 ($\chi^2(1) = 3.15, p > 0.1$).

5.2 Observed and Predicted Behavioural Tendencies

Figure 38 shows the number of the participants (X-axis) and the level of P_{risky} (Y-axis) across the four treatment sorted in an ascending order. The predicted risky choices refer to the prediction of P_{risky} of individual participants, assuming that they randomly select options in 60 Type A problems. The observed risky choices refer to the observed P_{risky} of the individual participants across the four treatments. The difference between the predicted and observed risky choices (P_{risky}) is statistically significant ($\chi^2(1) = 10.71, p < 0.01$). If subjects randomly select options in 60 problems by fifty-fifty, the prediction of P_{risky} would be according to binomial distribution. So that, for example the posibility of the ($P_{risky} > 0.9$

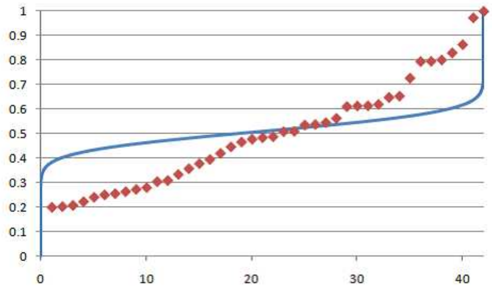

Figure 38: Predicted and observed each participant's P_{risky} across the four treatments sorted in an ascending order. The solid line corresponds to the prediction of P_{risky} across 42 participants. The dotted line corresponds to the observed P_{risky} across 42 participants. For example, from the prediction, we would see only two out of 42 participants, whose P_{risky} less than 0.4; while we observed 16 participants in the experiment (i.e., across the four treatments).

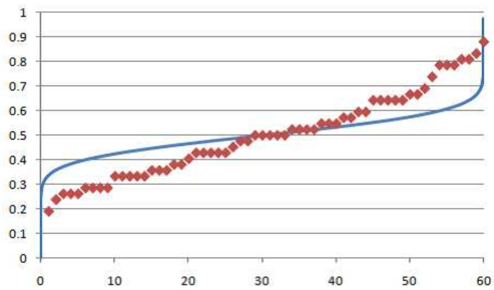

Figure 39: Predicted and observed P_{risky} of individual Type A problems across the four treatments sorted in an ascending order. The solid line corresponds to the prediction of P_{risky} across 60 Type A problems. The dotted line corresponds to the observed P_{risky} across 60 Type A problems. For example, from the prediction, we would see that the risky option should be chosen in 54 out of 60 Type A problems. Yet, we observed in the experiment that the risky option was chosen only in 44 problems.

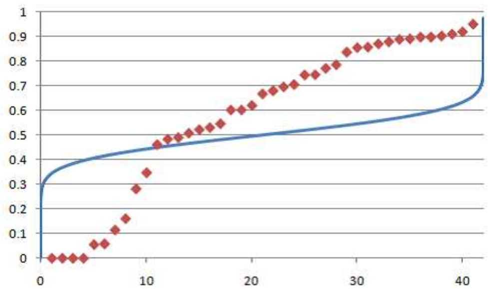

Figure 40: Predicted and observed each participant's P_{sooner} across the four treatments sorted in an ascending order. The solid line corresponds to the prediction of P_{sooner} across 42 participants. The dotted line corresponds to the observed P_{sooner} across 42 participants. For example, from the prediction, we would see 38 out of 42 participants, whose P_{sooner} is less than 0.6; while we observed only 17 participants in the experiment (i.e., across the four treatments).

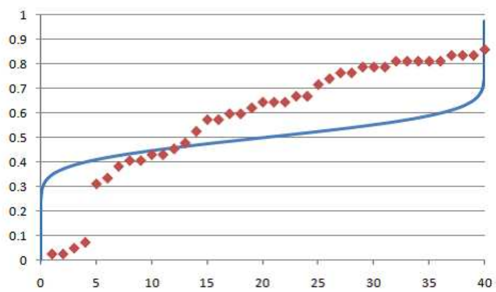

Figure 41: Predicted and observed P_{sooner} of individual problems across the four treatments sorted in an ascending order. The solid line corresponds to the prediction of P_{sooner} across 40 Type B problems. The dotted line corresponds tothe observed P_{sooner} across 40 Type B problems. For example, from the prediction, we would see that the sooner option should be chosen in 20 out of 40 Type B problems. Yet, we observed in the experiment that the sooner option was chosen only in 13 problems.

would be extreamly lower than observation. Or even if there are some particular priority or characteristics in the problems, for example choice between 1 percent to win 1000 and sure as 100 yen, average might be changed but it can not be the reason of this large distribution. We can also see the tendency of the heterogeneity in each histgrams like as Figure 9. These kind of distribution cannot explain by ordinaly approach which are using statistics.

Figure 39 shows the number of Type A problems (X-axis) and the level of P_{risky} (Y-axis) across the four treatment sorted in an ascending order. The predicted risky choices refer to the prediction of P_{risky} of individual Type A problems, assuming that risky and safe options are selected randomly. The observed risky choices refer to the observed P_{risky} of the individual problems across the four treatments. The difference between predicted and observed risky choices (P_{risky}) is statistically significant ($\chi^2(1) = 15.50, p < 0.01$). Also in this results, if 42 subjects randomly selected the options in each problems by fifty-fifty, the prediction of P_{risky} would be according to binomial distribution. So that, for example the posibility of the ($P_{risky} > 0.9$ would be extreamly lower than observation. In this case, the differencies of the problem characteristics appear to the results. For example, comparison between problem 2 and problem 6. These two kinds of problems has the same pay off amount on the case of win, and only the probability scale is different. Howevere there is significantly difference of total ration between these results. So in this distribution, there are more complicated mechanism underlying.

