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Testing the ATI hypothesis: Should multimedia instruction accommodate verbalizer-visualizer cognitive style? ☆

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Abstract

College students (Experiment 1) and non-college adults (Experiment 2) studied a computer-based 31-frame lesson on electronics that offered help-screens containing text (text group) or illustrations (pictorial group), and then took a learning test. Participants also took a battery of 14 cognitive measures related to the verbalizer-visualizer dimension including tests of cognitive style, learning preference, spatial ability, and general achievement. In Experiment 3, college students received either both kinds of help-screens or none. Verbalizers and visualizers did not differ on the learning test, and almost all of the verbalizer-visualizer measures failed to produce significant attribute *x* treatment interactions (ATIs). There was not strong support for the hypothesis that verbal learners and visual learners should be given different kinds of multimedia instruction.
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Some people (who could be called *visualizers*) learn better with visual methods of instruction, whereas other people (who could be called *verbalizers*) learn better with verbal methods of instruction. This idea–deeply engrained in the folklore of educational practice–is one aspect of what can be called the *attribute-treatment interaction (ATI) hypothesis*. In the case of verbalizer-visualizer differences, the ATI hypothesis predicts that visualizers will perform best on tests of learning when they receive visual rather than verbal methods of instruction, whereas verbalizers will perform best on tests of learning when they receive verbal rather than visual methods of instruction.

In spite of the widespread popularity of the ATI hypothesis among educators, the search for research-based ATIs over the last 25 years has had a somewhat disappointing history (Cronbach, 2002; Cronbach & Snow, 1977; Sternberg & Zhang, 2001). For example, Biggs (2001, p. 80) observed: "Significant disordinal interactions of this kind [ATIs] are rare, and providing for them is expensive if not impractical where more than one aptitude is addressed." In reviewing research on ATIs involving cognitive styles, Cronbach and Snow (1977) concluded: "The research has generated hypotheses but no firm conclusions" (p. 389). A quarter century later, the empirical research on ATIs still contains few consistent effects: "the results on any one (ATI) hypothesis are often inconsistent" (Cronbach, 2002, p. 21).

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The purpose of the present study is to carefully examine one aspect of the ATI hypothesis, using 14 different measures of the verbalizer-visualizer dimension, and an on-line science lesson that offers help screens in the form of printed text (text group) or illustrations (pictorial group). Previous work (Mayer & Massa, 2003) has identified three facets of the verbalizer-visualizer dimension-cognitive ability (i.e., proficiency in creating, holding, and manipulating spatial representations), cognitive style (i.e., tendency to use visual or verbal modes of knowledge representation and thinking), and learning preference (i.e., preference for receiving instruction involving pictures or words). In the present study, we examine whether students who score high on spatial ability, visual cognitive style, or visual learning preference learn better from a multimedia lesson containing pictorial help screens, whereas those scoring high on verbal ability, verbal cognitive style, or verbal learning preference learn better with text help screens. We also include several tests of general achievement related to mathematical and verbal achievement.

1. Experiment 1

Experiment 1 was conducted to determine whether visual learners learn better from multimedia instruction that offers help screens using pictures whereas verbal learners learn better from multimedia instruction that offers help screens using words.

1.1. Method

1.1.1. Participants and design

The participants were 52 college students recruited from the Psychology Subject Pool at the University of California, Santa Barbara, with 26 students serving in the pictorial group and 26 in the text group. The mean age was 18.00 years (S.D. = 1.04); the percentage of men was 44.20 ($n = 23$) and the percentage of women was 55.80 ($n = 29$); and the mean combined SAT score was 1180 (S.D. = 144).

1.1.2. Materials and apparatus

The individual differences materials consisted of 11 instruments measuring cognitive style, learning preference, or spatial ability in which high scores denote visualizers and low scores denote verbalizers, as well as three additional measures of general achievement. The instruments were categorized based on a previously conducted factor analysis (Mayer & Massa, 2003), and are summarized in Table 1.

Four measures assessed verbalizer-visualizer cognitive style: the 15-item Verbalizer-Visualizer Questionnaire (VVQ) developed by Richardson (1977) in which students rated their agreement to statements such as, "I prefer to read instructions about how to do something rather than have someone show me" along a 7-point scale; a 6-item Santa Barbara Learning Style Questionnaire intended to tap the same factor as the VVQ but with fewer questions (Mayer & Massa, 2003); a 5-item Learning Scenario Questionnaire that asked about preferences in five learning situations based on brief text descriptions, such as whether you would rather read a paragraph or see a diagram describing an atom (Mayer & Massa, 2003); and a 1-item Visual-Verbal Learning Style Rating in which students are asked to rate on a 7-point scale the degree to which they are more verbal than visual or more visual than verbal (Mayer & Massa, 2003). In addition, we included another measure intended to assess cognitive style that did not load onto the same factor as any of the other tests in previous work (Mayer & Massa, 2003): the verbal-imager subtest of the Cognitive Styles Analysis (CSA) developed by Riding (1991) in which students press "true" or "false" buttons in response to statements on a computer screen such as, "COAL and SNOW are the same COLOR."

Three instruments – all original – assessed learning preference in the context of authentic multimedia training tasks. First, there are two scales of a 5-item Multimedia Learning Preference Test which consisted of five text frames explaining the process of lightning formation presented via computer screen so that the learner can click on help buttons that offer an annotated graphic (i.e., pictorial help) or a glossary that define selected terms (i.e., verbal help); the choice scale was based on the number of times the learner selected the visual help first, and the preference scale was based on the number of times the learner reported that the visual help was most useful when asked subsequently. Finally, a 5-item Multimedia Learning Preference Questionnaire is a paper version of the preference scale of the Multimedia Learning Preference Test with a seven-point response scale ranging from strongly prefer verbal help to strongly prefer visual help for each item.

Three measures assessed a specific cognitive ability, namely spatial ability: a 3-minute version of the Card Rotations Test from the Kit of Factor-Referenced Cognitive Tests (Ekstrom, French, & Harman, 1976), a 3-minute version of the Paper Folding Test from the Kit of Factor-Referenced Cognitive Tests (Ekstrom et al., 1976), and a 2-item Verbal-

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