Manipulation of Loss Aversion by Changes in Endowment and Affect: 
An Integrative Study of Psychophysiology, Personality and Functional Imaging.

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Introduction
Kahneman and Tversky (1991) demonstrated that gains must be much larger than losses in for 
individuals to choose to play a mixed gamble of both gains and losses. It has also been 
suggested that an individual’s current wealth as well as his emotional status play an important 
role in economic decision-making. However, the direct involvement of wealth and emotion in 
risk aversion has not yet been firmly established. Here, we hypothesize that different levels of 
endowment and emotion will lead to distinct changes in loss aversion coefficient (LAC) and 
reaction times (RT) during decision-making. Specifically, we hypothesize that the emotional 
component from past experience of gains or losses has a stronger influence on the changes in 
LAC compared to the endowment component.

Methods
Sixteen healthy participants (age=20-26 years) performed a decision-making task of accepting 
or rejecting 64 monetary gambles (see figure 1) per session in a multisession study. In the first 
experiment consisting of 4 sessions, called the Emotion Manipulation Experiment (EME), 
participants received a certain sum of money as endowment in the first session, and were then 
informed at the end of each subsequent session about the outcome of their choices in terms of 
the amount of money they won or lost. In the second experiment also consisting of 4 sessions, 
called Endowment Manipulation Experiment (DME), participants received a certain sum of 
money as endowment in each session independent of the other session. Changes in 
endowment across sessions were maintained constant between the EME and DMEs and in all 
participants so that behavioural and neural loss aversion could be directly compared between 
the two experiments and in the whole group of participants.

Figure 1: An example trial in which subjects either accepts, rejects or does not decide, the 
gamble option presented from 8x8 loss x gain matrix (as in Tom et al., 2007) of the decision 
phase.
Functional imaging was performed in a Siemens 3T TIM Trio scanner with an event-related paradigm. For each participant, trait measures (STAI-trait scale) of personality were collected before the experiment, and state measures of affect (STAI-state scale and PANAS) were obtained before and after each session. Univariate analysis was performed on fMRI signals using SPM5, and subsequently a multivariate support vector classification and mapping of discriminating voxels (Sitaram et al., 2010, Lee et al., 2010a) were performed to ascertaining whether accept/reject decisions could be predicted from brain signals alone.

**Results**

In the EME, change in behavioural LAC (see Tom et al., 2007 for definition) was significantly larger when participants lost money in the previous session (EME) than when they won money (see figure 2). When personality measures were correlated with the LAC, a tendency for a negative correlation with the Neuroticism sub-scale ($r=-.48; p=.06$) and a positive correlation with the Impulsiveness sub-scale ($r=.49; p=.06$) were found. Our assessment of neural loss aversion by univariate analysis (SPM) could be conceptually divided into 3 distinct levels (see figure 3). A significant activation in the emotion network (e.g., insula) due to wins or losses in the previous session corroborated with our behavioral LAC. Multivariate classification of whole-brain fMRI signals (Sitaram et al., 2010, Lee et al., 2010) showed better-than-chance accuracy in discriminating between accept and rejects decisions, indicating that participant’s decision can be reliably predicted from brain activity alone.

![Figure 2. Percentage variation of LAC across sessions with respect to the first session for EME and DME.](image)
**Discussion**

The present work shows that not only do ‘losses loom larger than gains’ (Tom et al., 2007), but also that changes in emotion following losses rather than gains have an additional influence on the LAC over and above changes in endowment value. The present study also showed that personality traits such as neuroticism and impulsivity determine loss aversion in individuals. Our future work will examine if decisions can be predicted and manipulated in real-time by brain signal classification thus enabling to determine their causal antecedents (Sitaram et al., 2010).

**References**