Figure 40 shows the number of the participants (X-axis) and the level of P_{sooner} (Y-axis) across the four treatment sorted in an ascending order. The predicted sooner choices refer to the prediction of P_{sooner} of individual participants, assuming that they randomly select options in 40 Type B problems. The observed sooner choices refer to the observed P_{sooner} of the individual participants across the four treatments. The difference between the predicted and observed sooner choices (P_{sooner}) is statistically significant ($\chi^2(1) = 12.25, p < 0.01$). If subjects randomly select options in 60 problems by fifty-fifty, the prediction of P_{risky} would be according to binomial distribution. So that, for example the posibility of the

($P_{risky} > 0.9$ would be extreamly lower than observation. These results are all about type B problems, so its mechanism would be different from results of type A problem. However in these results, the tendency of the heterogeneity could be observed in wide range. Some participants selected only later choice and some participants selected only sooner choice, though there are 0.1 percent to more than 1 percent interest per day.

Figure 41 shows the number of the problems (X-axis) and the level of P_{sooner} (Y-axis) across the four treatment sorted in an ascending order. The predicted sooner choices refer to the prediction of P_{sooner} of individual Type B problems, assuming that sooner and later options are selected randomly. The observed sooner choices refer to the observed P_{sooner} of individual Type B problems across the four treatments. The difference between predicted and observed sooner choices (P_{sooner}) is statistically significant ($\chi^2(1) = 13.33, p < 0.01$). Also in this results, if 42 subjects randomly selected the options in each problems by fifty-fifty, the prediction of P_{risky} would be according to binomial distribution. So that, for example the posibility of the ($P_{risky} > 0.9$ would be extreamly lower than observation. In this case, the differencies of the problem characteristics appear to the results. Some problems are very similar pay off in spite of longer delay, and some problems are 1 percent different pay off with only 1 day delay.

6 Concluding Remarks

There have been behavioural outcomes of music in marketing (e.g. Alpert and Alpert, 1988; Gorn, 1982; Milliman, 1982; Park and Young, 1986; Simpkins and Smith, 1974) and in psychology (e.g. Iwanaga and Ito, 2002; Sundstrom and Sundstrom, 1986; Wolf and Weiner, 1972). However no attempts have been made by experimental economists to examine effects of music in economics decision making. With a toolset of experimental economics, this paper has investigated to what extent background music affects the DMs, who engage in decision making under risk and intertemporal decision making. The investigation has been conducted along with the assertion that music can affect human emotion and their behaviour, and is a way for us to make behaviour either powerful or less powerful.

It should be noted here that this paper has not discussed the effect of "levels" of noise. In the current experiment, level of noise was fixed and set at -20 dB. Different authors, however, used different levels of noise in their experiments, involving tasks (e.g., 62 dB and 78 dB in Carlson, Rama, Artchakov and Linnankoski (1997), 90dB in Baker and Holding (1993)). It is of importance to investigate the effects on levels of noise presented to the decision makers during choice tasks. On the one hand, low levels of noise may improve performance (Alain, Quan, McDonald and Van Roon, 2009). Zentall and Shaw (1980) showed that high levels of noise (i.e., 69dB) were detrimental though low levels (i.e., 64dB) were not. On the other hand, in their experiment conducted by Söderlund and coauthors (Söderlund and Smart, 2007), they fixed and set level of noise at 80dB and 81dB and their results showed on noise can benefit performance. To claim that level of noise is one of key determinants that affect behaviour in decision tasks that involve choice under risk and intertemporal choices, one may conduct relevant experiments, varying levels of noise to be presented to the participants.

Findings from the current paper will contribute to us to decide what background sound to employ when people engage in decision making. Deciding right background sound in a particular decision task is crucial, as wrong background sound can produce effects that totally neglect the objective of the exercise (Milliman, 1982). Thus, the findings can help managers interested in influencing behaviour of employees and consumers. It can also help bankers interested in influencing behaviour of investors, that is, interested in inducing the investors to buy low-risk assets (e.g., government bonds) and high-risk assets (e.g., mutual funds).

References

Abikoff, H., M. E. Courtney, P. J. Szeibel, and H. S. Koplewicz (1996) "The Effects of Auditory Stimulation on the Arithmetic Performance of Children with ADHD and Nondisabled Children," *Journal of Learning Disabilities*, Vol. 29, pp. 238–246.

Alain, C., J. Quan, K. McDonald, and P. Van Roon (2009) "Noise-induced Increase in Human Auditory Evoked Neuromagnetic Fields," *European Journal of Neuroscience*, Vol. 30, pp. 132–142.

Allais, M. (1953) "Le Comportement de l'Homme Rationnel devant le Risque: Critique des Postulats et Axiomes de l'Ecole Americaine," *Econometrica*, Vol. 21, pp. 503–546.

Alpert, J. I. and M. I. Alpert (1988) "Background Music as an Influence in Consumer Mood and Advertising Responses," in T. K. Scrull ed. *Advances in Consumer Research*, Honolulu: Association for Consumer Research, pp. 485–491.

Andrade, P. E. (2004) "Uma abordagem evolutionària e neuroscientifica da mùsica (Evolutionary and neuroscientific approach to music)," *Neurosciéncias*, Vol. 1, pp. 24–33.

Baker, M. A. and D. H. Holding (1993) "The Effects of Noise and Speech on Cognitive Task Performance," *Journal of General Psychology*, Vol. 120, pp. 339–355.

Baumgartner, H. (1992) "Remembrance of things past: Music, autobiographical memory, and emotion," *Advances in Consumer Research*, Vol. 19, pp. 613–620.

Beament, J. (2001) *How we hear music: The relationship between music and the hearing mechanism*, Woodbridge, UK: Boydell and Brewer.

Brayfield, A. H. and W. H. Crockett (1955) "Employee Attitudes and Employee Performance," *Psychological Bulletin*, Vol. 52, pp. 396–424.

Bruner, II, Gordon C. (1990) "Music, Mood, and Marketing," *Journal of Marketing*, Vol. 54, pp. 94–104.

