Experiment Two

Experiment Two aimed to examine whether SMs can operate without coming into consciousness, and to investigate the conditions upon which the SMs may get involved in decision making. For the first aim, subliminally-presented emotional pictures were used to unconsciously activate emotions, while the conscious information (i.e., expected value) was controlled. For the second aim, two card schedules, one with and the other without conflict (Chen et al., 2006), were applied.

Method

Participants

Forty-eight undergraduate and graduate students from National Chengchi University participated in Experiment Two voluntarily. They were randomly assigned to receive either card schedule with (male = 13, female = 11) or without (male = 8, female = 16) conflict. The task was about 60 minutes. Participants got NT $150 for the participation.

Task

The revised IGT is almost identical to the original IGT except 1) in the revised IGT, subliminally-presented emotional pictures are embedded in the task, 2) in the revised IGT, two different card schedules are used for two groups of participants respectively, and 3) the window for anticipation is modified to be fixed.

Subliminal emotional pictures. In the revised IGT, a 30 ms (Wiens & Öhman, 2007) emotional picture is shown each time after participant press button for card selection and just before the appearance of the outcome message (Figure 8, the second

panel). Twenty pictures from International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005) are selected and divided into four picture sets: (a) five pictures of positive animals (valence/arousal *mean* = 7.90/4.28), (b) five pictures of positive human faces (6.48/3.58), (c) five pictures of negative animals (3.67/6.25), and (d) five pictures of negative human faces (3.48/4.75). Each picture set is associated with one deck. Associations between the five picture sets and the four decks are counterbalanced, thus each picture set could be associated with all the decks across the 24 participants. Regarding to the order of picture presentation, the 40 cards of each deck are divided into 8 blocks, and the five pictures in a picture set are randomly presented within each block of deck.

Card schedules. Two card schedules were used in Experiment Two. In both schedules, expected values across all decks are equal. The two schedules mainly differ in outcome message, that is, the schedule conducted in this study includes both immediate gain and delayed loss which compete to each other thus result in a conflicting situation. (Figure 4, bottom). On the other hand, the schedule coming from Chen and his colleagues' study includes only a single number of

Figure 8. As shown in the second to the forth panel, a picture was presented 30 ms between a 20 ms and a 50 ms mask, at the location of the selected card.

either gain or loss (Chen et al., 2006), thus it is considered to include no, or at least less, conflict (Figure 4, up).

Fixed anticipatory window.   As suggested by Experiment One, using the period between trial beginning and card selection as anticipatory SCR window may be problematic because it is too short to record event-related SCR changes. To resolve this problem, a 4 s blank was inserted right after trial beginning. During this 4 s blank, there were four covered decks on the screen (as the first panel in Figure 6), and participants were asked to do nothing but just think about which deck he/she is going to select in this trial. The blank terminated with a sound "ding"[1] which informed participants that they could make selection. Any button-pressing before the "ding" sound would be invalid, that is, they could not trigger computer to show any feedback card, neither the emotional picture.

The modification in Experiment Two makes us to have at least 4 s to measure anticipatory changes. As a footnote here, according to Bechara, the insert of the 4s blank might not interfere with the SM processing (personal communication, May 26, 2007).

Procedure

Procedure in Experiment Two was identical to that in Experiment One, expect to changes in task instruction and in questions that were asked to check if participants aware of the pictures. The task instruction for Experiment Two is as followed (for Chinese version, see Appendix B):

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[1]It should be under concern that whether the sound "ding" could make any SCR activities that would in-turn confound the feedback and/or anticipatory SCRs we observed. According to our observation during data collection, the sound "ding" did lead some SCR changes. However, due to habituation, the changes decreased almost to zero during practice trials. In addition, if there was any sound effect remained to the formal trials, its effect might be equal to all experimental conditions. For the above reasons, it would be acceptable to insert the sound "ding" in the trial.

1. Now you are going to participate in a gambling game. You will get $2000 credit to start the game. At the end, we will see how much you won or lost. The goal of the game is to win as much money as possible.

2. There are several trials in the game. However, you can not know how long the game will continue. You must keep playing until the computer stops the game.

3. The procedure of the game is as followed:

   1) In the beginning of each trial, you will see four decks of cards A, B, C, and D, appearing on the screen. You can think about which deck you are going to select at this moment.

   2) A short time latter, the computer will generate a sound "ding" to imform that you are allowed to make selection. Please select one card from any of the four decks after listening to the sound.

