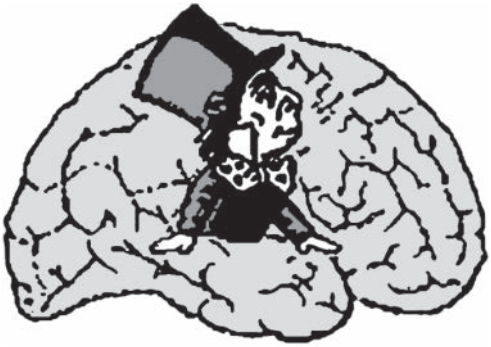
КОГНИТИВНАЯ НАУКА В МОСКВЕ

НОВЫЕ ИССЛЕДОВАНИЯ



МАТЕРИАЛЫ КОНФЕРЕНЦИИ 2017

ПОД РЕД. Е.В. ПЕЧЕНКОВОЙ, М.В. ФАЛИКМАН

УДК 159.9

ББК 81.002

К57

К57 Коллективный

Когнитивная наука в Москве: новые исследования. Материалы конференции 15 июня 2017 г.

Под ред. Е.В. Печенковой, М.В. Фаликман. – М.: ООО «Буки Веди», ИППиП. 2017 г. – 596 стр.

Электронная версия

ISBN 978-5-4465-1509-7

УДК 159.9

ББК 81.002

ISBN 978-5-4465-1509-7

MODULATION OF CHOICE-INDUCED PREFERENCE CHANGES USING TDCS

Rybina E.*, Colosio M., Klucharev V.
rybina.e.p@gmail.com
Center for Cognition and Decision Making, National Research University Higher School of Economics, Russian Federation

Abstract. The theory of cognitive dissonance suggests that individuals prefer new incoming information to be consistent with already existing knowledge. Conflicting or inconsistent information results in an emotionally uncomfortable state called cognitive dissonance. Cognitive dissonance theory suggests that a choice between two similarly valued alternatives creates psychological tension (cognitive dissonance) that is reduced by a post-decision re-evaluation of the alternatives. According to the action-based model of cognitive dissonance, activity in the posterior medial prefrontal cortex (pMFC) underlies the detection of cognitive conflicts and the reduction of the dissonance. Nevertheless, the neurocomputational foundation of cognitive dissonance remains unclear. In this study, for the first time we show that cathodal transcranial direct current stimulation (tDCS) of the pMFC significantly reduced post-decision re-evaluation of the alternatives. An ongoing follow-up study that applied anodal tDCS to the pMFC preliminarily showed a tendency to increase choice-induced preference changes. Our results suggest that cognitive dissonance, underlined by the activity of the prefrontal cortex, is a part of the performance-monitoring circuitry.

Keywords: cognitive dissonance, free choice, spread of alternatives, choice-induced preference changes, posterior medial frontal cortex, transcranial direct current stimulation, tDCS, cathodal tDCS, anodal tDCS

The study has been funded by the Russian Academic Excellence Project '5-100'.

Introduction

Cognitive dissonance is an inner conflict caused by an inconsistency between a person's beliefs, opinions, attitudes, ideas or actions. It motivates people to reduce discomfort by changing their contradicting opinions or attitudes to minimize any discrepancy between them (Festinger, 1957).

The neuronal mechanisms of cognitive dissonance are still not fully understood. Recent neuroimaging studies suggested that several brain regions are involved in preference changes induced by cognitive dissonance: the posterior medial frontal cortex (pMFC) (van Veen et al., 2009), ventral striatum (Izuma et al., 2010), posterior cingulate cortex (Qin et al., 2011) and dorsolateral prefrontal cortex (Harmon-Jones et al., 2008; Mengarelli et al.,2015). So far, it has

been suggested that the pMFC detects an inconsistency between actions or attitudes, while others regions are involved in conflict resolution and preference adjustments. Interestingly, repetitive transcranial magnetic stimulation of the pMFC decreased choice-induced preference changes during the "free choice" paradigm (Izuma et al., 2015).

We used a modified version of the "free choice" paradigm (Chen, Risen, 2010) to study changes of preferences evoked by cognitive dissonance (Brehm, 1956). In our study, for the first time, we used transcranial direct current stimulation (tDCS) of the pMFC to decrease and increase cognitive dissonance and preference changes.

Method

We conducted two tDCS studies. During Study 1 (n = 17, mean age = 23.6 years), we applied *inhibitory* cathodal tDCS to the pMFC. During Study 2 (n = 4, in progress), we applied *activating* anodal tDCS to the pMFC.

tDCS was applied using an 8-channel neuro-stimulator StarStim with two rubber electrodes with an active electrode size of 19.25 cm^2 and with a reference electrode size of 52 cm^2. The location of the electrodes was based on the international 10–20 system (Reinhart, Woodman, 2014). An active electrode was placed at the FCz position; reference electrode was located on the right cheek. Cathodal and anodal tDCS was delivered for 20 minutes at 1.5 mA intensity. The sham stimulation imitated real tDCS, with similar ramp-up and ramp-down at the beginning and at the end of the stimulation.