Carlson, S., P. Rama, D. Artchakov, and I. Linnankoski (1997) "Effects of Music and White Noise on Working Memory Performance in Monkeys," *Neuroreport*, Vol. 8, pp. 2853–2856.

Cassidy, G. and R. A. R. MacDonald (2007) "The Effect of Background Music and Background Noise on the Task Performance of Introverts and Extraverts," *Psychology of Music*, Vol. 35, pp. 517–537.

Corhan, C. M. and B. R. Gounard (1976) "Types of Music, Schedules of Background Stimulation, and Visual Vigilance Performance," *Peceptual and Motor Skills*, Vol. 42, p. 662.

Ellermeier, W. and J. Hellbrück (1998) "Is Level Irrelevant in 'Irrelevant Speech'? Effects of Loudness, Signal-to-noise Ratio, and Binaural Unmasking," *Journal of Experimental Psychology: Human Perception and Performance*, Vol. 24, pp. 1406–1414.

Frederick, S. and G. Loewenstein (2002) "Time Discounting and Time Preference: A Critical Review," *Journal of Economic Literature*, Vol. 40, pp. 351–401.

Gabrielsson, A. (2001) "Emotions in strong experiences with music," in P. N. Juslin and J. A. Sloboda eds. *Music and emotion: Theory and research*, Oxford: Oxford University Press, pp. 431–449.

Gorn, G. J. (1982) "The Effects of Music in Advertising on Choice Behavior: A lassical Conditioning Approach," *Journal of Marketing*, Vol. 46, pp. 94–101.

Green, L., N. Fristoe, and J. Myerson (1994) "Temporal Discounting and Preference Reversals in Choice Between Delayed Outcomes," *Psychonomic Bulletin and Review*, Vol. 1, pp. 383–389.

Hilliard, O. M. and Philip Tolin (1979) "Effects of Familiarity with Background Music on Performance of Simple and Difficult Reading Comprehension Tasks," *Perceptual and Motor Skills*, Vol. 49, pp. 713–714.

Hygge, S., G. W. Evans, and M. Bullinger (2002) "A Prospective Study of Some Effects of Aircraft Noise on Cognitive Performance in Schoolchildren," *Psychological Science*, Vol. 13, pp. 469–474.

Iwanaga, M. and T. Ito (2002) "Disturbance effect of music on processing of verbal and spatial memories," *Perceptual Motor Skills*, Vol. 94, pp. 1251–1258.

Iyer, P. (2006) "The Cuddliest Hero in Asia," Retrieved from *Time (Asia)* on 4 April, 2010, `http://www.time.com/time/asia/features/heroes/doraemon.html`.

Jacob, J. (1968) "Work Music and Morale: A Neglected but Important Relationship," *Personnel Journal*, Vol. 47, pp. 882–886.

Jones, D. M., C. Miles, and J. Page (1990) "Disruption of Proofreading by Irrelevant Speech: Effects of Attention, Arousal or Memory?" *Applied Cognitive Psychology*, Vol. 4, pp. 89–108.

Juslin, P. N. and S. Liljeström (in press) "How does music evoke emotions? Exploring the underlying mechanisms," in P. N. Juslin and J. A. Sloboda eds. *Handbook of music and emotion: Theory, research, applications*, Oxford: Oxford University Press.

Juslin, P. N. and D. Västfjäll (2008) "Emotional responses to music: The need to consider underlying mechanisms," *Behavioral and Brain Sciences*, Vol. 31, pp. 559–621.

Juslin, P. N., P. Laukka, S. Liljeström, D. Västfjäll, and Lundqvist, L.-O. (submitted) "A representative survey study of emotional reactions to music."

Kahneman, Daniel and Amos Tversky (1979) "Prospect Theory: An Analysis of Decision under Risk," *Econometrica*, Vol. 47, pp. 23–53.

Kirby, K. N. and R. J. Herrenstein (1995) "Preference Reversals due to Myopic Discounting of Delayed Reward," *Psychological Science*, Vol. 6, pp. 83–89.

McGehee, W. and J. Gardner (1949) "Music in a Complex Indutrial Job," *Personnel Psychology*, Vol. 2, pp. 405–417.

McKerchar, T. L, L. Green, J. Myerson, T. S. Pickford, J. C. Hill, and S. C. Stout (2009) "A Comparison of Four Models of Delay Discounting in Humans," *Behavioural Processes*, Vol. 81, pp. 256–259.

Millar, A. and D. Navarick (1984) "Self-Control and Choice in Humans: Effects of Video Game Playing as a Positive Reinforcer," *Learning and Motivation*, Vol. 15, pp. 203–218.

Milliman, R. E. (1982) "The Influence of Background Music on the Behavior of Restaurant Patrons," *Journal of Consumer Research*, Vol. 13, pp. 286–289.

Mowsesian, R. and M. Heyer (1973) "The effect of music as a distraction on test-taking performance," *Measurement and Evaluation in Guidance*, Vol. 6, pp. 104–110.

Park, C. W. and S. M. Young (1986) "Consumer Response to Television Commercials: The Impact of Involvement and Background Music on Brand Attitude Formation," *Journal of Marketing Research*, Vol. 23.

Rauscher, F. H., G. L. Shaw, and K. N. Ky (1993) "Music and Spatial Task-performance," *Nature*, Vol. 365, p. 611.

Salamé, P. and A. D. Baddeley (1982) "Disruption of Short-term Memory by Unattended Speech: Implications for the structure of Working Memory," *Journal of Verbal Learning and Berbal Behavior*, Vol. 21, pp. 150–164.

——— (1987) "Noise, Unattended Speech and Short-term Memory," *Ergonomics*, Vol. 30, pp. 1185–1194.

Samuelson, P. A. (1937) "A Note on Measurement of Utility," *Review of Economic Studies*, Vol. 4, pp. 155–161.

