The Present Study

Exploring Consciousness and SM Operation

The present study focuses on the relation between consciousness and SMH. Regarding to the study of Maia and McClelland (2004), it is important to note that the great amount of questions (234 questions in total) embedded in task might provide too much additional information about the task design. Besides, asking and answering these questions would make the task become too long, thus increases the probability that SMs might not work in its normal way (e.g., it might decay). Furthermore, it is manifest that in both studies of Bechara et al. (1997) and of Maia and McClelland (2004), the experimental manipulations (i.e., deck difference in monetary feedback) were all above consciousness. That is, participants could consciously be aware of the manipulation. Thus, any effects founded could be resulted from conscious processes. For this reason, unconscious emotion manipulations were applied in the present study.

A revised IGT was conducted by Chen and his colleagues (Chen, Yen, Chang, Chen, & Liao, 2005; Chen, Yen, Liao, & Chang, 2006) in which expected values of decks are all identical (Figure 4, up). However, there are different emotional pictures subliminally presented when different decks are selected. Based on the results of Murphy and Zajonc's study (1993), different subliminally-presented emotional pictures were expected to make participants generate distinguishable emotions associated with each deck. Thus, it was hypothesized that, although the expected values of decks were equal, the different emotions activated by different emotional pictures would unconsciously guide participants to select more cards from the decks associated with positive pictures, whereas to select fewer cards from the decks associated with negative pictures.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	EV
A	-150	200	100	-100	0	150	200	-50	50	0	-150	200	100	-100	0	150	200	-50	50	0	-150	200	100	-100	0	150	200	-50	50	0	-150	200	100	-100	0	150	200	-50	50	0	0
B	-100	100	0	-150	200	150	200	-50	50	0	-150	200	100	-100	0	150	200	-50	50	0	-150	200	100	-100	0	150	200	-50	50	0	-150	200	100	-100	0	150	200	-50	50	0	0
C	0	-150	100	200	-100	150	200	-50	50	0	-150	200	100	-100	0	150	200	-50	50	0	-150	200	100	-100	0	150	200	-50	50	0	-150	200	100	-100	0	150	200	-50	50	0	0
D	200	100	-150	0	-100	150	200	-50	50	0	-150	200	100	-100	0	150	200	-50	50	0	-150	200	100	-100	0	150	200	-50	50	0	-150	200	100	-100	0	150	200	-50	50	0	0

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	EV
A (+125)	0	0		0		0				-1250		0	0	-1250		0	0			-1250		0	0			0			0			-1250		0		0		0			0
B (+125)	0	0		0		0				-1250		0	0	-1250		0	0			-1250		0	0			0			0			-1250		0		0		0			0
C (+25)	0		0		0	0				-250		0	0				0			0	-250		0			0	0	0	-250			0			0	-250	0			0	0
D (+25)	0		0		0	0				-250		0	0				0			0	-250		0			0	0	0	-250			0			0	-250	0			0	0

Figure 4. Card schedules with and without conflict. (Up) The schedule created by Chen and his colleagues (Chen et al., 2005; Chen et al., 2006) is presumed to include no, or at least less, conflict because only one single feedback number is given to participants after a card being selected. Note that in the no-conflict schedule, the 40 cards are divided into 4 blocks, and cards within each block are randomized for each participant. (Bottom) The schedule conducted in this study is presumed to include conflict because immediate gain (the value in the bracket in the left panel) and delayed loss may compete with each other.

Exploring Task Conflict Degree and Task-Irrelevant Emotions in SMH

Chen and his colleagues had used the task mentioned above to examine the issue of

consciousness and SM operation, but the effect of emotion manipulation in their study did

not reach significant (Chen et al., 2005; Chen et al., 2006). Three possible explanations

for their non-significant results are listed as followed:

Emotions Were Never Activated by the Pictures

Chen and his colleagues used extremely horrible pictures and presumed that the

pictures are negative enough to activate negative emotions. However, it is important to note that, neither SCRs nor any other physiological responses were assessed in their study. Therefore, it is never known whether the stimuli they used could really make the intended emotion be activated.

SMs Influence Decision Making Only When the Task is With Conflict

In Chen and his colleagues' study (Chen et al., 2005; Chen et al., 2006), the card schedule they used was not mixed with immediate and delay outcomes. That is, each time when a card being uncovered, there was only a number, either positive or negative, given to participants (e.g., "you win 250" or "you loss 250"). Thus, without the competition between immediate and delayed outcomes, the task might be much easier, and the most importantly, it might involve no, or at least less, conflict which is considered to be the key feature of IGT.

It is suggested that tasks with higher difficulty would demand more use of affective processing skills (Peters & Slovic, 2000). Indeed, the VMPFC is found to be involved in situations with uncertainty, unpredictability, and with only partial information could be used to make decision (Elliott, Dolan, & Frith, 2000). More specifically, Damasio and his colleagues have commented that the SMs might operate only when the task is consisting of conflict (Damasio et al., 2002). Thus, the non-significant findings of Chen et al. (2006) could be explainable because the schedule they conducted was much easier and was consisting of no conflict.

