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Memory for the frequency of occurrence of karate techniques: A comparison of experts and novices

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Karate techniques were presented in a pattern to a group of karate students, half experts and half novices. The frequency with which these techniques appeared varied from 0 through 11. The experts and novices did not differ in the accuracy with which they judged the frequency of the techniques, but the experts showed a significant advantage over the novices in recalling the techniques. The results indicate that memory for the frequency of observed actions is not affected by subject variables such as prior knowledge, a finding consistent with the conclusion that memory for frequency is based on automatic processes.

Research (e.g., Hasher & Zacks, 1979, 1984) has shown that people are good at judging the frequency with which events have occurred, even when they do not originally intend to remember that frequency. Most of the earlier research on memory for frequency was done with verbal materials (e.g., word lists); in recent research, however, the earlier findings have been extended through the use of nonverbal materials as diverse as photographs of faces and line drawings of objects (Ozekes & Gilleard, 1989) and Japanese Kanji characters presented to English speakers (Brooks & Watkins, 1989; Wiggs, 1991). In the present study, we extend this research still further by examining observers' memory for a series of karate moves.

Hasher and Zacks (1979, 1984) proposed that the encoding of frequency is automatic, but there is controversy on this point (see, e.g., Fisk, 1986; Sanders, Gonzalez, Murphy, Liddle, & Vitina, 1987; Zacks, Hasher, & Hock, 1986). One kind of evidence cited in favor of the automaticity of encoding frequency is that people who differ from each other in intelligence or prior relevant knowledge usually show similar accuracy when asked to judge the frequency with which events have occurred (see, e.g., Hasher & Zacks, 1984). This contrasts with recall measures, which usually reveal large differences that are related to intelligence and prior knowledge. For example, experts recall more data in their domains of expertise than novices do (Ericsson, Chase, & Faloon, 1980).

In order to obtain further evidence regarding the automaticity of frequency encoding, in the present experiment we compared the memory for karate moves of karate experts and novices. The karate moves were presented in a *kata*—a logical sequence that consists of a list of prearranged martial arts techniques in a pattern. In karate, certain blocks and kicks have to occur in certain stances, depending on one's body motion, directional movement, and weight distribution. Karate techniques are used to make fighting more efficient and natural; particular stances provide a stable foundation for certain blocks and punches. Furthermore, the type of stance has to flow with the direction of body motion and weight distribution. For example, there are stances in which 70% of the weight is on the back leg and the stance is stable in all directions (fugal stance), and there are some stances in which the weight is evenly distributed but only stable in one direction (e.g., kima, chongul). Thus, there are some "illegal" moves that do not make sense in karate according to these principles. In the present experiment, no such illegal moves were used.

Given the literature on the effects of expertise (e.g., Charness, 1976; Chase & Simon, 1973), we expected that the experts would recall more karate moves than the novices would, because the experts already possessed an existing knowledge structure of the sport. However, we also expected that if the encoding of the frequency was automatic, the two groups would be equally accurate at judging the frequency with which moves had occurred.

METHOD

Design

The experiment had the between-subjects variable of expertise (experts vs. novices) and two within-subjects variables, the latter being the type of test (frequency judgment vs. recall) and actual presented frequency (0, 1, 2, 3, 4, 6, 7, 9, 11).

Subjects

The subjects were 30 student volunteers from the Tompkins Karate Association (TKA) Summer Karate Clinic, drawn from classes of experts and novices so that there were 15 subjects in each group. An ex-

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pert was defined as a first-degree black belt or other karate practitioner with at lest 3.5 years of experience in Tang Soo Do Moo Duk Kwan (taught at TKA). The most experienced expert had 8 years of training, and the least experienced had 3.5 years. The group was composed of 5 female and 10 male experts, with an age range of 15-45.

A novice was defined as a white belt or yellow belt, or any karateka with fewer than 1.5 years of training. The least experienced novice had 4.5 months of training; the most experienced had 1 year of karate training. There were 2 females and 13 males in this group, with an age range of 14-37 years.

Materials

A total of 20 karate techniques with variable frequencies were chosen from a kata created by the first author to ensure that the subjects had no prior exposure to it. The techniques and their frequencies were: upblock (4), downblock (2), reverse punch (11), front kick (2), sidekick (3), sudo block (6), round kick (1), U-punch (0), ridgehand (2), palm-up tension (3), X-block (1), down tension (2), kima stance (6), chongul stance (9), fugal stance (7), cat stance (2), mountain block (2), spinkick (0), hook kick (0), and elbow smash (1). This was the order in the subsequent frequency test list, but not the order of presentation, for these techniques must be presented within the logical confines of karate kata (e.g., mountain blocks must occur in a kima stance).

