Evaluating the cognitive process of color affordance and attractiveness based on the ERP

Department of Mechanical Engineering, Clemson University

Mo Chen, Ivan Mata
Advisor: Dr. Georges Fadel

Introduction and background

Motivation

"Attractive things work better". "What is beautiful is usable" or "what is beautiful is good". These studies indicate that attractiveness affects, even improves, the perception of an affordance. The affordance and attractiveness may be intertwined and mutually reinforce each other.

What is affordance and color affordance

The term affordance was coined by Gibson. What the environment offers the animal, what it provides or furnishes, either for good or ill. These affordances refer to action possibilities between artifacts and users. Color affordances are conventions related to colors. For example, the red color usually refers to "stop" or "danger".

Objective

The color affordance and color attractiveness relationship can be tested by varying two important color attributes, brightness and saturation. Users' response to varying color attributes can be measured by means of Event Related Potentials(ERPs).

Advantages of ERP brain measurements

An event-related potential (ERP) is the measured brain response that is the direct result of a specific *sensory, cognitive,* or *motor* event by using response averaging techniques..

- *Continuity:* Brain activity measured from before the stimulus, through the processing and until the user response. .
- *Non-invasive:* ERP is a non-invasive procedure, users are not exposed to radiation or drugs.
- *Temporal resolution:* ERP provides excellent temporal resolutions, accurate to milliseconds.
- *Cost:* ERP is much cheaper than other imaging techniques such as fMRI, PET, and MEG.

Experiment

Method

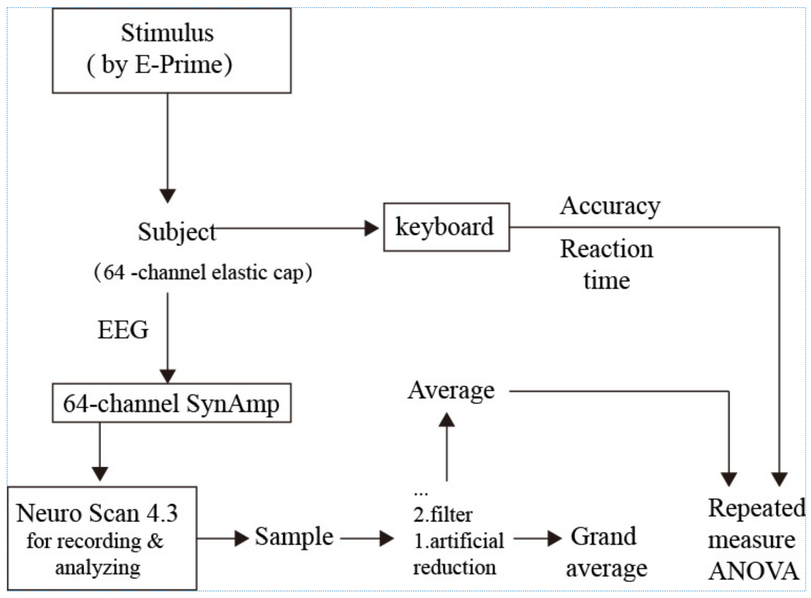

Fig.1 The experimental flow chart

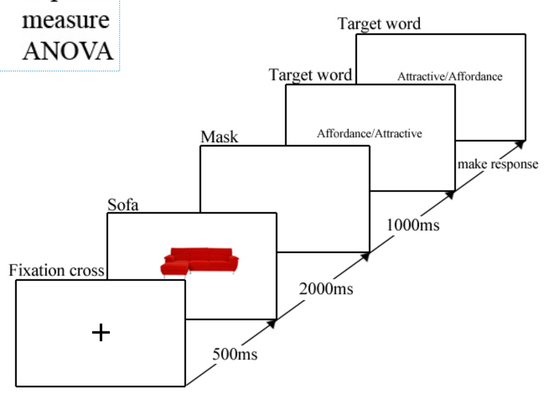

Fig.2 A single trial of the procedure as used in this experiment

Results

ERPs data

Results in Fig.3 show the averaged measurements of 4 electrodes for all 20 users for 4 different conditions. There are 64 electrodes in total.