Schlittmeier, S. J. and J. Hellbrück (2009) "Background Music as Noise Abatement in Open-Plan Of?ces: A Laboratory Study on Performance Effects and Subjective Preferences," *Applied Cognitive Psychology*, Vol. 23, pp. 684–697.

Simpkins, J. D. and J. A. Smith (1974) "Effects of Music on Source Evaluations," *Journal of Broadcasting*, Vol. 18, pp. 361–367.

Sloboda, J. A. (1992) "Empirical studies of emotional response to music," in M. Riess-Jones and S. Holleran eds. *Cognitive bases of musical communication*, New York: Americarn Psychological Association, pp. 33–46.

Sloboda, J. A. and S. A. O'Neill (2001) "Emotions in everyday listening to music," in P. N. Juslin and J. A. Sloboda eds. *Music and emotion: Theory and research*, Oxford: Oxford University Press, pp. 415–429.

Smith, H. C. (1947) "Mucis in Relation to Employee Attitudes, Piecework, Production and industrial Accidents," *Applied Psychology Monographs*, Vol. 14, p. 55.

Söderlund, S., G.and Sikström and A. Smart (2007) "Listen to the Noise: Noise is Beneficial for Cognitive Performance in ADHD," *Journal of Child Psychology and Psychiatry*, Vol. 48, pp. 840–847.

Solnick, J., C. Kannenberg, D. Eckerman, and W. Waller (1980) "An Experimental Analysis of Impulsivity and Impulse Control in Humans," *Learning and Motivation*, Vol. 11, pp. 61–77.

Sundstrom, E. and M. G. Sundstrom (1986) *Work places: the psychology of the physical environment in office and factories*, New York: Cambridge University Press.

Takahashi, T. (2009) "Theoretical Frameworks for Neuroeconomics of Intertemporal Choice," *Journal of Neuroscience, Psychology, and Economics*, Vol. 2, pp. 75–90.

Uhrbrock, R. S. (1961) "Music on the Job: Its Influence on Worker Morale and Production," *Personell Psychology*, Vol. 14, pp. 9–38.

Usher, M. and M. Feingold (2000) "Stochastic Resonance in the Speed of Memory Retrieval," *Biological Cybernetics*, Vol. 83, pp. L11–16.

von Neumann, John and Oskar Morgenstern (1944) *Theory of Games and Economic Behavior*, New Jersey: Princeton University Press.

Wolf, R. H. and F. F. Weiner (1972) "Effects of four noise conditions on arithmetic performance," *Perceptual and Motor Skills*, Vol. 35, pp. 928–930.

Ylias, G. and P. C. L. Heaven (2003) "The Influence of Distraction on Reading Comprehension: A Big Five Analysis," *Personality and Individual Differences*, Vol. 34, pp. 1069–1079.

Zentall, S. S. and J. H. Shaw (1980) "Effects of Classroom Noise on Performance and Activity of Second-grade Hyperactive and Control Children," *Journal of Educational Psychology*, Vol. 72, pp. 830–840.

Zhang, Jiajie, Todd R. Johnson, and Hongbin Wan (1998) "The Relation Between Order Effects and Frequency Learning in Tactical Decision Making," *Thinking and Reasoning*, Vol. 4, pp. 123–145.

Appendix 1

Summary of the payoff structure of choice problems. For example, Problem 61 involved a choice between Option A yielding the present 5000 yen and Option B yielding 5500 yen in seven days; while Problem 103 involved a choice between Option A yielding a 50 % chance of winning present 2000 yen and Option B yielding a 50 % chance of winning present 1000 yen.

	Option A				Option B				
Problem	win	lose	probability of winning	delay	win	lose	probability of winning	delay	category
1	8000	0	0.4	0	3000	0	1	0	A
2	4000	0	0.8	0	3000	0	1	0	A
3	3200	0	0.2	0	400	0	0.8	0	A
4	2200	0	0.5	0	1000	0	1	0	A
5	2000	0	0.4	0	1200	0	0.6	0	A
6	4000	0	0.2	0	3000	0	0.25	0	A
7	3200	0	0.1	0	300	0	1	0	A
8	4000	0	0.8	0	3000	0	1	0	A
9	5000	0	0.2	0	1000	0	1	0	A
10	5000	0	0.5	0	2500	0	1	0	A
11	400	0	0.8	0	300	0	1	0	A
12	3200	0	0.1	0	300	0	1	0	A
13	4000	0	0.2	0	3000	0	0.25	0	A
14	7200	0	0.4	0	2700	0	1	0	A
15	3600	0	0.8	0	2700	0	1	0	A
16	2880	0	0.2	0	360	0	0.8	0	A
17	1980	0	0.5	0	900	0	1	0	A
18	1800	0	0.4	0	1080	0	0.6	0	A
19	3600	0	0.2	0	2700	0	0.25	0	A
20	2880	0	0.1	0	270	0	1	0	A
21	3600	0	0.8	0	2700	0	1	0	A
22	4500	0	0.2	0	900	0	1	0	A
23	4500	0	0.5	0	2250	0	1	0	A
24	360	0	0.8	0	270	0	1	0	A
25	2880	0	0.1	0	270	0	1	0	A

