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Short Communication

Payoff affects tasters' decisions but it does not affect their sensitivity to basic tastes

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ABSTRACT

An experiment on taste sensory analysis was conducted to explore the effects of manipulating signal intensity and response incentives on sensitivity and decision processes when evaluating basic tastes under high ecological validity conditions. Salt concentration (0.07%, 0.1% or 0.75%) and payoff matrices that were intended to produce lenient, conservative, or neutral response strategies were manipulated in a full factorial between-subjects design. Salt concentration only affected the sensory process (sensory index A') while payoffs only affected the decision process (decision index B'_D). The effect of the payoff manipulation on the decision index was symmetrical for lenient and conservative induced response strategies, though less extreme than the values predicted by Signal Detection Theory for an optimal performance under unbalanced payoffs.

Evaluation in tasting panels has been traditionally focused on tasters' sensory performance, assigning panelists the role of assessing the intensity of desirable and undesirable attributes within a food. However, this traditional approach disregards the potential participation of subjective factors such as beliefs, motivations or preferences that may affect taster's decision criterion leading to the emergence of response biases such as a systematic propensity to believe that an attribute is present or absent (Schifferstein, 1996).

The importance of separating sensory for non-sensory (or decision-making) response components to achieve a correct characterization of tasters is not new (e.g., Rosett, Klein, & Ennis, 1997). An example of this necessity may be found in the study conducted by Moreno-Fernández, Ramos-Álvarez, Paredes-Olay, and Rosas (2012). They trained naïve subjects in a discriminative training easy-to-hard procedure within the field of olive oil tasting. These authors used the Signal Detection Theory (SDT), an approach that allows for the computation of different indices to infer the relative contribution of sensory and decision processes to performance (see Swets, 1996). Tasters showed a conservative bias (inclination to say that samples did not contain olive oil) that would have gone undetected using traditional psychophysics methods. As a step forward, Ramos-Álvarez, Moreno-Fernández, Paredes-Olay, and Rosas (2013) developed the double dissociation additive test (DDAT) that allows assessing the independence of the sensory and decision indexes used in SDT. In the DDAT at least one factor for each process is manipulated following the structure of a fully-crossed multi-way factorial design that allows for testing whether the factor associated to the decision process affects SDT decision index without affecting the sensory process, and vice versa (see also Martín-Guerrero, Paredes-Olay, Rosas, & Ramos-Álvarez, 2014).

The sensory process is affected by physical parameters such as the intensity of the stimulus (i.e., better acuity with higher intensities). However, decision criterion seems to depend on task instructions, on the base rates of presentation for each type of stimulus (i.e., a systematic bias to believe that the stimulus is present or absent depending on the relative frequency of signal trials, those that include stimulation, versus noise trials, that include background noise but lack the relevant stimulus); and on the payoff value (i.e., the systematic bias towards the presence/absence now depends on gains, difference between costs and benefits, associated with signal and noise trials) (Macmillan & Creelman, 2005; Swets, 1996; Wickens, 2002).

Within the factors that seem to affect decision criterion, the effect of manipulating the payoff matrix on decision-making has received large attention (e.g., Bohil & Maddox, 2003; Snodgrass & Corwin, 1988). However, to our knowledge, the effect of payoffs manipulation has not been explored in the taste domain, something potentially relevant given the peculiarities of tasting situations (see Ramos-Álvarez et al., 2013). The goal of the present study is filling that gap. In our experiment, signal (SN: target

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taste + distractor taste) and noise (N: distractor) were equally likely so that a priori probabilities ratio was set at a neutral value of 1. Fig. 1 shows the computed values used in this study to induce opposite symmetrical criterion strategies by programming differential incentives. A complementary goal was to evaluate the extent in which decision criterion may change under unbalanced payoffs and whether symmetrical effects may be induced for the lenient (bias to say yes) and conservative conditions (bias to answer no). Following the DDAT, our design included one factor for each process that were simultaneously manipulated in a complete factorial design: The magnitude of salt concentration (0.07%, 0.1%, and 0.75%) and the payoff matrices. The design allowed for testing the effects of the payoff manipulation under three different expected levels of sensory performance (see Martín-Guerrero, Rosas, Paredes-Olay, & Ramos-Álvarez, 2015).

