FREQUENCY EFFECTS AND MEASUREMENT OF GEOGRAPHICAL KNOWLEDGE

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Abstract

Many psychophysical experiments showed that subjective judgments are affected the frequency of stimulus presentation. Skewing in frequency distributions of stimulus presentation produces a shift in subjective scales of stimulus intensities. This bias is called Frequency Effect. However, no research was carried on to test if Frequency Effect can bias responses obtained in tests or questionnaires. In our research, we asked participants to indicate the correct capital city of a specific country and to judge how much difficult is the item, as well. The test was composed by 30 items, part of them with low, medium or high level of difficulty. We also presented participants three different forms of the test: a form wherein the easy items where more frequent; a form wherein the items with an intermediate level of difficulty were more frequent; a form wherein the difficult items were more frequent. Results showed that subjective judgments of item difficulty were affected by the form of the test. When difficult items are more frequent, participants respond more accurately and rate items as less difficult.

Contextual effects produce pervasive and general biases in subjective quantitative judgments (Parducci and Wedell, 1986). Frequency Effect is a particular contextual effect due to the skewing in frequency distributions. Generally, when stimuli are presented to participants who are asked to judge the intensity of the corresponding sensations (e.g.: brightness, loudness, weight, and so on), the subjective scales of sensations are biased if stimuli have different frequencies of presentation. For example, if stimuli with low intensity are more frequent than those with high intensity, the subjective scale of stimulus intensities is different form that obtained with distributions of stimuli wherein stimuli with high intensity are more frequent than those with low intensity. The Frequency Effect is a well known phenomenon whose existence in unidimensional scaling was demonstrated many years ago (Johnson, 1944). Poulton (1979) suggests to present all stimuli with the same frequency of presentation to avoid the bias due to the Frequency Effect. The bias in subjective judgments produced by the Frequency Effect was studied in many psychophysical experiments (Parducci, 1956; Parducci and Marshall, 1961; Parducci and Perrett, 1971; Parducci, Calfee, Marshall and Davidson, 1960; Johnson, 1944; Johnson, 1949; Sokolov, Pavlova and Ehrenstein, 2000; Schifferstein, 1994; Tommasi, 2001). However, at present time, no systematic studies were done to test if the Frequency Effect can bias subjective responses obtained with tests or questionnaires. For example, if we want to measure the degree of knowledge or ability of a person in a specific matter or task, how can we be sure that his responses cannot change if there is a prevalence of easy or difficult items inside the test? In our experiment we measured the degree of knowledge of geography of people by asking them which is the capital of a specific nation among different town names. Some geographical items were easy, others quite difficult and others very difficult. We presented participants three different forms of the test: in the first form easy items were more frequent than the others; in the second form items with medium

level of difficulty were the more frequent questions; in the third form very difficult items were the more frequent questions.

Method

Before starting the experiment, in a pilot study we asked some participant to rate the degree of difficulty of a list of questions concerning the capitals of different nations. For each item, participants have to select the right answer among five different towns. After ordering items on the basis of the degree of difficulty, three different forms of the test were provided. In each test, items were divided into three groups: the group composed by easy items (Easy); the group composed by items with medium difficulty (Medium); the group composed by very difficult items (Difficult). In the first form (T_1), the item frequencies for each group were, respectively, 15-10-5; in the second form (T_2), they were, respectively, 7-16-7; in the third form (T_3), they were, respectively, 5-10-15. 30 participants were presented the three forms of the test. Participants' age varied from 19 to 58 years, and many of them (87%) were students. Each participant had to respond to each form of the test. The time interval between each presentation was one day. The order of presentation of T_1, T_2 and T_3 was balanced, therefore the sample of participants was divided into 6 subgroups, each with a specific presentation order of the three tests. For each item two kind of answers were recorded: accuracy (1 = right response; 0 = wrong response) and degree of item difficulty, using integers from 1 (very easy item) to 10 (very difficult item).

Results and Discussion

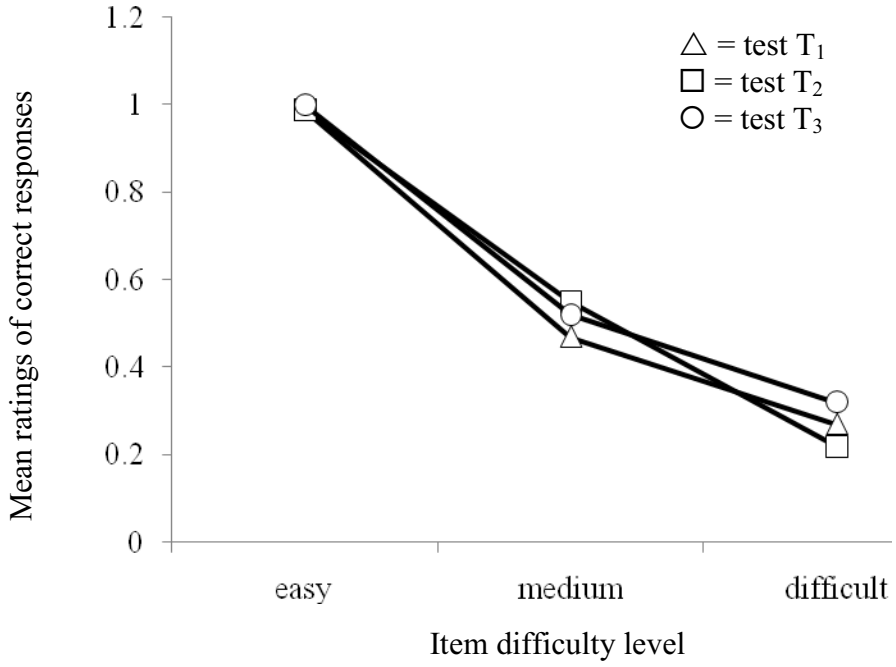

Fig. 1. Mean ratings of correct responses for items with different difficulty levels for test T_1, T_2 and T_3.