26	3600	0	0.2	0	2700	0	0.25	0	A
27	6400	0	0.4	0	2400	0	1	0	A
28	3200	0	0.8	0	2400	0	1	0	A
29	2560	0	0.2	0	320	0	0.8	0	A
30	1760	0	0.5	0	800	0	1	0	A
31	1600	0	0.4	0	960	0	0.6	0	A
32	3200	0	0.2	0	2400	0	0.25	0	A
33	2560	0	0.1	0	240	0	1	0	A
34	3200	0	0.8	0	2400	0	1	0	A
35	4000	0	0.2	0	800	0	1	0	A
36	4000	0	0.5	0	2000	0	1	0	A
37	320	0	0.8	0	240	0	1	0	A
38	2560	0	0.1	0	240	0	1	0	A
39	3200	0	0.2	0	2400	0	0.25	0	A
40	5600	0	0.4	0	2100	0	1	0	A
41	2800	0	0.8	0	2100	0	1	0	A
42	2240	0	0.2	0	280	0	0.8	0	A
43	1540	0	0.5	0	700	0	1	0	A
44	1400	0	0.4	0	840	0	0.6	0	A
45	2800	0	0.2	0	2100	0	0.25	0	A
46	2240	0	0.1	0	210	0	1	0	A
47	2800	0	0.8	0	2100	0	1	0	A
48	3500	0	0.2	0	700	0	1	0	A
49	3500	0	0.5	0	1750	0	1	0	A
50	280	0	0.8	0	210	0	1	0	A
51	2240	0	0.1	0	210	0	1	0	A
52	2800	0	0.2	0	2100	0	0.25	0	A
53	2000	0	0.4	0	1000	0	0.8	0	A
54	1900	100	0.5	0	1000	0	1	0	A
55	1800	0	0.4	0	900	0	0.8	0	A
56	1710	90	0.5	0	900	0	1	0	A
57	1600	0	0.4	0	800	0	0.8	0	A
58	1520	80	0.5	0	800	0	1	0	A

59	1400	0	0.4	0	700	0	0.8	0	A
60	1330	70	0.5	0	700	0	1	0	A
61	5000	0	1	0	5500	0	1	7	B
62	5000	0	1	0	5005	0	1	1	B
63	5000	0	1	0	5050	0	1	1	B
64	5000	0	1	0	5010	0	1	7	B
65	5000	0	1	0	5020	0	1	14	B
66	5000	0	1	0	5500	0	1	14	B
67	5000	0	1	0	5050	0	1	30	B
68	1000	0	1	7	2000	0	1	14	B
69	1000	0	1	7	1100	0	1	30	B
70	5000	0	1	0	5500	0	1	30	B
71	4500	0	1	0	4950	0	1	7	B
72	4500	0	1	0	4504	0	1	1	B
73	4500	0	1	0	4545	0	1	1	B
74	4500	0	1	0	4509	0	1	7	B
75	4500	0	1	0	4518	0	1	14	B
76	4500	0	1	0	4950	0	1	14	B
77	4500	0	1	0	4545	0	1	30	B
78	900	0	1	7	1800	0	1	14	B
79	900	0	1	7	990	0	1	30	B
80	4500	0	1	0	4950	0	1	30	B
81	4000	0	1	0	4400	0	1	7	B
82	4000	0	1	0	4004	0	1	1	B
83	4000	0	1	0	4040	0	1	1	B
84	4000	0	1	0	4008	0	1	7	B
85	4000	0	1	0	4016	0	1	14	B
86	4000	0	1	0	4400	0	1	14	B
87	4000	0	1	0	4040	0	1	30	B
88	800	0	1	7	1600	0	1	14	B
89	800	0	1	7	880	0	1	30	B
90	4000	0	1	0	4400	0	1	30	B
91	3500	0	1	0	3850	0	1	7	B

92	3500	0	1	0	3503	0	1	1	B
93	3500	0	1	0	3535	0	1	1	B
94	3500	0	1	0	3507	0	1	7	B
95	3500	0	1	0	3514	0	1	14	B
96	3500	0	1	0	3850	0	1	14	B
97	3500	0	1	0	3535	0	1	30	B
98	700	0	1	7	1400	0	1	14	B
99	700	0	1	7	770	0	1	30	B
100	3500	0	1	0	3850	0	1	30	B
101	2000	0	1	0	1000	0	1	0	C
102	1000	0	1	0	500	0	1	0	C
103	2000	0	0.5	0	1000	0	0.5	0	C
104	2000	0	1	0	500	0	1	0	C
105	1800	0	1	0	900	0	1	0	C
106	900	0	1	0	450	0	1	0	C
107	1800	0	0.5	0	900	0	0.5	0	C
108	1800	0	1	0	450	0	1	0	C
109	1600	0	1	0	800	0	1	0	C
110	800	0	1	0	400	0	1	0	C
111	1600	0	0.5	0	800	0	0.5	0	C
112	1600	0	1	0	400	0	1	0	C
113	1400	0	1	0	700	0	1	0	C
114	700	0	1	0	350	0	1	0	C
115	1400	0	0.5	0	700	0	0.5	0	C
116	1400	0	1	0	350	0	1	0	C
117	2000	0	0.5	0	2000	0	0.6	0	C
118	1800	0	0.5	0	1800	0	0.6	0	C
119	1600	0	0.5	0	1600	0	0.6	0	C
120	1400	0	0.5	0	1400	0	0.6	0	C

Appendix 2

The P_{risky} of individual 42 participants. The right hand columns show the individual P_{risky}, and numbers of risky and safe choices chosen in each treatment. For example, Participant 4 in Treatment 1 was presented with 17 Type A choice problems, and chose only risky options in all of 17 problems. On the other hand, Participant 42 in Treatment 4 was presented with 12 Type A choice problems, and chose risky options in 5 problems and safe options in 7 problems.