Each participant visited the experiment twice with a one-week break in between visits (within-subject design). Conditions were counterbalanced. The "free choice" paradigm consisted of three tasks. During the *Rating task 1* (see Fig. 1), the participant evaluated items using an 8-point Likert scale. Next, after 20 minutes of tDCS, the participant performed the *Choice task*. In this task, food items were presented in pairs and participants had to choose the one food that they liked most. Unknown to the participant, the tree conditions were created (preprogramed): there were "easy choices", "difficult choices" and "computer choices" trials. "Easy choice" trails consisted of liked and disliked items (creating no cognitive

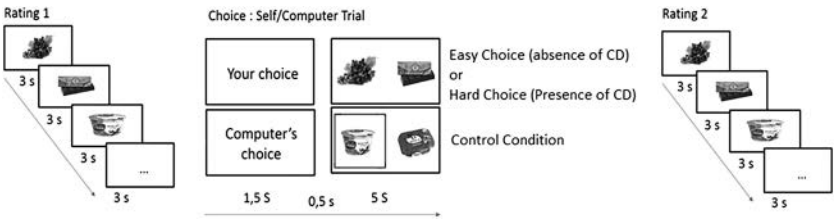


Figure 1. Free choice paradigm. During *Rating task 1*, participants rated food items. Next, during the *Choice task*, participants freely selected one of two food items. In *Rating task 2*, participants rated the same food items again.

dissonance during the choices). “Difficult choice” trails consisted of two highly preferred items (creating a strong cognitive dissonance during the choices). “Computer choice” trials were similar to “difficult choice” trials but choice was made by the computer (creating no cognitive dissonance during the choices).

After the *Choice task*, participants performed the *Rating task 2*. The magnitude of preference changes evoked by cognitive dissonance were measured as a difference between the ratings of the same items in the *Rating task 2* and *Rating task 1*.

Results

Study 1. A two-way repeated-measures ANOVA with *Stimulation* (tDCS, sham) × *Choice* (chosen item, rejected item) × *Evaluation* (Rating task 1, Rating task 2) revealed that cathodal tDCS of the pMFC significantly reduced reevaluation of rejected items after difficult choices (see Fig. 2) as compared to the sham condition ($F(1,16) = 4.65$, $p = .046$). A separate paired *t*-test confirmed differences between the cathodal stimulation and sham condition for rejected items in the difficult choice ($t(16) = 0.095$, $p = .005$).

Study 2. The study is still in progress. Fig. 3 shows preliminary results for four participants. A paired *t*-test revealed a tendency for an effect of anodal tDCS of the pMFC to increase preference changes relative to the sham condition, but it was not significant with $n = 4$ ($t(3) = -1.4$, $p = .13$).

Discussion and conclusions

Cathodal tDCS of the pMFC decreased reevaluation of food items, which were rejected during difficult choices. It suggests that cathodal tDCS of the pMFC effectively reduced cognitive dissonance. Our pilot study indicated that anodal tDCS of the pMFC might increase reevaluation of food items which were rejected during difficult choices. Our findings are consistent with previous results about the involvement of the pMFC in a choice-induced preference changes mechanism

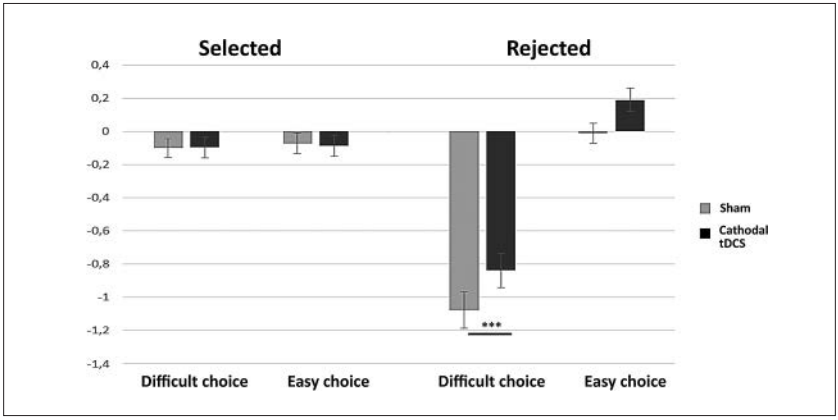


Figure 2. Results of Study 1

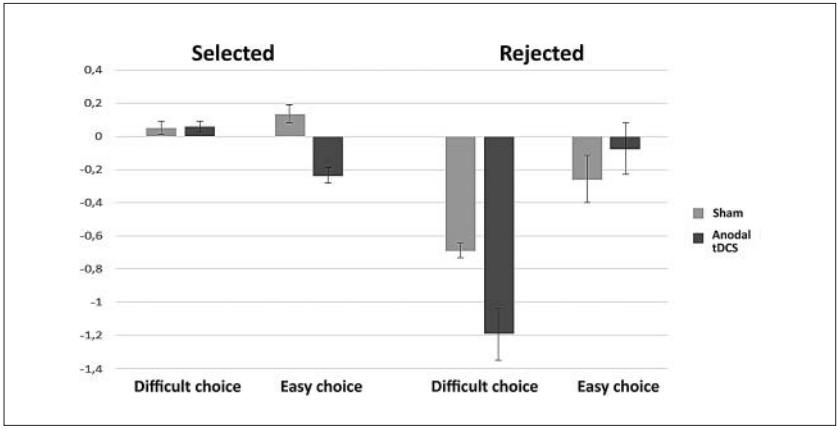


Figure 3. Preliminary results of Study 2 (n = 4)

