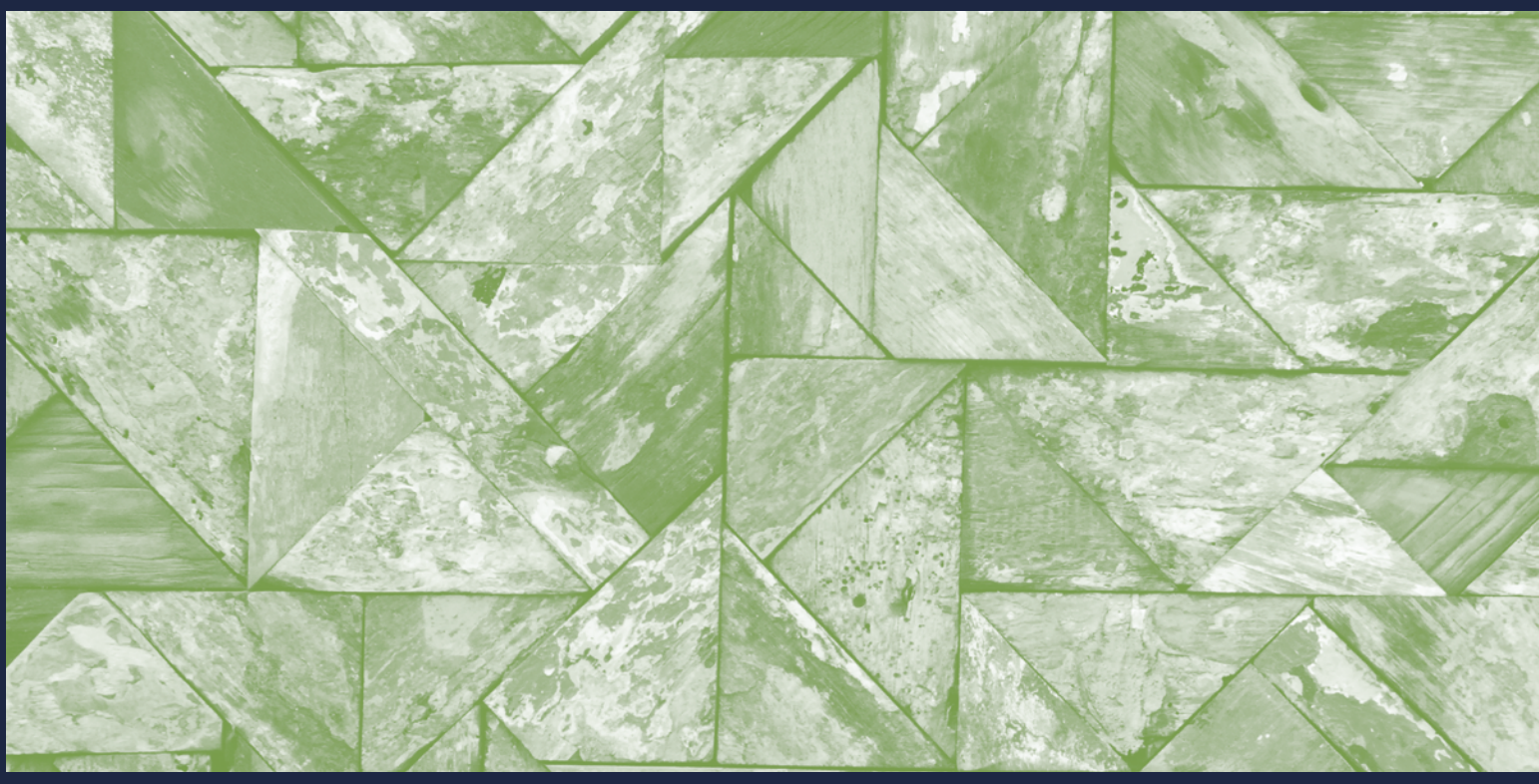
MAT

MILLER ANALOGIES TEST®

Understanding Analogies

The Analogy Item Format and the *Miller Analogies Test*



Don Meagher, EdD
Senior Research Director
Clinical Assessment

Pearson

www.pearsonassessments.com/mat

For inquiries or reordering:
800.622.3231
www.pearsonassessments.com/mat

Copyright © 2021 NCS Pearson, Inc. All rights reserved.

Warning: No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any information storage and retrieval system, without the express written permission of the copyright owner.

Pearson, Miller Analogies Test, MAT, and the **MAT logo** are trademarks in the U.S. and/or other countries of Pearson PLC or its affiliate(s).

NCS Pearson, Inc. 5601 Green Valley Drive Bloomington, MN 55437

Produced in the United States of America.

v.A

Product Number 66206

Understanding Analogies

Two views of analogies

Once a mainstay of college admission tests, many educators have come to see the analogy format as obsolete, something like a manual typewriter in the age of digital technology. The title of a sample quiz of GRE item types that appeared in a *New York Times* "Education Life" supplement—"Forget Analogies, Reason More, Memorize Less"—sums up this all too common perception that analogies require fewer cognitive abilities than other item types and are not worthy of admission tests.