	Treatment 1			Treatment 2			Treatment 3			Treatment 4		
Participant	risky	safe	P_{risk}	risky	safe	P_{risk}	risky	safe	P_{risk}	risky	safe	P_{risk}
1	2	13	0.13	4	10	0.29	3	13	0.19	3	12	0.20
2	6	14	0.30	2	10	0.17	6	10	0.38	6	6	0.50
3	4	13	0.24	3	13	0.19	4	12	0.25	5	6	0.45
4	17	0	1.00	14	4	0.78	11	2	0.85	10	2	0.83
5	10	5	0.67	8	8	0.50	11	4	0.73	5	9	0.36
6	7	7	0.50	8	7	0.53	12	3	0.80	10	6	0.63
7	14	0	1.00	11	2	0.85	18	2	0.90	6	7	0.46
8	14	0	1.00	14	0	1.00	17	2	0.89	13	0	1.00
9	5	13	0.28	4	14	0.22	4	9	0.31	1	10	0.09
10	7	4	0.64	7	8	0.47	4	12	0.25	6	12	0.33
11	4	8	0.33	6	8	0.43	15	3	0.83	9	7	0.56
12	7	11	0.39	2	11	0.15	7	7	0.50	3	12	0.20
13	3	6	0.33	5	11	0.31	3	11	0.21	5	16	0.24
14	10	4	0.71	6	8	0.43	10	8	0.56	11	3	0.79
15	5	9	0.36	11	3	0.79	11	7	0.61	4	10	0.29
16	4	13	0.24	6	9	0.40	1	14	0.07	4	9	0.31
17	4	8	0.33	4	13	0.24	3	9	0.25	4	15	0.21
18	4	10	0.29	11	7	0.61	12	4	0.75	6	6	0.50
19	14	0	1.00	18	0	1.00	16	0	1.00	12	0	1.00
20	2	14	0.13	3	13	0.19	3	9	0.25	8	8	0.50
21	7	3	0.70	10	5	0.67	13	5	0.72	9	8	0.53
22	5	9	0.36	4	10	0.29	7	9	0.44	7	9	0.44
23	16	0	1.00	13	5	0.72	14	3	0.82	7	2	0.78
24	6	9	0.40	7	7	0.50	8	9	0.47	7	7	0.50
25	4	9	0.31	0	13	0.00	5	14	0.26	4	11	0.27

26	3	11	0.21	1	16	0.06	5	11	0.31	5	8	0.38
27	6	7	0.46	7	6	0.54	11	8	0.58	7	8	0.47
28	5	6	0.45	6	9	0.40	9	9	0.50	9	7	0.56
29	12	2	0.86	15	2	0.88	12	4	0.75	9	4	0.69
30	7	5	0.58	8	8	0.50	13	5	0.72	9	5	0.64
31	9	10	0.47	6	8	0.43	6	7	0.46	6	8	0.43
32	11	5	0.69	10	9	0.53	6	5	0.55	6	8	0.43
33	3	12	0.20	5	13	0.28	6	7	0.46	4	10	0.29
34	3	10	0.23	2	14	0.13	4	10	0.29	3	14	0.18
35	2	13	0.13	5	6	0.45	6	13	0.32	8	7	0.53
36	12	3	0.80	5	11	0.31	9	2	0.82	12	6	0.67
37	8	8	0.50	8	7	0.53	4	11	0.27	4	10	0.29
38	6	6	0.50	11	3	0.79	11	6	0.65	9	8	0.53
39	12	0	1.00	13	4	0.76	11	4	0.73	11	5	0.69
40	7	10	0.41	9	8	0.53	4	4	0.50	9	9	0.50
41	7	4	0.64	16	0	1.00	9	5	0.64	12	7	0.63
42	9	12	0.43	7	3	0.70	7	10	0.41	5	7	0.42
Total/AVG	303	306	0.50	315	326	0.49	351	302	0.54	293	324	0.47
Max			1.00			1.00			1.00			1.00
Min			0.13			0.00			0.07			0.09

Appendix 3

The P_{sooner} of individual 42 participants. The right hand columns show the individual P_{sooner}, and numbers of sooner options and late options chosen in each treatment. For example, Participant 17 in Treatment 1 was presented with 16 Type B choice problems, and chose sooner options in 11 problems and later options in 5 problems. On the other hand, Participant 34 in Treatment 3 was presented with 13 Type B choice problems, and chose sooner options only in 2 problems.

Participant	Treatment 1			Treatment 2			Treatment 3			Treatment 4		
	sooner	later	P_{sooner}	sooner	later	P_{sooner}	sooner	later	P_{sooner}	sooner	later	P_{sooner}
1	7	0	1.00	13	0	1.00	8	1	0.89	10	1	0.91
2	2	1	0.67	9	6	0.60	5	2	0.71	12	3	0.80
3	0	7	0.00	0	8	0.00	0	10	0.00	0	15	0.00
4	1	6	0.14	2	5	0.29	3	11	0.21	0	12	0.00
5	8	3	0.73	5	3	0.63	5	6	0.45	6	4	0.60
6	7	3	0.70	4	6	0.40	6	2	0.75	4	8	0.33
7	11	1	0.92	6	2	0.75	7	0	1.00	11	2	0.85
8	0	11	0.00	0	9	0.00	2	7	0.22	0	11	0.00
9	5	2	0.71	8	1	0.89	14	1	0.93	8	1	0.89
10	13	1	0.93	8	0	1.00	8	2	0.80	6	2	0.75
11	9	1	0.90	8	4	0.67	6	4	0.60	4	4	0.50
12	7	0	1.00	11	0	1.00	10	1	0.91	8	3	0.73
13	13	1	0.93	7	0	1.00	9	1	0.90	7	2	0.78
14	4	5	0.44	6	8	0.43	2	4	0.33	2	9	0.18
15	6	4	0.60	11	3	0.79	5	1	0.83	6	4	0.60
16	0	8	0.00	0	11	0.00	0	7	0.00	0	14	0.00
17	11	5	0.69	4	1	0.80	12	2	0.86	5	0	1.00
18	4	7	0.36	6	3	0.67	3	4	0.43	5	8	0.38
19	1	10	0.09	0	9	0.00	1	6	0.14	0	13	0.00
20	5	3	0.63	4	6	0.40	7	4	0.64	9	2	0.82
21	8	5	0.62	6	3	0.67	8	0	1.00	8	2	0.80
22	5	7	0.42	5	7	0.42	5	3	0.63	4	4	0.50
23	5	2	0.71	8	0	1.00	12	0	1.00	11	2	0.85
24	8	2	0.80	9	1	0.90	11	0	1.00	8	1	0.89
25	8	2	0.80	5	9	0.36	3	2	0.60	4	7	0.36