A sour taste (N) and a sour and salty taste compound (SN) were used. The use of a combination of basic tastes has the advantage with respect to the use of natural foods of increasing the experimental control, as it simplifies controlled manipulation while bringing the situation to the natural setting in which tasters usually confront complex stimuli. As in classic SDT experiments (Snodgrass & Corwin's, 1988), three levels of payoff (conservative, neutral, and lenient) were manipulated while stimulus probabilities remained constant. We expected response criterion to be strict in the conservative payoff condition and lax in the lenient payoff condition. Additionally, as payoff manipulations were symmetrical, we expected the criterion placement to be symmetrical as well (see computations in Fig. 1). Finally, since we assume that the two factors affect two independent processes, we predict no statistical interaction between them.

1. Methods

1.1. Participants

A hundred-twenty-six undergraduate volunteers of the University of Jaén, 108 females and 18 males, between 18 and 48 years old (*Mdn* = 21.4), participated in the study. They were randomly assigned to each of the 9 experimental groups ($n = 14$). Age and gender distribution was uniform across groups. Though the female/male ratio was unbalanced, gender differences in sensations are not significant up to the age of 40 (e.g., Velle, 1987). The experimental control followed the protocol established by Ramos-Álvarez et al. (2013).

1.2. Materials and apparatus

Two types of taste stimuli in aqueous solution were used in each session: noise mixture was made with 1.5% of a sour compound [Pulco Lemon Flavor, Orangina Schweppes: lemon juice (40%), water (56%), and pulp of lemon (4%), and 98.5% of distilled water]. A small amount of salt was added to the mixture to conform the signal stimulus. Signal stimulus differed in the concentration of salt (0.07%, 0.1%, and 0.75%) across groups. Solutions were presented in plastic glasses at room temperature. Each glass contained 7 ml (see additional details in Ramos-Álvarez et al., 2013).

1.3. Procedure

Procedure was identical to the one described in Ramos-Álvarez et al. (2013) except for what follows. Participants were trained with a game in which they experienced a discrimination task for twenty trials. In each trial, two slightly differently sized figures were presented (one representing the salty sample, and the other representing the no salty sample). Participants had to identify the figure that briefly appeared on the screen. The payoff matrix corresponding to participant's assigned condition, and continuous feedback were used so that participants could learn the monetary contingencies that were going to be used in the experiment later. Participants were instructed to try to earn the maximum number of points. If a given participant was not able to maximize the expected value, the game was repeated up to three times, ensuring that way that all participants understood the payment scheme.

Lenient strategy was induced through the following instructions:

In this simple visual game you must detect the possible presence of salt in the tasting glass, which is represented by a slightly larger figure. Also you should try to gain the maximum number of points according to the following rules:

- When you answer "yes" and your answer is correct (because there was salt) you win 50 points.
- When you answer "yes" and your answer is incorrect (because there was no salt) you lose 10 points.

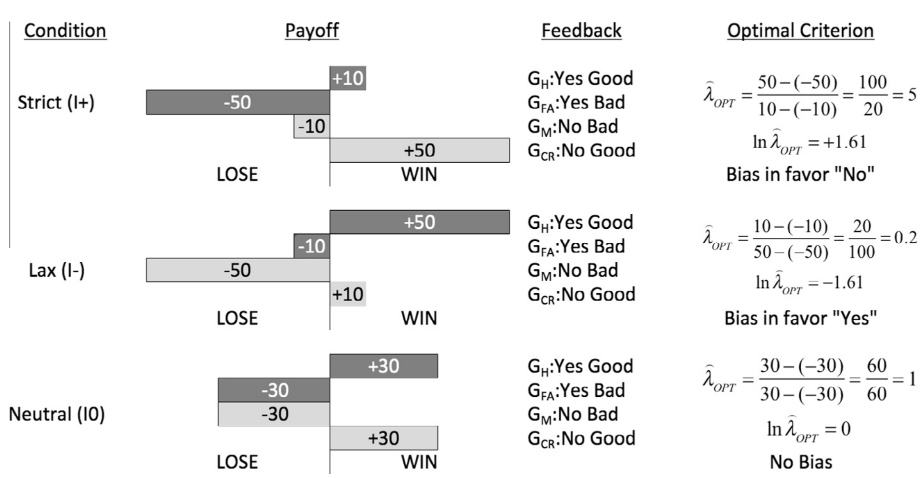

Fig. 1. Normative computations. From left to right: experimental conditions, payoff matrix detailing gains (G) associated to each of the 4 types of possible execution, the type of feedback, and details of the calculation of the Signal Detection Theory optimal criterion under the experimental manipulation used in this study. The optimal criterion is derived from the product of expectations (odds ratio associated to noise and signal) and incentives (ratio generated by gains: the difference in earnings between correct Rejections and false alarms, G_{CR}–G_{FA}, divided by the difference in earnings between hits and misses, G_H–G_M). The figure omitted the detail of the expectations since they remained neutral in the experimental design.