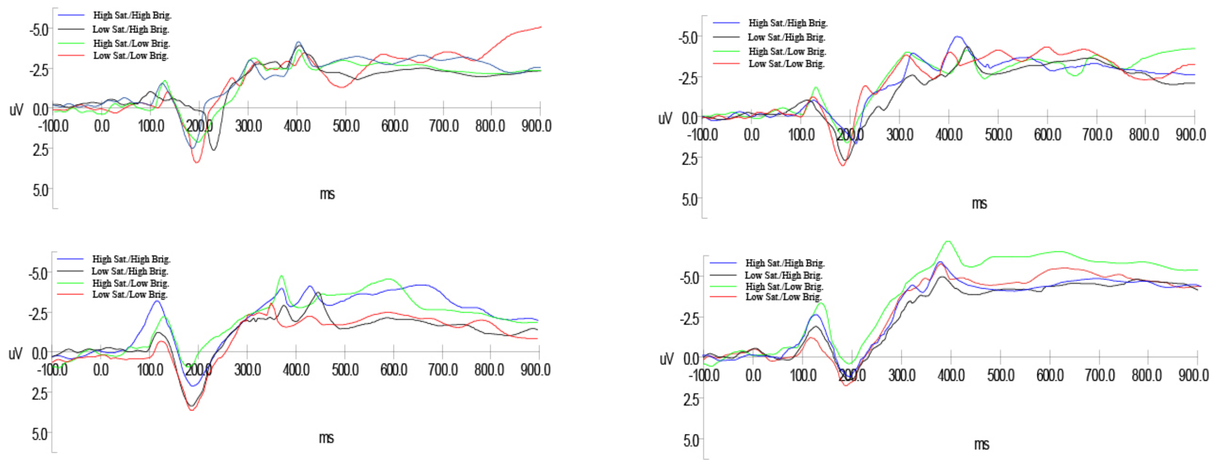

Fig. 3 The amplitude under the four conditions from -100ms to 900ms

The next results scalp topographical maps (Fig.4) for selected ERP components in response to four conditions

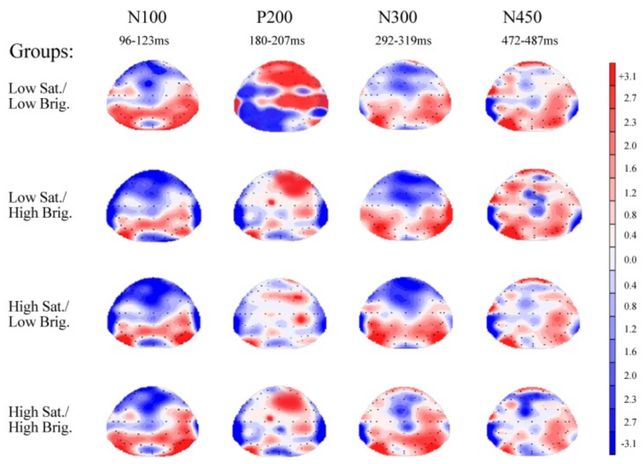

Fig. 4 The distributions of voltage over the scalp for 64 electrodes and 20 participants

80-130ms epoch:
- Color affordance : F=6.294, P=0.023<0.025

180-230ms epoch
- Color affordance :F= 5.421, P<0.05 (F2, F4, F6, F8)
- Color affordance: F= 5.236, P<0.05 (C1, Cz, C2)

280-330ms epoch
- Color affordance: F=5.324, P<0.05 (C1, Cz, C2),
- Color attractiveness: F=6.128, P<0.05(C1, Cz, C2)

380-530ms epoch
- Color affordance: F=3.10, P>0.05
- Color attractiveness: F=4.787, P<0.05

Fig. 5 Statistical parameters from ERP

Behavioral data

Statistical parameters for perceived color affordance and attractiveness for all experimental conditions (Unit: ms)

Group	Color affordance	Color attractiveness
Low Sat./ Low Brig.	426.625±368.161	731.725±198.142
Low Sat./ High Brig.	544.5±143.665	779.193±248.139
High Sat./ Low Brig.	496.875±173.621	804.716±218.253
High Sat./ High Brig.	430.125±47.867	761.284±213.649

ANOVA test reveals that the types of judgment have a main effect, F=5.018, P=0.03

ANOVA is also used to analyze the reaction time of the four groups considering color attractiveness only and found that the p-value is 0.894, which means there is no significance (>0.05). The same results for color affordance.

Conclusions

- There is no indication that either aspect reinforces the other.
- Color affordance is involved in the cognitive process prior to color attractiveness
- The color attractiveness is influenced by brightness, the brighter, the more attractive the artifact appears to be

Future work

- We should take an object which has high color affordance and color attractiveness as an experimental stimulus
- In order to get more valuable and reliable results, we could make use of more colorful artifacts

Acknowledgment

- National Natural Science Foundation of China (Grant No. 71271053)
- Humanities and Social Science Foundation of Ministry of Education of China (Grant No. 12YJAZH134)

For more information, please contact
Mo Chen at moc@clemson.edu