26	6	2	0.75	6	1	0.86	9	2	0.82	10	4	0.71
27	1	11	0.08	3	5	0.38	0	9	0.00	0	11	0.00
28	9	2	0.82	10	3	0.77	10	0	1.00	6	0	1.00
29	0	11	0.00	0	8	0.00	0	6	0.00	0	15	0.00
30	10	3	0.77	6	2	0.75	8	0	1.00	5	6	0.45
31	5	4	0.56	7	1	0.88	10	2	0.83	5	6	0.45
32	5	2	0.71	6	1	0.86	11	2	0.85	13	0	1.00
33	6	5	0.55	5	3	0.63	7	5	0.58	3	6	0.33
34	6	3	0.67	5	4	0.56	2	11	0.15	5	4	0.56
35	5	2	0.71	1	15	0.06	1	5	0.17	2	9	0.18
36	11	0	1.00	6	0	1.00	12	3	0.80	7	1	0.88
37	0	8	0.00	0	12	0.00	0	6	0.00	0	14	0.00
38	13	0	1.00	10	0	1.00	8	0	1.00	9	0	1.00
39	7	6	0.54	4	4	0.50	6	3	0.67	7	3	0.70
40	5	2	0.71	7	0	1.00	15	1	0.94	9	1	0.90
41	5	9	0.36	4	5	0.44	8	2	0.80	3	4	0.43
42	6	1	0.86	9	5	0.64	8	3	0.73	6	2	0.75
Total/AVG	248	168	0.60	234	174	0.57	267	141	0.65	228	220	0.51
Max			1.00			1.00			1.00			1.00
Min			0.00			0.00			0.00			0.00

Appendix 4

The P_{risky} of individual 60 type A problems. For example, we observed in Treatment 1: (1) Problem 26 was performed by 9 participants and all of them chose risky options; (2) Problem 12 was performed by 14 participants, and 7 of them chose risky options and the rest 7 chose safe options and; (3) Problem 17 was performed by 4 participants and all of them chose safe options.

Problem	Treatment 1			Treatment 2			Treatment 3			Treatment 4		
	risk	safe	P_{risk}	risk	safe	P_{risk}	risk	safe	P_{risk}	risk	safe	P_{risk}
1	4	3	0.57	5	5	0.50	2	12	0.14	4	7	0.36
2	6	5	0.55	4	5	0.44	8	7	0.53	4	3	0.57
3	4	6	0.40	6	7	0.46	10	3	0.77	2	4	0.33
4	4	11	0.27	3	5	0.38	6	4	0.60	5	4	0.56
5	6	2	0.75	6	1	0.86	8	4	0.67	9	6	0.60
6	10	2	0.83	7	2	0.78	9	3	0.75	8	1	0.89
7	4	8	0.33	2	3	0.40	7	4	0.64	6	8	0.43
8	4	2	0.67	8	7	0.53	7	3	0.70	9	2	0.82
9	2	8	0.20	4	5	0.44	2	9	0.18	0	12	0.00
10	3	6	0.33	1	11	0.08	4	2	0.67	3	12	0.20
11	1	6	0.14	11	6	0.65	8	3	0.73	3	4	0.43
12	7	7	0.50	4	6	0.40	6	5	0.55	5	2	0.71
13	6	5	0.55	4	0	1.00	15	2	0.88	8	2	0.80
14	5	4	0.56	2	4	0.33	6	7	0.46	8	6	0.57
15	6	5	0.55	6	6	0.50	7	3	0.70	8	1	0.89
16	6	6	0.50	5	5	0.50	8	6	0.57	3	3	0.50
17	0	4	0.00	7	9	0.44	1	6	0.14	8	7	0.53
18	5	4	0.56	6	7	0.46	5	6	0.45	2	7	0.22
19	10	3	0.77	6	4	0.60	7	0	1.00	11	1	0.92
20	9	6	0.60	5	8	0.38	2	6	0.25	1	5	0.17
21	5	2	0.71	12	0	1.00	5	5	0.50	5	8	0.38
22	3	12	0.20	2	4	0.33	3	8	0.27	2	8	0.20
23	1	8	0.11	5	7	0.42	6	7	0.46	0	8	0.00
24	8	4	0.67	8	8	0.50	6	1	0.86	5	2	0.71
25	8	6	0.57	1	6	0.14	6	3	0.67	5	7	0.42
26	9	0	1.00	9	4	0.69	2	2	0.50	13	3	0.81

