The authors are with the Institute for Health Promotion and Sport Sciences, Eötvös Loránd University, Budapest, Hungary.
Therefore, physically active undergraduates were called for volunteering in the inquiry. The emerging sample \((n = 267, 95 \text{ men; } 172 \text{ women, mean age } = 20.0 \text{ yrs, } SD = 1.7 \text{ yrs})\), reported nearly nine hours of physical activity per week (mean = 8.93 hr, \(SD = 5.0, \text{ MDN } = 8.0 \text{ hr}\)), had a similar cultural background, and gave consent to participation in the investigation. Their task was to place in rank-order, on the basis of expected effectiveness—ranging from the most- to the least-effective—nine images of unbranded (imaginary) nutritional supplements in sport performance enhancement including green and red drinks, white and red pills, white powder, white caplet, energy bar, green gel, and white lotion. The nine fictive agents were selected as unnamed alternatives, resembling in perceptual characteristics, to the most common legally (nonprescription based) available, “over the counter” nutritional supplements in the region. The images were presented simultaneously to the participants using identical neutral plain color background. Respondents were asked not to associate the supplements with any specific commercially known products and to pay attention only to the perceptual characteristics of supplements. They also had to indicate whether they have used a resembling (in color and route of administration) supplement in the past. A total of three rankings were performed, in counterbalanced order, separately for: 1) strength, 2) endurance, and 3) concentration. No time restriction was imposed in the course of the study for the performance of the rankings. Participants did not consult or interact with anybody during the test session.

### Data Analysis

The data gathered from the participants were inputted, and then verified for accuracy, in Excel files. Subsequently, these data files were imported into the SPSS statistical software (version 19) for statistical analyses. Kendall’s W tests were performed for data on endurance, strength, and concentration. This test is an extension of the Friedman Test \(\chi^2\) that simultaneously reveals the results for the concordance (W, or the Kendall’s Coefficient of Concordance) in ranking the various substances. To test the association between the perceived effectiveness of the supplements and past experience with a similar substance, Spearman’s rho correlations were computed. For testing between-gender differences in past experience with similar (resembling to the rated) agents, one-way analysis of variance (ANOVA was used).

### Results

A total of 93.6\% of the participants have self-reported using in the past one or more supplements with perceptual characteristics resembling those presented in the current work. The means and standard deviations (in brackets) were as follows: 2.1 (1.5) for endurance, 1.8 (1.3) for strength and 1.7 (1.2) for concentration. No statistically significant differences were disclosed in these measures between men and women.

Friedman’s \(\chi^2\) was statistically significant in all three ratings (endurance \(\chi^2 = 83.24, p < .001\); strength \(\chi^2 = 151.96, p < .001\); concentration \(\chi^2 = 235.12, p < .001\); see Figure 1). Post hoc tests obtained on these results are summarized in Table 1). However, the Kendall’s W values were small in all three instances (endurance=.04, strength=.07, and concentration=.11), showing no agreement and, therefore, large interpersonal variability, in the order of perceived effectiveness of the supplements.

Further, nine Friedman tests (one for each fictive agent) were used with Bonferroni corrections to test the statistical differences in the expectancy of effectiveness among the three performances. These results revealed that statistically significant between-performance type differences \((p < .001)\) have emerged in the case of white lotion, white powder, green gel, and energy bar (Figure 1). The expected effectiveness of the other five perceptual characteristics did not differ statistically significantly among the three types of performances.

Finally, two correlational analyses yielded no significant results for endurance \((\rho = .03)\) and strength \((\rho = -.13)\). However, a statistically significant correlation was obtained between the perceptual characteristics and past experience with similar form of supplement for concentration \((\rho = .96, p < .001)\).

### Discussion

The findings reveal that images of unnamed nutritional supplements with different physical characteristics are perceived as having different effectiveness in enhancing three types of performances: strength, endurance, and concentration. For endurance, the green and red drinks, red pill, white powder and white capsule were perceived by the majority as most effective in enhancing performance, while the white lotion and the green gel were perceived as least effective. The latter two could be seen as generally pain relievers, rather than energy sources for endurance. For strength performance, seven substances with different visual-perceptual properties fared equally well against white lotion and green gel, again likely for the same reason as for endurance. For concentration, the green drink and the energy bar were ranked superior to the “white stuff” including white lotion, white powder, white capsule, and white pill. The finding supports recent results that color has a major influence on the subjective perception of effectiveness and resulting action of various substances (Köteles et al., 2009). From a practical point of view, these results suggest that the color and the route of administration of nutritional supplements influence the expected effectiveness, and hence the preference, of agents taken for different types of performance enhancements in sport. Gels and lotions may be the least attractive choices for enhancing endurance, strength, and concentration.

