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Title	ACTION-MONITORING SYSTEM REGARDS THE FAILURE TO GAIN AS MORE SIGNIFICANT THAN THE LOSS
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Description	10/25-29, 2006. the Hyatt Regency Hotel, Vancouver, BC, CANADA. Poster Session 2・Friday, October 27, 2006 : 87
Citation	The 46th Annual Meeting of the Society for Psychophysiological Research
Issue Date	2006-10
Doc URL	https://hdl.handle.net/2115/15866
Type	conference presentation
File Information	06SPR_Asuka.pdf

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ACTION-MONITORING SYSTEM REGARDS THE FAILURE TO GAIN AS MORE SIGNIFICANT THAN THE LOSS

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Introduction

Action-Monitoring System

- monitors and evaluates our action to achieve goals
- relates to response correction and adaptive behavior
- The ERN and the CRN are effective indices of action-monitoring system.

Error-Related Negativity; ERN

- negative deflection elicited by the erroneous response
- observed clearly in response-locked ERP
- peaks at around 100 ms after the response and shows a frontocentral scalp distribution

Correct Response Negativity; CRN

- ERN-like negative deflection following the correct response
- smaller than the ERN

Motivational effect (reward or punishment)

The ERN reflects evaluation of the outcome of the error as well as detection of the error.

- The outcome of the response always accompanies our action, and more significant outcome for the performer elicits the larger ERN.
- Some studies reporting the motivational effect on the ERN manipulated the motivational factor by providing or confiscating monetary incentives.

Reward condition
Monetary incentives increase only for correct response, and remain unchanged for the error (FAILURE TO GAIN).

Punishment condition
Monetary incentives given before the task decrease only for the error (LOSS), and remain unchanged for correct response.

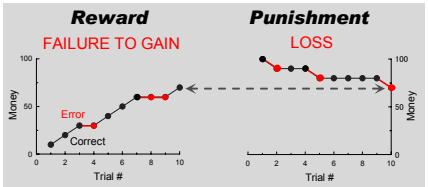
It has been reported that **the CRN** does not reflect the significance of the outcome.

- In the reward condition, monetary incentives did not influence on the CRN.

(Gehring and Nisenson, 2000 etc.; Hajcak et al., 2005).

Even when both errors ("FAILURE TO GAIN" and "LOSS") lead an equal amount of reward in total, are the significances of these errors equivalent exactly?

When the punishment is given to the error, does the motivational factor have an effect on the correct response?



Purpose

To investigate

1. how does the action-monitoring system evaluate FAILURE TO GAIN and the LOSS
2. whether the motivational effect is specific to the error-processing or not in reward and punishment condition

Methods

Participants

12 volunteers (6 males and 6 females) ages between 21 – 31 yrs.

Task

an arrowhead version of the flanker task with the RT deadline (mean RT of the practice trial + 1*SD*)

Table 1. All stimulus types and response hand assigned to each target

Stimulus type		Response hand
>>>>>	<<><<	Right
<<<<<	>><>>	Left

Each stimulus was presented in random order with equal probability and participants responded with each thumb.

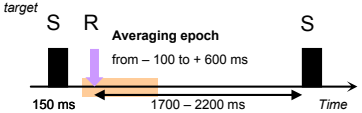


Fig. 1. The time course of one trial.

Condition

Table 2. Three motivational condition manipulated the reward and punishment

Response category		Correct (CR)	Error (ER)	Late Response
Condition	Control (CNT)	0	0	0
	Punishment (PNS)	0	-¥2.5	-¥2.5
	Reward (RWD)	+¥2.5	0	0

1 condition = 200 trials (5 blocks X 40 trials)

¥1000 was paid to the participant for perfect performance in PNS and RWD conditions.

Recordings & Data analysis

RT: the time from stimulus presentation to button press
EEG: Fz, FCz, Cz, and Pz (ref.: nose tip, bandpass: 0.05-30 Hz, A/D: 500 Hz)
EMG: the right and the left forearms
Averaging epoch: 700 ms (including 100 ms preceding the button press), Artifact rejection: ±100 μV
Excluded trials: RT < 200 ms, RT deadline < RT, and the trials contaminated by response conflict or correction
ERN: Peak amp. of the difference wave (error - correct)
CRN: Mean amp. Between 50-150 ms after the button press

Results & Discussion

Behavioral data

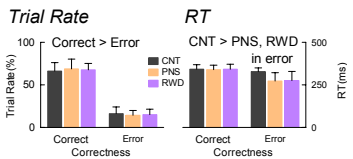


Fig. 2. Trial rate and mean RT for correct and error response in each condition.

Stimulus Compatibility Effect on Correct Trials

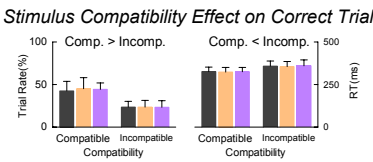


Fig. 3. Trial rate and mean RT for correct response in each condition.

Error RT: CNT > PNS and RWD

- Participants responded quickly in order to prevent the late response, when the error was accompanied by the FAILURE TO GAIN or the LOSS, and then quick response produced the error.

Correct trial rate: Comp. > Incomp; Correct RT: Incomp. > Comp.

- Motivational factor does not influence the response-generation process related to stimulus compatibility.

ERP data

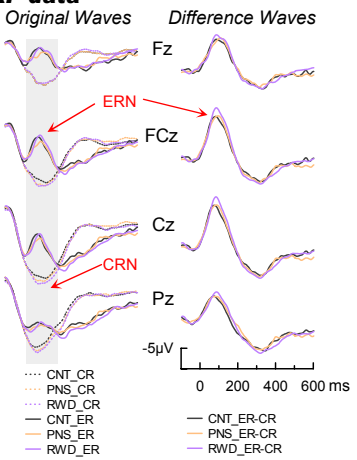
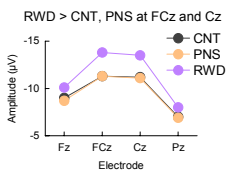


Fig. 4. Grand-averaged waves for correct and error trials (left) and difference waves (right) in each condition.

ERN



ERN result showed a different pattern from error RT.

CRN

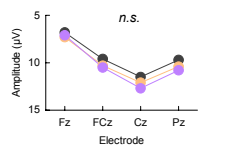


Fig. 5. ERN peak amplitude (above) and CRN mean amplitude (below).

ERN amp.: RWD > CNT, PNS

- The significance of the error was not evaluated according to the persistence of monetary reward or punishment.
- It was the most important issue for the participants whether participants could increase their reward in RWD compared to PNS and CNT conditions in which participants have no chance to increase their reward.

CRN amp.: Motivational effect was not significant

- This result supports the report that motivational effect is specific to error processing.

Conclusion

1. Action-monitoring system
   - evaluates erroneous behavior differently according to the situation, even if those produce the same conclusive result.
   - makes positive efforts to get the reward.
2. Different processes evaluate the significance of the correct and error response respectively in the action-monitoring system regardless of the situation.

The 46th Annual Meeting of the Society for Psychophysiological Research 10/25-29 2006 Vancouver, BC, CANADA