   3) After your card selection being made, the computer will tell you the result of the selected card. The symbol "+" and "-" on the card represent win and loss respectively, and the number following the symbol represents the magnitude you win or loss. [Every so often, however, when you select on a card, the computer tells you that you won some money, but then it says that you also lost some money. For example, "+500, -200" represents you can totally get $300 at this trial] (the sentence in the parentheses would not be presented in the no-conflict schedule).

   4) At the end of each trial, your money account will be updated and will be shown on the screen center.

5. Notes:

   1) You are absolutely free to switch from one deck to another any time you wish.

   2) Each time you select a card from a deck, the color of the card turns red or black. The colors of the cards are irrelevant in this game.

3) The computer does not make you win or lose money at random. The feedback of each card is preprogrammed before the game starts.

4) Among deck A, B, C, and D, some decks will make you win more than others, whereas some will make you loss more than others. You can win if you stay at decks which make you win more, or stay away from the decks which make you loss more.

5) The goal of the game is to win as much money as possible and, if you find yourself unable to win, make sure you avoid losing money as much as possible.

6. You will do practice trials and take a 3 minutes rest before the game starts.

In addition, three questions were asked after the task in order to check if the pictures were aware of by participants (Chen et al., 2006):

1. Did you find anything unusual during the task?

2. Did you see anything skimming over the screen? If yes, please describe what you saw.

3. Did you see any pictures skimming over the screen? If yes, please describe what you saw.

Furthermore, because participants were not told about the subliminally-presented pictures when signing the consent form, for ethic concern, another consent form was given to participants after debriefing. If they declined to sign the form, their data would be erased immediately.

SCR Recording & Analysis

SCR recording was almost the same as that in Experiment One. However, the SCR electrodes were attached on the non-dominated hand, rather than on the dominant hand.

SCR artifacts were inspected visually and were excluded before data segmentation. It is important to note that data segmentation in Experiment Two was quite different from

that in studies by Bechara and his colleagues (e.g. Bechara et al. 1999). As mentioned above, in their studies the anticipatory window is the period from trial beginning to card selection. However, anticipatory window in Experiment Two as well as in Experiment Three was defined as the 4 s period prior to card selection. That is, we segmented the 1024 data points (256 points/s $\times$ 4 s) prior to the point of card selection plus the 1 point of card selection (i.e., time zero). As the result, while anticipatory window in Bechara et al. is varying from trial to trial, our anticipatory window is fixed (i.e. $1024 + 1 = 1025$ points). On the other hand, while the feedback SCR window in Bechara and his colleagues' studies is the 5 s right after card selection, in order to make match to the anticipatory window, we used 4 s rather than 5 s as the feedback SCR window in this study. Thus, the 1024 points after card selection plus the 1 point of card selection (i.e., time zero) was segmented for feedback window (1025 in total).

After segmentation being finished, anticipatory and feedback SCRs were baseline-corrected by their first data point respectively. That is, the 1025 data points during anticipatory window were baseline-corrected by the point of -4000 ms. On the other hand, the 1025 data points during the feedback window were baseline-corrected by the point of time zero (i.e. card selection). Next, anticipatory and feedback SCRs were calculated separately. The anticipatory SCR values were calculated by the mean amplitude of the 1025 data points during the 4 s anticipatory window. On the other hand, the feedback SCR value was taken from the highest data point (i.e. peak) during the feedback window.

Both anticipatory and feedback SCRs were then divided into subtypes according to the associated pictures of the selected deck. That is, when the selected deck is associated with positive pictures, the anticipatory and feedback SCRs are thus labeled as anticipatory SCRs for positive picture and feedback SCRs for positive picture respectively. On the

other hand, when the associated picture is negative, the SCRs are thus labeled as anticipatory SCRs for negative picture and feedback SCRs for negative picture respectively.

Results

Data from participants who reported seeing any pictures or images were excluded. These excluded data were then replaced by new collected data. The total exclusion rate for conflict schedule condition was 14.29%, and for no-conflict schedule condition was 17.24%.

Two variables for data analysis were Picture (positive vs. negative; within-subject variable) and Schedule (conflict vs. no-conflict; between-subjects variable). As a footnote here, for each dependent variable (i.e. card selection, anticipatory SCRs, and feedback SCRs), two separate *t-tests*, one for conflict schedule condition and the other for no-conflict condition, were proceeded. For controlling the type I error, we made the two *t*-tests within each dependent variable to share the *α* value of .05.

