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Emotional balances in experimental consumer choices

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ABSTRACT

This paper presents an experiment, which builds a bridge over the gap between neuroscience and the analysis of economic behaviour. We apply the mathematical theory of Pavlovian conditioning, known as Recurrent Associative Gated Dipole (READ), to analyse consumer choices in a computer-based experiment. Supplier reputations, consumer satisfaction, and customer reactions are operationally defined and, together with prices, related to READ's neural dynamics. We recorded our participants' decisions with their timing, and then mapped those decisions on a sequence of events generated by the READ model. To achieve this, all constants in the differential equations were determined using simulated annealing with data from 129 people. READ predicted correctly 96% of all consumer choices in a calibration sample ($n = 1290$), and 87% in a test sample ($n = 903$), thus outperforming logit models. The rank correlations between self-assessed and dipole-generated consumer satisfactions were 89% in the calibration sample and 78% in the test sample, surpassing by a wide margin the best linear regression model.

1. Introduction

John Watson, founder of behaviourism, is quoted to have said in 1922, "The consumer is to the manufacturer, the department stores and the advertising agencies, what the green frog is to the physiologist" (DiClemente & Hantula, 2003). Many decades later, we cannot but agree with this provocative insight, although we know a lot more about consumer behaviour, its conditioning, and economic psychology in general. Today fMRI methods help us discover how brain systems interact when we think about economic decisions (see for example Camerer, Loewenstein, and Prelec (2005)). Yet, these studies still try to locate regions in the cortex involved in forming emotions, judgments, and decision making (cf. Winkielman, Knutson, Paulus, and Trujillo (2007)). It might be advantageous to complement such an observational approach, or even step aside from it for a while, by using more extensively the available theoretical models.

In this paper, we present experimental evidence that the mathematical theory of Pavlovian conditioning, known as Recurrent Associative Gated Dipole (READ) (Grossberg & Schmajuk, 1987) is able to capture essential features of consumer behaviour. A computer based experiment showed how a supplier of a fictitious service provoked satisfaction and disappointment, and gradually built its own reputation in the minds of participants as consumers. Accommodated by READ, these factors turned out to be strong predictors of customers' decisions to retain or abandon their current supplier. Our work borrows ideas from affective balance theory (Grossberg & Gutowski, 1987) and the Leven and Levine (1996) neural model of a consumer.

2. Experiment

This experiment investigates the links between (1) monetary outcome and momentary affect, (2) previous emotional experience and supplier reputation, and (3) provoked emotions and consumer decisions to retain or abandon the current supplier. It was conducted in May 2007 and involved 129 students of economics from Sofia University. Its content bears resemblance to the Bulgarian market of mobile phone services where two leading providers offered indistinguishable quality and prices at the time of the study. However, similarities with other markets in other countries would have been just as useful.

In each of 17 rounds the participant sees on a computer screen an advertised price (P_a) offered by the current supplier, which serves as orientation about what final price (P_f) might be expected (Fig. 1). No payments with real money are made. Prices P_a were adjusted to fluctuate slightly around an average monthly bill obtained in a survey among another 40 students. Thus, P_a varied within 40 ± 5 Bulgarian leva, and 1 lev is 0.5 euros.

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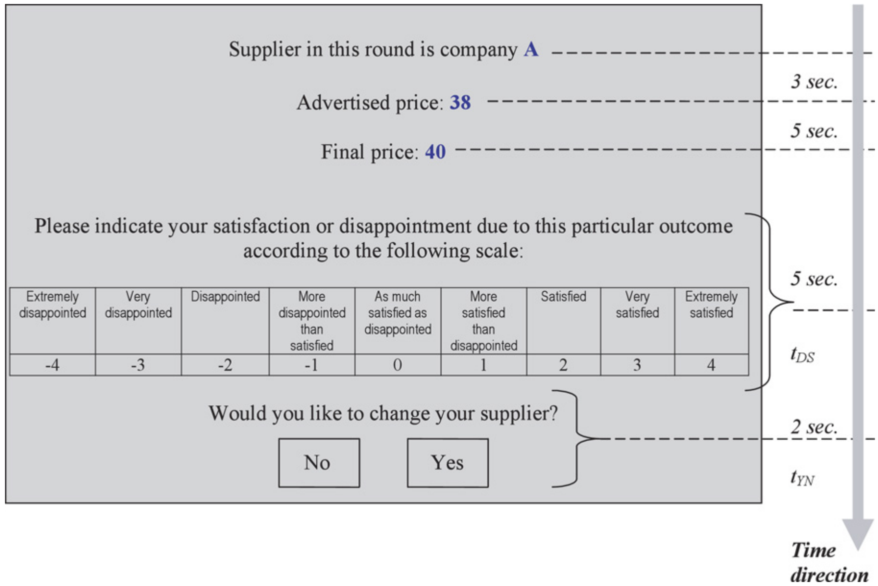

Fig. 1. Experimental screen of the software application. The downward arrow indicates how events unfold in time during one round. All periods have fixed duration except the time t_{DS} needed by the participant for self-assessment of satisfaction or disappointment, and time t_{YN} needed to choose next supplier. We imposed no time constraints on these decisions. Once a No or Yes is chosen, a new round starts with a blank screen. Immediately the new supplier name is shown.