evoked by cognitive dissonance. The role of the pMFC in this mechanism is still unclear. Further studies will demonstrate whether the pMFC only detects conflicts or if it also plays a role in the reduction of the conflicts.

References

Brehm J.W. Post-decision changes in desirability of alternatives // The Journal of Abnormal and Social Psychology. 1956. P. 384–389.

Chen M.K., Risen J.L. How choice affects and reflects preferences: revisiting the free-choice paradigm // Journal of Personality and Social Psychology. 2010. Vol. 99. No. 4. P. 573–594. doi:10.1037/a0020217

Festinger L. A theory of Cognitive Dissonance. Stanford: Stanford University, 1957.

Harmon-Jones E., Gerdjikov T., Harmon-Jones C. The effect of induced compliance on relative left frontal cortical activity: A test of the action-based model of dissonance // European Journal of Social Psychology. 2008. Vol. 38. No. 1. P. 35–45. doi:10.1002/ejsp.399

Izuma K., Akula S., Murayama K., Daw-An Wu X., Marco Iacoboni X., Adolphs R. A causal role for posterior medial frontal cortex in choice-induced preference change // The Journal of Neuroscience. 2015. Vol. 35. No. 8. P. 3598–3606. doi:10.1523/JNEUROSCI.4591-14.2015

Izuma K., Matsumoto M., Murayama K., Samejima K., Sadato N., Matsumoto K. Neural correlates of cognitive dissonance and choice-induced preference change // Proceedings of the National Academy of Sciences of the United States of America. 2010. P. 22014–22019. doi:10.1073/pnas.1011879108

Mengarelli F., Spoglianti S., Avenanti A., Di Pellegrino G. Cathodal tDCS over the left prefrontal cortex diminishes choice-induced preference change // Cerebral Cortex. 2015. Vol. 25. No. 5. P. 1219–1227. doi:10.1093/cercor/bht314

Qin J., Kimel S., Kitayama S., Wang X., Yang X., Han S. How choice modifies preference: Neural correlates of choice justification // NeuroImage. 2011. Vol. 55. No. 1. P. 240–246. doi:10.1016/j.neuroimage.2010.11.076

Reinhart R.M.G., Woodman G.F. Causal control of medial–frontal cortex governs electrophysiological and behavioral indices of performance monitoring and learning // The Journal of Neuroscience. 2014. Vol. 34. No. 12. P. 4214–4227. doi:10.1523/JNEUROSCI.5421-13.2014

van Veen V., Krug M. K., Schooler J. W., Carter C. S. Neural activity predicts attitude change in cognitive dissonance // Nature Neuroscience. 2009. Vol. 12. No. 11. P. 1469 – 1474. doi:10.1038/nn.2413

Изменение переоценки предпочтений, вызванной сложным выбором, с помощью tDCS

Е. Рыбина*, М. Колосио, В. Ключарев
rybina.e.p@gmail.com
1 — Центр нейроэкономики и когнитивных исследований,
2 — НИУ «Высшая школа экономики», Москва, Россия

Аннотация. Согласно теории когнитивного диссонанса, люди предпочитают информацию, которая соответствует их уже существующим убеждениям. Конфликт, образующийся в результате несоответствия поступающей информации убеждениям, вызывает некомфортное ощущение, которое называется «когнитивный диссонанс». Это же ощущение возникает при необходимости выбрать одну из двух одинаково оцениваемых опций. Когнитивный диссонанс, возникающий из-за несоответствия между необходимостью выбора и высокой оценкой обоих вариантов, толкает к уменьшению этого диссонанса и переоценке предложенных вариантов. Согласно *action-based* модели когнитивного диссонанса, активность медиальной фронтальной коры может свидетельствовать о детектировании конфликта и последующей переоценки предпочтений. Тем не менее, нейронные механизмы когнитивного диссонанса остаются неясными. В текущем исследовании мы показали, что катодная tDCS медиальной фронтальной коры значимо уменьшает переоценку предпочтений. Второй эксперимент с анодальной tDCS в стадии сбора данных, однако, предварительные данные показывают тенденцию к увеличению переоценки предпочтений. Эти результаты подтверждают, что медиальная префронтальная кора вовлечена в нейронные механизмы когнитивного диссонанса.

Ключевые слова: когнитивный диссонанс, свободный выбор, изменение предпочтений, медиальная фронтальная кора, транскраниальная электрическая стимуляция, tDCS, катодная tDCS, анодная tDCS