For the above reason, another card schedule was conducted in this study (Figure 4, up). Similar to the schedule used in Chen et al. (2006), all the decks here are associated with equal expected values. Thus, when there is no picture being presented, theoretically participants may equally select across the four decks, as that in the schedule of Chen et al.

(2006). Our pilot study (*n* = 12) confirmed this idea that participants showed no preferences to any of the decks, $t(11) = 1.47$, *ns*.

The difference between the two schedules is on the degree of task conflict. In the schedule conducted in this study (with conflict), immediate gain and delayed loss compete to each other (i.e., immediate gain is larger in deck A and B, whereas delayed loss is smaller in deck C and D; as that in the original IGT), thus resulting in a conflicting situation. In contrast, in the schedule used in Chen et al., there is no (or relative less) conflict because the outcome is presented by a single number, rather than two numbers.

Only Emotions Derived From the Task Could be Taken as SMs and Then Influence Decision Making

Another possible explanation for the non-significant results is that, as suggested by Bechara (personal communication, August 12, 2006), emotions activated by pictures are irrelevant to the task. That is, only emotions derived from task outcomes could in turn be reactivated and influence decision making. So, regardless how much the picture-activated emotion was, since it was irrelevant to the task, it would not be treated as SMs to guide decision making.

Bechara's comment to Chen and his colleagues' study is reasonable, but is remained to be empirically examined. It is notable that Bechara's idea implies an appraisal process in that emotion activated by monetary feedback should be attributed to a specific source, say, the task. However, it is the thing that the appraisal process is rarely mentioned in SMH. Furthermore, appraisal process is commonly considered as a cognitive and conscious process. If the appraisal process is necessary, it would be against Damasio's notion that SMs could operate without consciousness. For the above reasons, the question whether the task-irrelevant emotion could be taken as SMs was examined in this study.

Questions in the Present Study

The present study aimed to answer three questions:

1. Whether the SMs can operate without coming into consciousness?

2. Whether SM operation is involved in decision making only when the task or situation is with conflict?

3. Whether task-irrelevant emotion could be taken as SMs which will in turn guide decision making?

Regarding to these questions, the first and the second question were answered in Experiment Two, and the third one was answered in both Experiment Two and Three.

In Experiment One, in order to confirm the findings reported by Damasio and his colleagues (Bechara et al., 1996), the original IGT experiment was replicated.

In Experiment Two, a revised IGT with subliminal emotion manipulations was used, and a 2 (conflict vs. no-conflict schedule; between-subject factor) x 2 (decks associated with positive vs. negative pictures; within-subject factor) mixed design was conducted. Participants were randomly assigned to receive either the card schedule conducted in this study (conflict) or the card schedule of Chen et al. (2006)(no-conflict).

In the conflict schedule group, it was hypothesized that the subliminally-presented pictures could make different emotions being generated and being associated with different decks. Then, these emotions would in turn reappear before card selection, serve as SMs, and would consequently guide participants to approach to decks with positive pictures and to withdraw from the decks with negative pictures. As the results, we predicted that positive pictures associated decks would be selected more than negative picture associated decks. In addition, it was also expected to observe higher anticipatory and feedback SCRs respectively before and after selecting decks with negative pictures.

In the condition of no-conflict schedule, it was oppositely hypothesized that since

SM operation might not be involved, emotions activated by subliminally-presented pictures would not be taken as SMs, thus we would not observe anticipatory SCR before card selection. As the result, the four decks would be equally selected across the task.

The Experiment Two allowed us to examine all the three questions addressed above. In addition to Experiment Two, the question "whether task-irrelevant emotions are capable to be taken as SMs which will in turn guide decision making" could be answered in Experiment Three as well. In Experiment Three, the task of subliminal pictures (as that in Experiment Two) was used but its card schedule was replaced by the original IGT schedule. That is, in Experiment Three participants played the original IGT card schedule but emotional pictures were subliminally presented. It is important to note that, in Experiment Three the good decks (i.e., deck C and D, which is with positive expected value) were associated with negative pictures, whereas the bad decks (i.e., deck A and B, which is with negative expected value) were associated with positive pictures. As the result, a competing condition (monetary feedback vs. emotional picture) was created which allows us to differentiate picture-activated emotions from task-derived emotions. The rationale was: If the picture-activated emotions are not capable to function as SMs and to influence decision making, then decision making would be guided only by monetary feedback. As the result, it was predicted that participant's performance in Experiment Three would be the same as that in Experiment One. In contrast, if the pictures do insert any observable effect, given that its effect was in opposite direction to the monetary feedback, it was predicted that the IGT performance would be interfered. That is, participant's preference to good decks (with negative subliminal pictures) would decrease.