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Raleva, G., Stafford, T. orcid.org/0000-0002-8089-9479, Thirkettle, M. et al. (1 more author) (2018) No contribution of object category information in perceptual thresholds : evidence from Candy Crush. In: Perception. AVA Christmas Meeting 2017, 18 Dec 2017, London, UK. SAGE Publications , p. 571.

https://doi.org/10.1177/0301006618756416

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No contribution of reward and expertise on visual thresholds: Evidence from Candy-Crush game

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Background and Aims

Visual learning refers to the enhanced sensitivity to visually relevant stimuli. Training and experience produce long-lasting enhancements in decision making based on sensory evidence. Seeking reward is also a powerful factor in altering behaviour, both in the short term and longer term, with decisions being biased towards the options with high expected value. Moreover, reward is also known to affect perceptual learning tasks. Indeed, in a visual search task high-magnitude reward feedback after a successful trial results in priming of reward associated visual features (Hickey, Chelazzi & Theeuwes, 2010). Consistent with this is the observed activity enhancement in retinotopic areas corresponding to the trained visual fields (Schwartz, Maquet & Frith, 2002).

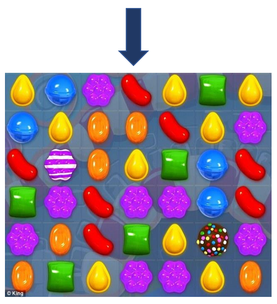
The aim of the present project is to establish the effect of reward and expertise on visual sensitivity by identifying the perceptual thresholds for reward- and neutral- associated stimuli.

We predicted that affective-value improves visual sensitivity such that experienced players will have lower visual threshold for the Candy Crush reward - associated stimulus (i.e. 'Candies' which reward the player in-game) relative to the neutral one.

Methods

Design

33 Candy Crush players and 32 non-players



Candy Crush players have deliberately given themselves many hours of practice. Candy Crush is a “match three” game where players swaps 2 adjacent candies among several on the gameboard to make a row or column of at least 3 matching-coloured candies. Importantly, there are also “special” candies with larger board-cleaning abilities that serve as power-ups. These candies have different affective in-game values. Therefore, we compared a neutral candy icon with a rewarding one (this icon is associated with the highest reward value in the game).

During the experiment participants completed a staircase 2AFC procedure whereby one of the image contained a certain target (target present) and the other didn’t (target absent). **There were 4 different targets:**

Candy Crush rewarding target CC-R	Candy Crush neutral target CC-N	Control rewarding target (NCC-R)	Control neutral target (NCC-N)
			

Stimuli and Procedure

Both target present and target absent images were generated of a pool of icons. Images constituted of a 7x7 visual array (49 single icons). Both target present and absent images were generated from a random mixture of 17 distractor icons, with the addition of a target icon for the target present images. To prevent habituation effects, 40 different instances of images were created for each participant – each image instance differed in the number of replicates of a particular distractor and their positions in the array.

The created images were scrambled to different extent, ranging from level of scrambling 59 (no scrambling) to level 0 (highest scrambling). Images were scrambled using diffeomorphic transformations (Stojanoski & Cusack, 2014). Diffeomorphic scrambling has advantages over other scrambling methods such as phase, box and texture scrambling because it preserves the basic visual properties of images (spatial frequency, perceptual organisation) intact. Presentation of conditions was randomised. Each condition was presented in a separate block, preceded by instructions of the specific target type for this condition.

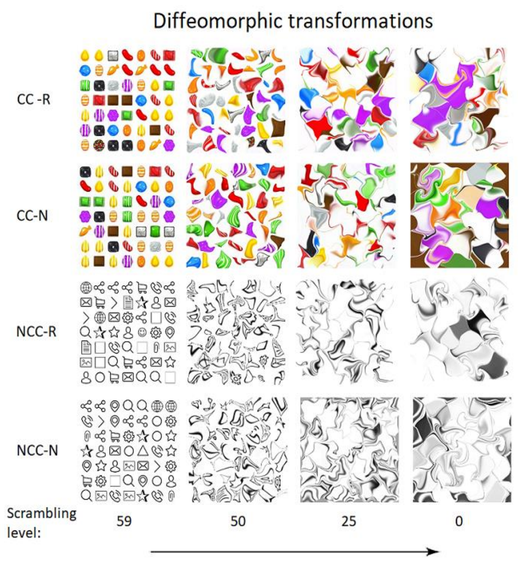


Figure 1. Sample images of the 4 conditions at 4 different levels of diffeomorphic scrambling.

