A PSYCHOPHYSICAL APPROACH TO AGEING

Ana Garriga-Trillo
CEEN and Psychology Faculty, UNED
Madrid, Spain

Abstract

From its very beginning psychophysics related subjective phenomena with physical variables using an exact science, mathematics, for its formulation (Fechner, 1860). Although this seems to be a totally objective method, extreme positions have been raised throughout time dichotomising reality into either cognitive or sensory approaches even though there is plenty of data for and against both sides. A reconciliation has been proposed within measurement theory (Garriga-Trillo, 1995) and in a complementarity theory of psychophysics arguing that the same phenomena should be conceptualised in both ways (Baird, 1997). Within this realm we will present data from two psychophysical experiments exploring what variables really determine our responses when assessing different distances within their city and time spans. Due to our growing elderly population, our samples will include different age ranges. Results show that: cognitive responses are mainly explained by its sensory stimuli in both time and distance domains, and distance and time estimations are influenced by age.

Traditional psychophysical scaling (Weber´s Law, 1846; Fechner´s Law, 1850; Stevens Law, 1957) assumes that psychological scaling (Thurstone´s Law of Comparative Judgment, 1927) is something outside its domain. This dichotomy did not exist when Thurstone first published his Law but, afterwards, it has been totally accepted. It is also linked to the separation between the sensory continuum and the judgmental, or cognitive, one. Nevertheless, Garriga-Trillo (1995) has found that this proximity exists and could lead to a direct connection between sensory and cognitive domains within psychophysical scaling using an affine transformation between measurements and finding that both sensory and cognitive measurements belong to the same scale, an interval one. Baird (1997) mentions these results and proposes a more close relationship between continua, stating a complementarity theory for psychophysics including within it a sensory and a judgment model. He concludes that psychophysical results have a degree of uncertainty that comes from two complementary and mutually completing viewpoints: sensory and cognitive.

Considering two different aspects (time and distance), this research will study the relationships between sensory and cognitive time and also sensory and cognitive distances. Sensory variables will refer specifically to Time and Distance Stimuli. Cognitive variables will refer to Time and Distance Responses and other non-sensory variables. Both sensory and cognitive variables will be presented conjointly in time and distance and the data analyses will include parametric and non-parametric techniques.

Method

Participants

Time experiment: A total of fifty subjects living in Madrid, took part in the experiment. Their ages ranged from 16 to 57 years (M = 40 years), and 58% of them were females. The distribution for years of schooling (YS) and civil status (CS) was: YS - no schooling at all (33.3%), elementary-six years (42.9%), high school-12 years (13.5%), university-more than 12 years (10.3%), and CS - single (7.1%), married (65.1%), widowed (27.8%). All subjects were naive to the nature and aims of the experiment. All participants were tested individually. They received no payment for participating in the experiment.

Distance experiment: A total of one hundred subjects living in Toledo, took part in the experiment. Their ages ranged from 18 to 59 years (M = 40 years). The distribution of years of schooling (YS) was: elementary-six years (40%), high school-12 years (30%), university-more than 12 years (30%). All subjects were naive to the nature and aims of the experiment. All participants were tested individually in their city. They received no payment for participating in the experiment.

Procedure

Time experiment: Seven time intervals (.5, .7, .9, 1.1, 1.3, 1.5, 1.7 seconds) were bounded by two 2000c/sec computer beeps. Its duration interval was 0.33 seconds. Five blocks were presented and each stimulus was randomised within each block. The instructions asked to estimate the time elapsed, in seconds, between two computer generated beeps of the same intensity.

Distance experiment: Ten relevant urban landmarks were chosen within Toledo. Seven sites are within the city centre and three sites are on the outskirts of the city. Subjects were asked to asses all 45 distances ($C_{10,2}$) in meters, using the same order of presentation on all subjects.

Results and Discussion

Time experiment: Two types of statistical analyses will be used to obtain our time data results: (1) A non-parametric technique: Answer Tree and (2) A parametric one: backward regression analysis.