27	2	9	0.18	2	8	0.20	4	7	0.36	3	7	0.30
28	8	4	0.67	6	1	0.86	6	6	0.50	5	6	0.45
29	3	4	0.43	2	6	0.25	9	3	0.75	7	8	0.47
30	2	7	0.22	4	5	0.44	7	1	0.88	8	8	0.50
31	6	4	0.60	6	4	0.60	6	4	0.60	6	6	0.50
32	7	2	0.78	12	1	0.92	11	0	1.00	7	2	0.78
33	2	8	0.20	4	6	0.40	5	10	0.33	3	4	0.43
34	6	3	0.67	9	5	0.64	4	3	0.57	8	4	0.67
35	4	7	0.36	4	8	0.33	1	6	0.14	3	9	0.25
36	5	3	0.63	2	7	0.22	6	8	0.43	1	10	0.09
37	9	4	0.69	5	7	0.42	6	4	0.60	5	2	0.71
38	8	5	0.62	2	6	0.25	3	3	0.50	8	7	0.53
39	7	2	0.78	11	2	0.85	8	5	0.62	5	2	0.71
40	4	10	0.29	4	7	0.36	5	6	0.45	1	5	0.17
41	5	7	0.42	9	4	0.69	5	5	0.50	4	3	0.57
42	10	8	0.56	2	0	1.00	7	9	0.44	4	2	0.67
43	2	3	0.40	5	8	0.38	6	4	0.60	5	9	0.36
44	9	0	1.00	9	2	0.82	7	2	0.78	3	10	0.23
45	10	1	0.91	5	2	0.71	14	3	0.82	6	1	0.86
46	3	4	0.43	7	4	0.64	6	7	0.46	4	7	0.36
47	3	2	0.60	12	6	0.67	7	3	0.70	5	4	0.56
48	3	6	0.33	5	8	0.38	3	11	0.21	1	5	0.17
49	2	4	0.33	4	6	0.40	6	6	0.50	6	8	0.43
50	9	3	0.75	5	4	0.56	6	3	0.67	4	8	0.33
51	5	4	0.56	9	8	0.53	1	5	0.17	6	4	0.60
52	7	2	0.78	6	5	0.55	11	2	0.85	9	0	1.00
53	3	7	0.30	6	8	0.43	1	12	0.08	1	4	0.20
54	2	4	0.33	6	9	0.40	3	7	0.30	3	8	0.27
55	3	5	0.38	3	9	0.25	4	5	0.44	4	9	0.31
56	5	8	0.38	1	7	0.13	6	7	0.46	3	5	0.38
57	2	8	0.20	4	9	0.31	4	6	0.40	2	7	0.22
58	2	8	0.20	2	7	0.22	8	5	0.62	3	7	0.30
59	5	7	0.42	1	6	0.14	6	6	0.50	4	7	0.36

60	4	8	0.33	2	6	0.25	3	7	0.30	9	3	0.75
Total/AVG	303	306	0.50	315	326	0.49	351	302	0.54	293	324	0.47
max			1.00			1.00			1.00			1.00
min			0.00			0.08			0.08			0.00

Appendix 5

The P_{sooner} of individual 40 type B problems. For example, we observed in Treatment 2: (1) Problem 94 was performed by 10 participants and all of them chose sooner options; (2) Problem 86 was performed by 6 participants, and 3 of them chose sooner options and the rest 3 chose later options and; (3) Problem 88 was performed by 11 participants and all of them chose later options.

Problem	Treatment 1			Treatment 2			Treatment 3			Treatment 4		
	sooner	later	P_{sooner}	sooner	later	P_{sooner}	sooner	later	P_{sooner}	sooner	later	P_{sooner}
61	2	9	0.18	4	7	0.36	7	3	0.70	1	9	0.10
62	7	1	0.88	11	2	0.85	8	3	0.73	7	3	0.70
63	6	6	0.50	3	5	0.38	10	2	0.83	6	4	0.60
64	7	2	0.78	5	3	0.63	13	0	1.00	9	3	0.75
65	10	2	0.83	8	0	1.00	11	3	0.79	5	3	0.63
66	5	4	0.56	2	9	0.18	6	1	0.86	4	11	0.27
67	11	3	0.79	10	4	0.71	7	1	0.88	6	0	1.00
68	0	10	0.00	0	8	0.00	2	8	0.20	1	13	0.07
69	6	2	0.75	5	3	0.63	11	6	0.65	6	3	0.67
70	4	5	0.44	1	6	0.14	5	6	0.45	9	6	0.60
71	3	4	0.43	3	10	0.23	6	8	0.43	1	7	0.13
72	8	3	0.73	9	3	0.75	10	0	1.00	7	2	0.78
73	6	3	0.67	6	7	0.46	6	1	0.86	6	7	0.46
74	10	3	0.77	11	1	0.92	5	1	0.83	5	6	0.45
75	8	0	1.00	5	2	0.71	7	1	0.88	12	7	0.63
76	3	3	0.50	6	7	0.46	3	4	0.43	4	12	0.25
77	10	1	0.91	10	1	0.91	7	3	0.70	8	2	0.80
78	0	12	0.00	0	8	0.00	1	10	0.09	1	10	0.09
79	4	2	0.67	9	5	0.64	5	4	0.56	7	6	0.54
80	4	6	0.40	6	4	0.60	6	7	0.46	4	5	0.44
81	3	2	0.60	2	11	0.15	7	5	0.58	6	6	0.50
82	10	4	0.71	7	3	0.70	6	3	0.67	7	2	0.78
83	5	4	0.56	5	2	0.71	10	3	0.77	7	6	0.54
84	8	3	0.73	13	2	0.87	12	1	0.92	2	1	0.67
85	5	1	0.83	8	2	0.80	6	1	0.86	13	6	0.68
86	4	6	0.40	3	3	0.50	7	4	0.64	4	11	0.27

87	11	2	0.85	7	4	0.64	12	1	0.92	3	2	0.60
88	1	12	0.08	0	11	0.00	0	7	0.00	0	11	0.00
89	8	1	0.89	6	4	0.60	7	4	0.64	6	6	0.50
90	6	6	0.50	7	2	0.78	6	9	0.40	5	1	0.83
91	4	6	0.40	5	8	0.38	4	3	0.57	4	8	0.33
92	7	2	0.78	6	3	0.67	9	3	0.75	11	1	0.92
93	7	6	0.54	7	3	0.70	5	5	0.50	7	2	0.78
94	12	4	0.75	10	0	1.00	5	2	0.71	7	2	0.78
95	9	2	0.82	9	0	1.00	9	1	0.90	8	4	0.67
96	8	8	0.50	6	2	0.75	5	4	0.56	3	6	0.33
97	13	2	0.87	4	2	0.67	9	0	1.00	10	2	0.83
98	0	13	0.00	1	10	0.09	0	6	0.00	0	12	0.00
99	7	1	0.88	7	2	0.78	9	4	0.69	5	7	0.42
100	6	2	0.75	7	5	0.58	3	3	0.50	11	5	0.69
Total/AVG	248	168	0.60	234	174	0.57	267	141	0.65	228	220	0.51
max			1.00			1.00			1.00			1.00
min			0.00			0.00			0.00			0.00