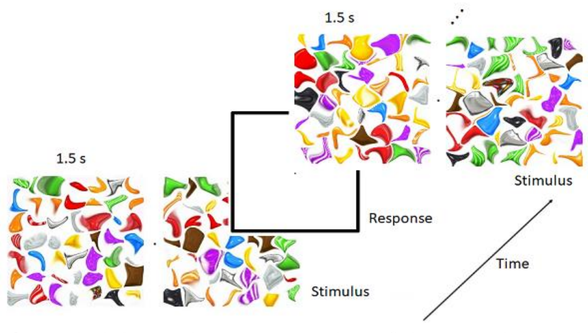
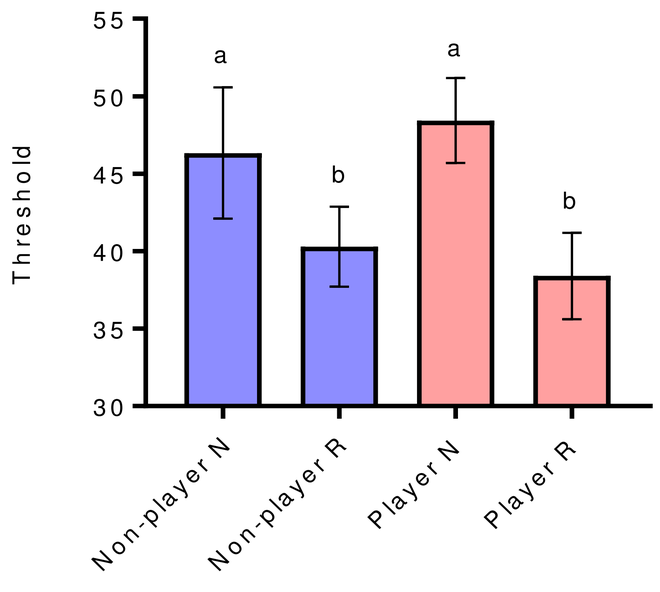


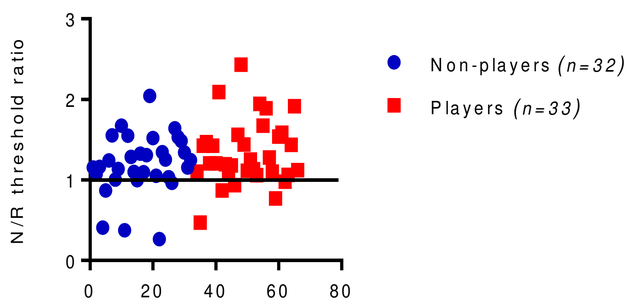
Figure 2. Schematic representation of the experimental procedure.

Results



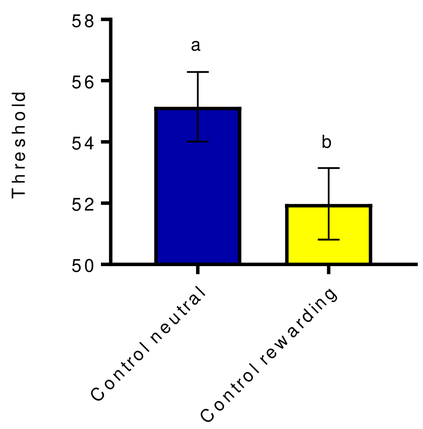
No difference in Candy Crush rewarding and neutral thresholds between players and non-players

Figure 1. Mean threshold values with 95% CI for Non-players neutral, Non-players rewarding, Players neutral and Players rewarding, ANOVA, F(3, 126)=9.654, p<0.0001.



Significant difference between thresholds for rewarding and neutral Candy Crush targets in both players and non-players

Figure 2. Ratio between Candy Crush neutral and Candy Crush rewarding threshold values for non-players and players



Significant difference between the control rewarding and control neutral thresholds in all participants

Figure 3. Mean threshold values with 95% CI of all participants for control neutral and control rewarding images, paired t-test, t(64)=3.90, p=0.0002

Conclusions

- Both players and non-players were significantly better at detecting the rewarding Candy Crush target than the neutral target.
- All participants showed similar reductions in threshold for the reward-associated control target compared to the neutral control target.
- Even though our most practiced players had accumulated years of experience, there was no association between playing time and perceptual thresholds. Our results suggest that there is a strong contribution of the basic visual features to performance levels both with the Candy-Crush and control targets, and provide no evidence that even long experience with reward-association heightens perceptual sensitivity, independent of object category information.

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