Using the Answer Tree algorithm, the dependent variable, DV, considered was *Response* or *Time Estimations* (TE). Stimuli or Real Time (ReT), Gender (G), Age (A), Experimental Block (EB), Response Time (RT), Confidence in the given response (CO), Confidence Response Time (CORT) and Absolute Error (AE=|ReT-TE|) are the independent variables (IIVV). Our results show that *Age* is the only significant independent variable. Time estimations between two beeps can predict age. The expected mean is 1.1. The youngest subjects (16-21 years) have the highest mean time estimations, they overestimate the real mean time span. The oldest group, 40-57 years, have the second closest time estimation to the expected mean, being the closest one the age group from 30-33 years.

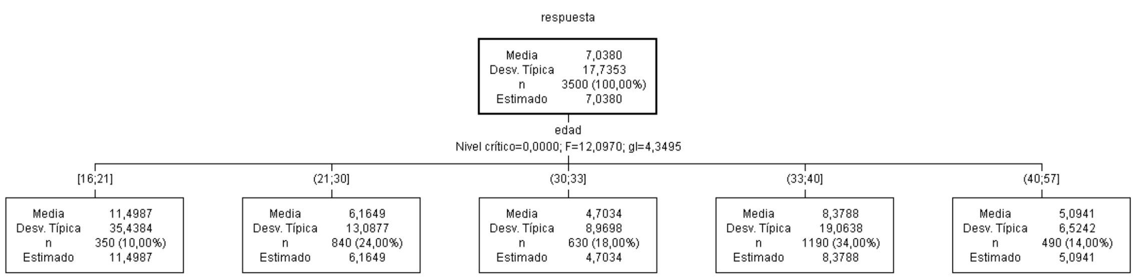


Figure 1. Age (Edad) as IV and Time EstimationResponse (Respuesta) as DV.

The dependent variable for the backward regression equation is TE and all the independent ones were considered. The resulting regression equation is:

TE´= 0.373 ReT + 0.14 G + 0.13 A – 0.043 CORT (1)

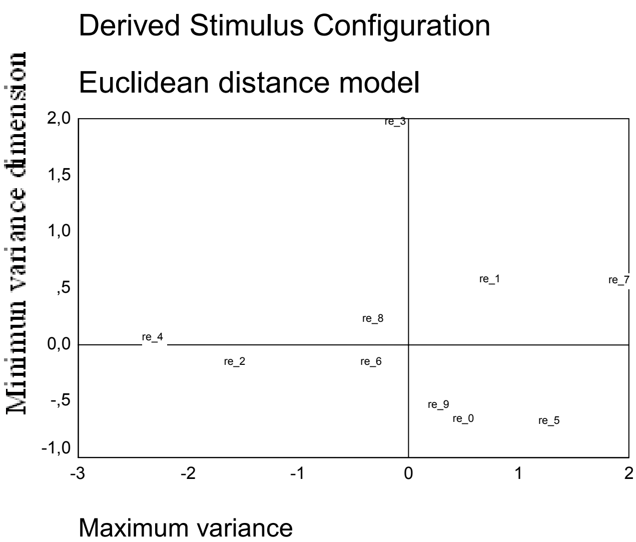
The percentage of explained TE variance is 17.5%. The greatest weight for estimated time is due to real time, ReT. This implies the reliability of the responses given. Considering both analyses, *Age* is a relevant variable when estimating time.

Distance experiment: Two types of statistical analyses will be also used to obtain our distance data results: (1) A backward regression analysis and a (2) Multidimentional scaling analysis. Considering Perceived Distances (**PD)** as the dependent variable and as independent ones Real Distance (**D**), City Knowledge (**CK,** on a scale from 0-10 where 0 = No knowledge at all and 10 = Expert knowledge), Years living in the city (**YC**) and Confidence in your response (**CO,** on a scale from 0-10 where 0= No confidence at all and 10=Totally confident), one obtained a backward multiple regression equation including all the variables mentioned. The regression equation obtained is:

PD´ = 0.79 D + .03 CK – 0.05 YC (2)

The percentage of explained variance is 62%. Although CK and YC have significant coefficients their weights are low, so one can say that the most relevant factor is real distance between sites. The only neglected variable was confidence in your response (CO). So we can conclude that : perceived distance is best explained by magnitude estimates using a city map and it is mainly explained by the real distance between sites. It implies that subjects responses to distances between sites are close to the real distance. Since other relevant independent variables were not included in the regression equation, one considered perceived distance ANOVAS (Between subjects effects with Magnitude Estimates using Maps), for four variables (Years of schooling-YS, age-A, home place-HP and work place-WP). The respective F values were YS=32.3, A=9.87, HP=30.49 & WP=12.2. All F´s are highly significant ($p<0.000+$). The age effect is relevant but not the most significant one.

Our multidimensional scaling analyses will refer to two types of maps: a Real Map (re) and a Cognitive Map (cp) as one can see in Figure 2.



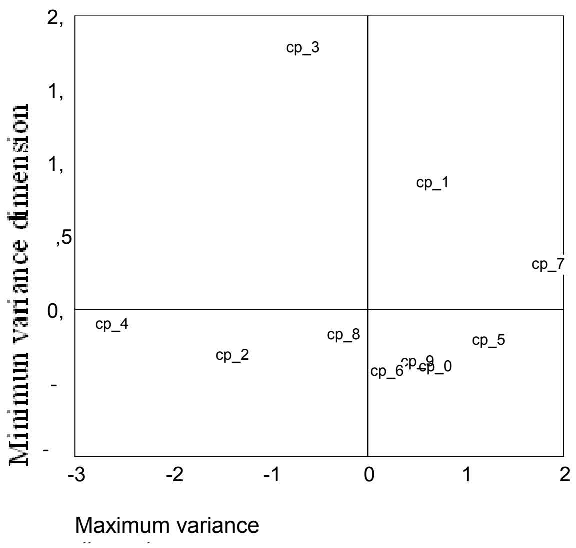


Figure 2. Cognitive map (cp) and Real map (re).

The Real Map uses real distances as input, and the Cognitive Map uses the estimated distances given by the subjects. The reason to build both maps is for comparing the subjects responses´ map with the real map obtained from real distances. All subjects responses are considered. As we can see in Figure 2, there is a great agreement, $R^2 = 0.99$, between the real map and the cognitive map. Analysing the points in each quadrant of the real distances (re) and comparing them with the subjects distance responses (cp) one finds many coincidences regarding the four quadrants: in the first quadrant numbers 1 and 7 coincide; number 3 happen together in the second one; 2 and 4 are together in the third one; and 5, 9 and 0 coincide in the fourth one. Only two points are displayed to another quadrant (6 and 8), although the displacement is not so far away. That means that subjects give distance values between points that are very close to reality (80% of coincidence). In this case, the subjects responses have been obtained from **M**agnitude **E**stimations and using a city **Ma**p.

Considering all our results one can conclude that: - as age increases, time increases in the regression model. – the age effect is significant in distance estimation. - determining spatial relations of a complex layout can be well done with only a small subset of such and age is a relevant variable. - using magnitude estimates for assessing distances from maps give better results than using other methods. – Ageing affects cognitive distances and, subsequently, cognitive maps.

References

Baird, J.C. (1997). *Sensation and Judgment. Complementarity Theory of Psychophysics.* Mahwah, New Jersey: Lawrence Erlbaum Associates, Publishers.

Garriga-Trillo, A. (1995). Thurstone´s and Stevens´scaling models:Toward a unifying paradigm. In C.A. Possamai (Ed.) *Fechner Day 95* (pp.195-200). Cassis, France: International Society for Psychophysics.

Garriga-Trillo, A. (2004). Cognitive mapping in the elderly. In A.M.Oliveira, M. Texeira, G.F. Borges y M.J.Ferro (Eds.) *Fechner Day 2004* (pp. 241-246). Coimbra, Portugal: International Society for Psychophysics.