

## General Discussion

In this study, we first replicated the original IGT study in Experiment One. Our data indicated that Taiwanese normal participants showed similar performance pattern as that in Caucasian (e.g. Bechara et al., 1994, Carter & Pasqualini, 2004) and Japanese (Suzuki et al., 2003) people. However, it is notable that compared to Caucasians whose anticipation time for card selection is in average 5 s (Bechara et al., 1999), Taiwanese participants in our study only took 639.93 ms for anticipation. According to Bechara and Damasio (2005), SM operations involve several serial processes, including (a) VMPFC reactivates past emotional experiences which are initially encoded by the amygdala; (b) VMPFC and amygdala next activate brainstem to generate SMs around the body; (c) the SMs around the body then are relayed back to the brainstem, insula and somatosensory cortex; and (d) finally the inputs from insula and somatosensory influence areas related to motor responses and behavioral actions like striatum, anterior cingulate cortex (ACC), and supplementary motor area (SMA). The above processes frame a loop which is called “body-loop”. It is no doubt that each process in body-loop demands time, especially the ones which are taken place around the body. For example, SCR latency to peak takes at least 1 to 3 s in average. Therefore, it would be interesting that Taiwanese participants only anticipated 639.93 ms but still performed advantageously in the IGT. One possible explanation is that, according to Bechara and his colleagues, once the body-loop being built and the SM representation being constructed within the brain, the SM signal could by-pass the body and would be relayed from amygdala directly to brainstem receiver (it is called “as-if body loop”; Bechara et al., 2005). Thus, without signals going down to the body, time would be saved and the decision would be made more quickly.

It the case that Taiwanese do anticipate as long as Caucasians when the body-loop

is in operation, but Taiwanese enter to “as-if body loop” much quicker than Caucasians? In order to test this hypothesis, we computed participants’ anticipation time of the first 20 trials ( $M = 979.93$ ,  $SD = 324.78$ ). Although it was a little bit higher than the average of the 100 trials, it was still much lower than the 5 s reported in Bechara and his colleagues’ studies (e.g. Bechara et al., 1999).

The Experiment Two and Three were designed to investigate the relations between consciousness and SM operation. In Experiment Two, emotions were manipulated unconsciously to examine whether the unconsciously-evoked emotion can operate as SMs to guide decision making. In addition, in order to examine the conditions upon which SM operation can or can not occur, the degree of task conflict was also manipulated. Findings in behavioral data indicated that positive and negative picture associated decks were not selected differently in either conflict schedule or no-conflict schedule condition. However, anticipatory and feedback SCR data together suggested that the subliminally-presented pictures did exert effects in the condition with conflict schedule, that is, both anticipatory and feedback SCRs were higher for positive picture associated decks than for negative picture associated decks when the task is with conflicts.

It is important to note that we hypothesized that negative pictures might be related to higher anticipatory and feedback SCRs. The reason we derived such hypothesis was that, according to Bechara et al. (1999), SCRs are more sensitive to negative events than to positive events. The data in Experiment Two, however, suggested that it were the positive pictures, rather than negative pictures, that related to higher anticipatory and feedback SCRs. Although it is opposite to our expectation, we consider the case that positive pictures relate to higher SCRs would not be problematic because (a) A great amount of studies have demonstrated that viewing positive pictures can induce similar degree of SCR change as viewing negative pictures (e.g. Cuthbert, Schupp, Bradley,

Birbaumer, & Lang, 2000); and (b) if individual's decision making is guided by any kinds of information, the information must be distinguishable. Therefore, we suggest that what should be focused here is the question "whether there are distinguishable SCR differences between positive and negative pictures", instead of arguing which one is with higher or lower SCRs.

Findings in SCR data in the conflict condition of Experiment Two suggested that the positive and negative subliminally-presented pictures did make different emotions being generated, as indexed by feedback SCRs. Similar to SMs, the emotions then were reactivated before subsequent card selections, as indexed by anticipatory SCRs. However, it is important to note that, the different activated emotions before card selections could not function as SMs to guide participants to select more cards with positive pictures or fewer cards with negative pictures. That is, although the picture-evoked emotions were reactivated before decision making in this case, they could not function as SMs to influence decision making. More importantly, it is the thing that all the emotion effects observed were restricted within the conflict schedule condition.

Taken together, it can be concluded that in the conflict schedule condition, (a) There were different emotions activated by subliminally-presented pictures; (b) like SMs, the emotions reappeared before subsequent card selection; and (c) the reappeared emotions could not exert influences on card selection. On the other hand, in the no-conflict schedule condition, (a) There were no distinguishable emotions activated by pictures; Consequently, (b) anticipatory emotions before selecting positive versus negative picture associated decks did not differ, and (c) card selection number of positive versus negative picture associated decks did not differ as well.

Regarding to the three research questions of this study: (a) Whether the SMs can operate without coming into consciousness? (b) whether SM operation is involved in

decision making only when the task or situation is with conflict? and (c) whether task-irrelevant emotion could be taken as SMs which will in turn guide decision making? Findings in Experiment Two can certainly provide answers to the first and the third question. First, it may be the case that either task-relevant or task-irrelevant emotions (i.e. incidental emotion) can be taken as some kind of information that is used to facilitate future decision making. As information, the emotions in-turn will be reactivated in the future when people face the same or similar situation. Thus, in the Experiment Two we can see that the emotions activated by pictures reappeared before future decision making.

Second, since not only the emotions but there are also many other information (e.g. conscious operation) that relates to the situation, it is likely that emotion per se could not determinately rein decision making. In other words, decision making should base upon the integration of a variety of information, rather than upon just emotion. As the result, although in the Experiment Two we observed distinguishable emotions before card selections, without conscious involvement, the emotions alone could not make participants select differently in the gambling task.