Ratings of expected effectiveness of five out of the nine supplements (i.e., green drink, red pill, red drink, white capsule, and white pill) did not differ among the three performances. The finding suggests that these agents
Complementing Figure 1, the table shows the results of the post hoc pairwise comparisons of the perceived/rated potencies of nine substances in enhancing endurance (E), strength (S), and concentration (C).

<table>
<thead>
<tr>
<th></th>
<th>Green Drink</th>
<th>White Lotion</th>
<th>Red Pill</th>
<th>White Powder</th>
<th>Green Gel</th>
<th>Red Drink</th>
<th>White Capsule</th>
<th>Energy Bar</th>
<th>White Pill</th>
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</table>

Note. Statistically significant differences (p < .05) between the rows and columns are indicated with a star.
may fair equally well in being selected for enhancing three different types of performance in sport. However, rated as least effective, the white lotion and green gel, as well as the white powder and energy bar were expected to have different effects on the three performances studied. Effectiveness ratings indicate that the white lotion and green gel were thought to be primarily effective for endurance, whereas the white powder was thought to be superior for enhancing endurance and strength, and the energy bar for concentration.

The low correlation between perceived effectiveness of the presented agents and the past experience with a resembling supplement obtained for endurance- and strength-enhancement in contrast to the high correlation with concentration, affords only a hypothetical explanation. It is likely that few students have already used nutritional supplements for enhancing strength and endurance. However, the relationship between perceived effectiveness of the agents and past experience with a similar substance was very strong for concentration. A likely explanation is that while studying for exams many students may resort to certain supplements for enhancing concentration, which could be the source of the high correlation between perceived effectiveness of the agent and past experience with a resembling supplement.

The ranking agreement was low between the participants, which could be ascribed to diverse subjective beliefs and experiences. Information and experience determine to a large extent the placebo or nocebo effects manifested by various individuals (Stewart-Williams & Podd, 2004). These findings may present a dilemma for research using a quantitative-statistical approach. A plausible solution in future research may be to recruit representative samples of the general population and then assess their preexisting beliefs concerning the effectiveness of a given agent. Subsequently, the examination of a treatment effect should somehow consider (i.e., as covariate) the past beliefs about the effectiveness of a given agent to determine the actual, or net, effect of the tested substance. Based on the current results, it is possible that observed efficacies would differ between “responders” (those who believe in the effectiveness of the agent before consumption) and “non-responders” (those who are skeptical or distrust the effectiveness of the agent before consumption). Unfortunately, net treatment effects were not gauged in this study, because the agents were fictive and only the effects of perceptual characteristics—of imaginary supplements—were examined in addressing the main scope of the research.

**Limitations of the Study**

The current study has certain limitations that ought to be considered in future research. First, by using a ranking-order assessment instead of a rating scale, a “forced-choice” method was employed. This could yield different results from assessing expectations of effectiveness on a Likert scale on which two or more perceptually different agents may be rated as equal in the perceived effectiveness. Future studies should also examine the perceived absolute effectiveness of unbranded products varying in shape and color. Second, the undergraduate sample studied here, in spite of reporting nearly nine hours of regular physical activity per week, may not be fully
representative of the elite athletic population competing at high levels or the typical “sport-supplement consumers” who are involved in exaggerated hours of training, and who are under some pressure for achievement. Finally, the nine unnamed / fictive agents, with specific perceptual characteristics, may not represent the full spectrum of freely available supplements in various sociocultural environments. It is highly recommended that prospective studies, pursuing this line of inquiry, also use real or known (branded) supplements to establish “net effects” beyond the perceived effectiveness.

Conclusions

Some agents (green and red drinks, red and white pills, and white capsule) appear to be perceived as equally effective for enhancing endurance, strength, and concentration. Others (white lotion and powder, green gel, and energy bar) are perceived as having different effects on the studied performances. This information shows that color and form of a nutritional supplement affect its expected effectiveness and, therefore, possibly the choice of the agent. Accordingly, unbranded products with color and form bearing the highest expectancy may be preferred in selection and/or consumption of nutritional supplements for various aspects of sport performance. Interindividual ratings and, therefore, expected efficacies vary to a great extent. Research on nutritional supplements aimed at enhancing sporting performances should take into consideration the initial expectancy—developed on the basis of knowledge or media-spread information and/or past experience—associated with the studied supplement.

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Authors’ Note on Contribution: AS participated in the design, statistical analysis, and manuscript preparation; MB and KF participated in the design, data collection, data reduction, and manuscript preparation; GB served as the principal investigator and contributed to study design, data collection, as well as manuscript preparation. All authors read and approved the revised manuscript.

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