The final price is shown on the screen a few seconds after the advertised and both never coincide. When the difference $(P_a - P_f)$ is positive (denoted ΔP^+), the customer is effectively offered a discount, otherwise one is asked to pay more (ΔP^-). Then the participant has to assess his (her) disappointment or satisfaction (*DS*) on a nine-point scale. Its adverb–adjective compounds were created for us by the Bulgarian psycholinguist Encho Gerganov, in such a way as to make the segments between neighbouring points equidistant in line with Cliff's (1959) multiplicative rule. In the Bulgarian language this is an interval scale with semantically exact opposites at the ends (Gerganov, 2007), although this may not necessarily be so for its English translation in Fig. 1. The numerical scale $(-4, -3, \ldots, 4)$ beneath only reinforces the idea of equidistance in the participant's mind.

Just seconds after the emotion question, one has to choose between suppliers *A* and *B* for the next round. Changing the current supplier incurs no costs. That decision taken, the round ends, and a new one begins with a blank screen. The first round always starts with supplier *A*. Note that the 'No' button indicating decision not to change the supplier is placed below the 'disappointment' part of the scale. Thus, we avoided that a mere convenience in navigating the mouse between the areas of disappointment and abandoning could cause an additional correlation between the answers to these two questions.

We fixed most of the time intervals and recorded all human reaction times (Fig. 1). This information was needed for calibrating the READ differential equations.

Each participant finds themselves in one of four experimental treatments (Fig. 2). In treatment *A* the price differences vary slightly, unlike *D*, where they fluctuate substantially. The other treatments are homogeneous in the sense that only discounts are offered (*B*), or more money is asked for (*C*). As all cases bear some resemblance to real life circumstances, we call them 'Saturated', 'Favourable', 'Hostile', and 'Fluctuating' markets.

One feature of our design is that the prices and price differences shown on the screen are predetermined and do not depend on the participant's decisions. Should he (she) choose for example to change supplier *A* with supplier *B*, in the next round he (she) would receive exactly the same offer (Fig. 1) as if supplier *A* had been retained. With this experimental design, each participant generates a sequence of unique ordering of both suppliers.

Treatments *B* and *C* create expectations in only one direction and thus provoke diminishing emotional responses like in a hedonic or satisfaction treadmill (Kahneman, 1999). It may happen that a financial discount could cause disappointment because a larger amount had been anticipated. Similarly, a mild satisfaction could be observed when less money is lost than expected. Our experimental evidence is that in about five hundred observations in each treatment, in *A* and *D* such 'paradoxical' answers were less than ten percent, as compared to 18% in *B* and 26% in *C*. Standard analytic tools like linear regression would ignore such effects and would always associate discount with satisfaction and loss with disappointment. Their explanation by Kahneman and Tversky's prospect theory would invoke a shifting reference point and would be purely phenomenological. In contrast, the gated dipole dynamics with neurotransmitter release and replenishment offers a natural way to understand such emotional reactions (Grossberg & Gutowski, 1987).

3. Connecting the READ neural model with the empirical data

Transferring information from empirical data to the differential equations of READ comprised a computational experiment in its own right. Essentially, in it we mapped each person's record of events, and their timing, on a sequence of events generated by the numerical solution of the READ system of equations (Fig. 3). We present now the model as we use it and explain how we connected it with the data. Its adapted equations are:

$$\frac{dx_1}{dt} = -A.x_1 + P_a + \delta.\Delta P^+ + M.x_7 \tag{1a}$$

$$\frac{dx_2}{dt} = -A.x_2 + P_a + \delta.\Delta P^- + M.x_8 \tag{1b}$$

$$\frac{dy_1}{dt} = B_1(1 - y_1) - C_1 x_1 y_1 \tag{2a}$$

$$\frac{dy_2}{dt} = B_2(1 - y_2) - C_2 x_2 y_2 \tag{2b}$$

$$\frac{dx_3}{dt} = -A.x_3 + D.x_1 y_1 \tag{3a}$$

$$\frac{dx_4}{dt} = -A.x_4 + D.x_2 y_2 \tag{3b}$$