Frequency Effect and response accuracy

A 3 (test T_1 vs. test T_2 vs. test T_2) × 3 (Item Group Easy vs. Medium vs. Difficult) × 6 (Presentation Order) shows that the main factor Test and the main factor Item Group are

significant ($F_{2, 48} = 3.88$ and 235, respectively, $p < .05$). The interaction Test × Item Group is not significant ($F_{4, 96} = 1.56$). The effect of Presentation Order of the three tests is not significant ($F_{5, 24} = .9$). Figure 1 displays the mean ratings of correct responses for each group of items. The mean ratings for easy items are equivalent in test T_1, T_2 and T_3, while they tend to diverge from one test to another for items medium and high difficulty level. In particular, The mean ratings of correct responses increase when the frequency of easy items decreases and the frequency of difficult items increases.

Frequency Effect and item difficulty

A 3 (test T_1 vs. test T_2 vs. test T_2) × 3 (Item Group Easy vs. Medium vs. Difficult) × 6 (Presentation Order) shows that the main factor Test and the main factor Item Group are significant ($F_{2, 48} = 4.86$ and 468, respectively, $p < .05$). The interaction Test × Item group is significant ($F_{4, 96} = 3.91$, $p < .05$). The effect of Presentation Order of the three tests is not significant ($F_{5, 24} = 1.26$). Figure 2 displays the mean ratings of difficulty for each group of items. The mean ratings for easy items are equivalent in test T_1, T_2 and T_3, while they tend to diverge from one test to another for items with medium and high difficulty level. In particular, the mean ratings of item difficulty decrease when the frequency of easy items decreases and the frequency of difficult items increases.

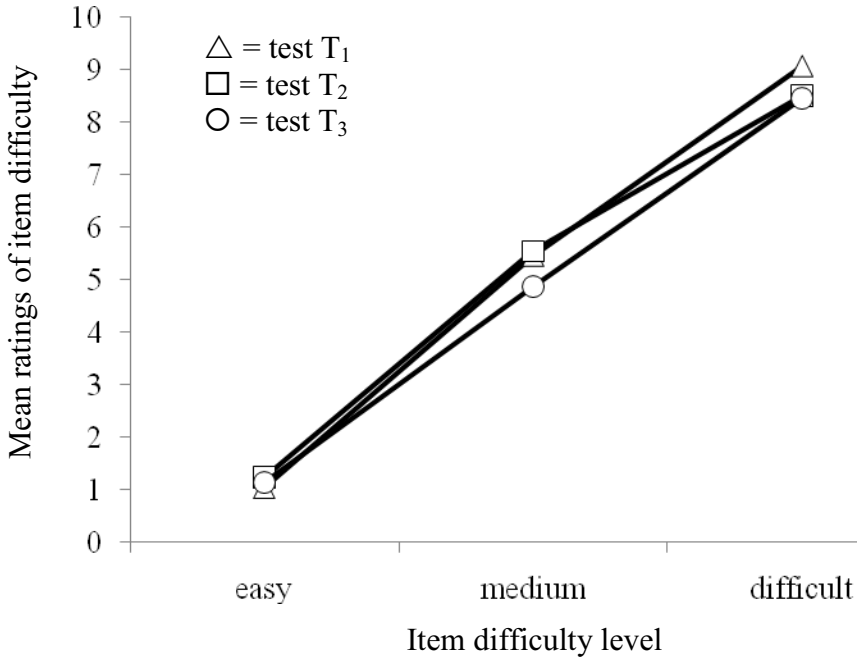

Fig. 2. Mean ratings of difficulty for items with different difficulty levels for test T_1, T_2 and T_3.

According to our experimental data, the Frequency Effect can bias subjective scales of responses to the geographical test. In particular, when difficult items are more frequent than easy ones, subjective responses tend to become more accurate and participants tend to perceive items as "less difficult". The former result could appear as counter-intuitive, however, it could be possible that participants can pay more attention to the items when the task needs a greater cognitive load. Therefore, participants' responses are more accurate when

the cognitive task is hard. The latter result can be explained as a special kind of contrast effect between items: when a difficult item is presented together with many items with the same difficulty level, it appears less difficult than usual. When a difficult item is presented together with many easy items, it appears more difficult than usual.

In conclusion, the Frequency Effect can bias subjective responses to tests measuring the individual level of knowledge or ability, reducing, therefore, the validity of the measurement scales of cognitive ability. More systemic studies should be carried on also on responses obtained with tests which measure intelligence or personality traits of different subjects to test if the Frequency Effect can affect measurements of intelligence or personality.

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