In summary, the answers to the first and the third research question are that, the emotions, either task relevant or task irrelevant, can serve as some kinds of information and can be reactivated when people face the same or similar situations in the future. However, emotion per se can not determinately rein decision making unless it is integrated with other conscious or cognitive information.

Regarding to the second research question “Whether SM operation is involved in decision making only when the task or situation is with conflict?”, in conflict schedule condition, the emotion effect in feedback and anticipatory SCRs suggested that the process of taking emotion as situational information, as well as the process of reactivating it before decision making, can be taken place when the task is with conflict. On the other

hand, in the no-conflict condition, although the non-significance in anticipatory SCRs might suggest that the processes happening in conflict condition would not occur when the task is without conflict, it should be noted that the emotion effect was also not significant in feedback SCRs. Thus, it might be the case that the subliminal manipulation of emotion in no-conflict condition was failed. That was, no distinguishable emotions were activated by positive or by negative pictures. As the result, since there were no distinguishable emotions being activated, one could not expect to see any differentiated emotions being “reactivated” in the future.

Taken together, the answer to the second research question is that, in the condition with conflict, the process of taking emotion as situational information, as well as the process of reactivating it before decision making, can be taken place. It is worthwhile to note that, as suggested above, these two processes are necessary but not sufficient to SM operation, that is, the products of these processes are required to be integrated with other conscious information to altogether guide decision making. On the other hand, although the emotion effect was not significant in no-conflict condition, we can not make the conclusion that the SM operation (in particular, taking emotion as situational information and reactivating it before decision making) was absent in no-conflict condition because the non-significance in anticipatory SCRs may result from the failure in emotion manipulation. Therefore, the question “whether SM operation can occur when the task or situation is without conflict” still remains to be further investigated.

In Experiment Three, participants played the original IGT schedule and emotional pictures were subliminally presented in the same way as that in Experiment Two. By matching good decks with negative pictures and bad decks with positive pictures, it was hypothesized that if there is any observable effect caused by the emotional pictures, selection of good decks would decrease whereas selections of bad decks would increase.

In addition, it is also expected to see anticipatory or feedback SCR changes that caused by the subliminal pictures. However, the behavioral data as well as SCR data indicated that the good/bad deck difference did not differ between experimental and control groups. In other words, presenting emotional pictures did not cause any observable effect, either in the dependent variable of card selection, of anticipatory SCRs, or of feedback SCRs.

Behavioral data in Experiment Three are consistent with the findings in Experiment Two. In both experiments, the subliminally-presented pictures did not make influence on participant's card selection. However, compared to the Experiment Two in that emotional pictures exerted effect on anticipatory and feedback SCRs, in Experiment Three there was no observable emotion effect found in anticipatory or in feedback SCRs. One possible explanation for the no significance result is that, even if there is any SCR change caused by the subliminally-presented pictures, they would be relatively fewer than the SCR change caused by monetary feedbacks. In particular, the original IGT card schedule was used in both experimental and control groups. In the original IGT, bad decks are associated with negative expected value and higher risk level, whereas good decks are associated with positive expected value and lower risk level. Thus the SCR differences caused by the monetary feedback between good and bad decks might be too large as the result the effects led by subliminal pictures would be obscured. In other words, we suspected that the subliminally induced emotions, if there is any, may be obscured by the effects caused by monetary feedbacks. However, this hypothesis remains to be further examined.

In conclusion, the present study examined the relation between SM operation and consciousness. Findings here suggested that the unconsciously-activated emotions alone are not capable to influence decision making. Therefore, we concluded that there might be some kind of conscious operation, although now it can not be specified, that is necessary

for SM operation.

The findings in this study confirm previous works by Adinoff et al. (2003), Hinson et al. (2002), Jameson et al. (2004), and Maia and McClelland (2004). More importantly, to our knowledge this study is the first attempt to examine SM operation by means of manipulating unconscious emotion and controlling conscious information. With the expected value of decks being controlled, the emotion effects we observed do suffer relatively less internal threats of consciousness than previous studies.

Data in this study also suggested a possible mechanism for SM operation. Emotions as well as other cognitive processes which relate to a decision making situation would be encoded as “information to this situation”. Next, every time when the same or similar situation is faced, all the encoded information would be reactivated (for the emotional information, it would be re-experienced; i.e., SMs). Reactivation of this emotional and cognitive information together provides individuals a predictor to the possible outcome of each choice. It is important to note that, according to our data, emotional information alone can not determinately rein decision making. Rather, we suggest that the emotion should be integrated with other information, and then they altogether could make influences on individual’s decision making.

Furthermore, the reappearance of the picture-activated emotion in the conflict schedule of Experiment Two also suggests that the task irrelevant emotion can be taken as situational information. However, as addressed above, it could not influence decision making only until it is integrated with other conscious information. It is notable that the findings here is against Bechara’s suggestion that task-irrelevant emotion can not be taken as SMs (personal communication, August 12, 2006), however, is consistent with the findings by Zajonc and his colleagues (e.g. Murphy & Zajonc, 1993). In their study, it is demonstrated that task-irrelevant emotions (i.e. emotions activated by viewing 4 ms

emotional faces) can bias participant's preference to neutral Chinese characters.

Finally, the present study also examined the condition upon which the SM operation may take place. Our data suggests that the SM operation does occur when the task is with conflict. This is consistent with previous findings that VMPFC is involved in decision making situation with uncertainty, unpredictability, and with only partial information being available (Elliott et al., 2000). However, due to the failure in emotion manipulation in the no-conflict condition, the question whether SM can operate in the condition without conflict can not be answered in this study and is remained to be further investigated.