Behavioral Data

Figure 9 shows participants' card selections in the 2 schedule conditions. For examining whether positive and negative pictures associated decks were selected differently in any schedule conditions, two *t-tests* were proceeded respectively. No any emotion effect was revealed in any conditions ($ts(23) < .77$, *ns*.). That is, decks
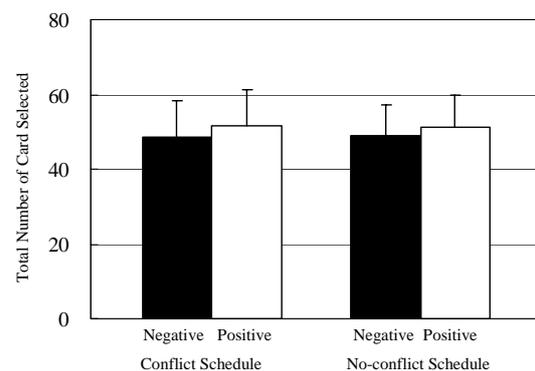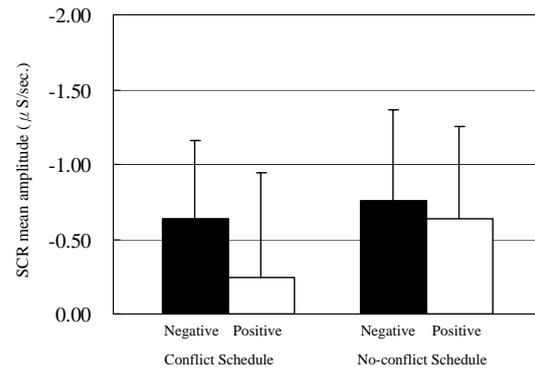

Figure 9. Total number of card selected from decks associated with positive or negative pictures in the conflict schedule condition (left) and no-conflict schedule condition (right). In both conditions, no difference between positive and negative pictures was revealed.

associated with positive pictures were selected equally to decks associated with negative pictures in either conflict or no-conflict condition.

Anticipatory SCR

Figure 10 shows anticipatory SCRs for conflict (left panel) and for no-conflict (right panel) schedule condition. For examining the emotion effects in anticipatory SCRs, a *t-test* was proceeded for each of the conditions. In conflict schedule condition, it revealed that positive pictures were related to higher anticipatory SCRs ($t(23) = 2.59$, $p < .025$). In contrast, emotion effect was not announced in the condition of no-conflict schedule ($t(23) = 1.49$, *ns.*).

Figure 10. Anticipatory SCRs from decks associated with positive or negative pictures. In the conflict schedule condition (left), anticipatory SCR were significantly higher for positive pictures associated decks than for negative pictures associated decks. In no-conflict schedule condition (right), no difference was revealed.

Feedback SCR

Figure 11 shows feedback SCRs for conflict (left panel) and for no-conflict (right panel) schedule condition. As for anticipatory SCRs, a *t-test* was proceeded for each of the two conditions. In the conflict schedule condition, emotion effect was approaching to significant ($t(23) = 1.75$,
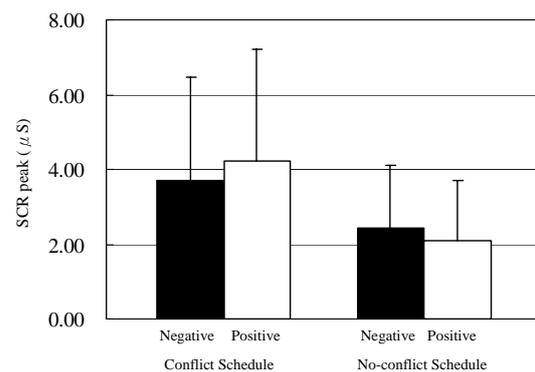
Figure 11. Feedback SCRs from decks associated with positive or negative pictures. In the conflict schedule condition (left), feedback SCR were higher for positive pictures associated decks than for negative pictures associated decks (approached significant, $p = .09$). In no-conflict schedule condition (right), no differences was revealed.

$p = .09$). On the other hand, emotion effect was neither reaching nor approaching to significant in the condition of no-conflict schedule ($t(23) = 1.37$, *ns.*).

Summary

In summary, behavioral data indicated that subliminal pictures did not make participants select differently in the gambling task, either in the conflict or in the no-conflict condition. However, the SCRs data suggested that in the condition with conflict schedule, the subliminally-presented emotional pictures did exert effects in anticipatory SCRs ($p < .025$) and in feedback SCRs ($p = .09$). On the other hand, it was as predicted that emotion effect on SCRs was not found when the task schedule was with no conflict. Nevertheless, it is notable that the direction of the emotion effect in anticipatory and feedback SCRs were opposite to our prediction. In the conflict schedule condition, it were the positive pictures rather than the negative pictures that related to higher anticipatory and feedback SCRs.