Procedure

The experiment began with the presentation of the following spoken instructions: "Please pay close attention to the kata you are about to see, because later your memory for the techniques in the kata will be tested." Then a kata, performed by the first author (a second-degree black belt karate instructor with 13 years of experience), was presented to all subjects simultaneously, although the experts were seated separately from the novices. Afterward they were asked for their judgment of the frequency with which each technique occurred; for example, "How many times did a downblock occur?" As this was asked, the isolated technique was executed, so there would be no ambiguity. The subjects recorded their responses on an answer sheet, which was collected immediately following this part of the experiment and was replaced with a blank sheet. There followed a 5-min retention interval, during which time the subjects were asked to count aloud by threes as a group. At the end of this period, a free-recall test was conducted for 60 sec, during which the subjects wrote down any techniques they could remember.

RESULTS

Frequency Estimation

A mean frequency estimate for each actual frequency was obtained by calculating a mean across subjects for every technique that occurred with a certain frequency. Mean frequency estimates for the two groups are shown in Figure 1.

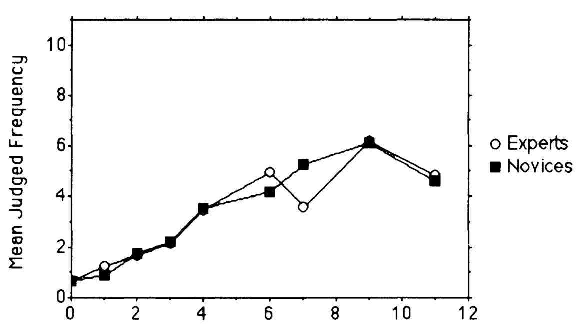

Figure 1. Mean judged frequency of karate techniques, as a function of actual frequency, for experts and novices.

As the figure makes clear, the subjects' judgments about the frequency with which the techniques occurred was close to the actual frequency. Furthermore, there was little difference between the experts' and the novices' judgments. In fact, the correlation between actual frequency and judged frequency was .907 ($n = 9, p < .0007$) for the experts and .909 ($n = 9, p < .0007$) for the novices.

Recall

Any item written down on the subjects' answer sheets that was recognizable as one of the presented techniques in the kata was counted as correct, even if it was misspelled. No one recalled items that were not in the initial sequence. As expected, the experts recalled substantially more techniques than did the novices, with the experts recalling on the average nearly twice as many techniques as did the novices. The mean number recalled by the experts (of a possible maximum of 20) was 14.9 items (*SD* = 2.0; range, 13-16), and the mean number recalled by the novices was 8.3 items (*SD* = 2.0; range, 6-12). This difference is statistically significant [$t(28) = 11.2$, $p < .001$].

DISCUSSION

This study shows that experts and novices are equally accurate at judging the frequency of karate moves, although experts are notably better than novices at free recall of the moves. In subsequent conversation, the subjects expressed surprise at being able to judge the frequency of the techniques so accurately. In fact, most thought that they had had particularly poor memories for the frequency of the various moves. This surprise is consistent with the argument that frequency information is encoded without awareness or effort, and that frequency encoding is automatic for a wide variety of events, including actions such as karate techniques.

For the most part, the pattern of accuracy in memory for the frequency of karate moves is quite similar to that obtained in studies done with other types of stimuli. Typically in such studies (e.g., Hasher & Zacks, 1984), mean judged frequency is almost identical to the actual frequency up to frequencies of approximately four, but for higher frequencies, people tend to underestimate. There was one technique that neither group judged very accurately—reverse punch—which was the only technique presented 11 times. When subjects were asked about this, their responses suggested a presentation error, in which the reverse punch was thrown too fast relative to other techniques in the kata to be noticed. This discrepancy in speed probably affected the judgment of the subjects, for research has shown that the bias of underestimating the frequency of an event can be traced to a number of possible sources, including disproportionate exposure duration (Lichtenstein, Slovic, Fischoff, Layman, & Combs, 1978).

In the case of recall, the fact that the experts were better than the novices was not likely due to a difference in the ability to generate the names; both the experts and the novices were familiar with the names of all the karate moves used. When the subjects were questioned about their responses on the recall task, the novices indicated only that they tried to remember as many techniques as they could. The experts, on the other hand, reported that they used recall strategies. For example, when trying to remember whether sudo blocks were used, they remembered that sudo blocks usually occur in fugal stances and that upblocks and downblocks usually occur in chongul stances. That is, instead of trying to recall individual bits of information, the experts gathered whole patterns of information into "chunks." It has been shown that the chunks recalled by experts are richer than those recalled by novices in the domains of digit span skill (Chase & Ericsson, 1982), basketball (Allard, Graham, & Paarsalu, 1980), computer programming (Soloway, Adelson, & Erlich, 1988), and medical practice (Norman, Brooks, & Allen, 1989).

The karate experts relied on a storehouse of prior relevant knowledge gained through years of experience in seeing these techniques paired together; the novices did not have the necessary martial arts background from which to draw inferences and chunk the material into meaningful packets of information. The recall strategies that the experts used were based on frequency-of-occurrence information that they encoded into long-term memory from exposure to the techniques over the years. This is consistent with the argument that frequency information is used in acquiring new knowledge and in organizing and retrieving existing knowledge (see, e.g., Hasher & Zacks, 1984; Wiggs, 1991).

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