However, both research evidence and practical experience suggest the opposite of such claims and point to the usefulness and economy of the analogy format in measuring skills that are important to success in college, graduate school, and work. It is for these reasons that the *Miller Analogies Test* (MAT)—an exam composed entirely of analogy items—continues to show predictive value in admission decisions. This paper presents the view that the analogy item format represents a valid way to measure important cognitive skills, and that responding to test items stated as analogies reflects comprehension skills and analytical reasoning abilities that are essential to success in graduate school.

Copyright © 2021 NCS Pearson, Inc. All rights reserved.

Why Analogies?

The MAT is a high-level mental ability test requiring the solution of problems stated as analogies. The degree to which the MAT measures meaningful characteristics—its *construct validity*—depends on the value of the analogy format in assessing abilities that are essential to success in graduate school. Evidence from psychologists suggests that it does.

Many cognitive psychologists suggest that the ability to think analogically has practical benefits in activities such as problem solving, constructing explanations, and building arguments, and represents a fundamental way in which understandings of the world are formed and communicated (Bartha, 2019; Gentner et al., 2001; Holyoak & Thagard, 1996; Kollias & McClelland, 2013).

Psychologists also suggest that the analogy format represents an efficient and effective way to sample reasoning processes and to measure verbal reasoning, inferential ability, and analytical intelligence (Kuncel et al., 2004; Kmiecik et al., 2019; Lohman, 2004; Resing et al., 2017; Richland & Simms, 2015; Sternberg, 1977, 1985, 1988). Psychologist Robert Sternberg has suggested that all of the information-processing components involved in inductive reasoning are required to solve analogy problems (1985):

1. **Encoding** — comprehending relevant information
2. **Inference** — relating given concepts to other concepts
3. **Mapping** — recognizing common rules shared by concepts
4. **Application** — applying inferred rules to new concepts
5. **Comparison** — choosing options that conform to ideals
6. **Justification** — judging the reasonableness of choices
7. **Response** — demonstrating choices made by inductive reasoning

According to David Lohman of the University of Iowa, analogies represent an efficient item type that allows the sampling of verbal reasoning processes (2004). Lohman considers the recent trend of moving away from using the analogy as an item type in standardized testing, and away from aptitude testing generally, to be a mistaken attempt to make admission testing more equitable. Indeed he argues that aptitude tests have an advantage over achievement tests in making predictions about success in new situations.

Independent studies have found the MAT to be a moderate to strong predictor of subsequent performance, with predictive validity statistics comparable to other standardized admission tests commonly used by graduate and professional schools (Kuncel & Hezlett, 2007a, 2007b). In a meta-analysis, Kuncel et al. (2004) also suggest that the MAT represents an especially useful measure of general cognitive ability, which they consider to be strongly related to the acquisition of knowledge and skills. The authors conclude that the analogical reasoning required on the MAT involves all the principles of cognition and represents a valid predictor of performance in both academic and work settings.

The MAT has been designed to measure the same cognitive processes that researchers have identified as involved in solving problems stated as analogies.

What is an Analogy?

Defining the MAT Analogy

An analogy is a way of showing that two situations share a relational structure. A MAT analogy is a statement suggesting that two terms are related to each other in the same way that two other terms are related to each other.

Solving MAT analogies first involves recognizing a relationship between two given terms and then looking for the same relationship between a third given term and one of four possible answer options.

The correct answer must be selected by inferring the relationship between two of the given terms and then *mapping* this relationship onto the pair formed by the third given term and one of the answer options. Mapping—correctly seeing the relationship between pairs of related terms—is the essence of solving the MAT analogy.

An analogy item that effectively assesses analytical reasoning involves both understanding the meaning of the terms involved and then recognizing relationships between terms. The difficulty of a MAT analogy item is not only related to the difficulty of the terms involved, but also involves the subtlety of the relationship between the terms.

Copyright © 2021 NCS Pearson, Inc. All rights reserved.

The Structure of a MAT Analogy Item

MAT analogy items are written as equations in the form "A : B :: C : D," which can be read either as "A is related to B in the same way that C is related to D" or as "A is related to C in the same way that B is related to D." Examinees are informed that an item is never constructed so that the first term is related to the fourth term.

In a MAT item, one term in the analogy is missing and has been replaced with four answer options, only one of which correctly completes the analogy to form two pairs of terms with a valid logical relationship between them.

An Example of a MAT Analogy Item

One term in each MAT analogy item has been replaced with four options, only one of which is correct. The examinee is expected to select the option that creates a valid analogy, as illustrated in the following example:

Homophone : (*a*. articulation, *b*. principle, *c*. significance, *d*. synonym) :: Pronunciation : Meaning

The first step in solving this item is to decide which two of the three terms in the stem form a complete pair—either "Homophone is related to Pronunciation" (the first term is related to the third term) or "Pronunciation is related to Meaning" (the third term is related to the fourth term).

In this example, *Pronunciation* and *Meaning* are related in the sense that a pronunciation can have meaning, and *Homophone* and *Pronunciation* are related in that homophones are words that are pronounced the same way. The only way to determine which of these relationships is the essential one in the analogy is to look at the four answer options.

In this item, the correct answer is "*d*. synonym" because a homophone is one of two or more words that have the same pronunciation, and a synonym is a word that has the same meaning as another word.

Thus, the two terms in each pair are related in the sense that one term is a defining characteristic of the other. Each of the other three options has some relationship to one or more of the three given terms but does not form a valid analogy.

As this example illustrates, MAT analogies involve an analytical reasoning process in the context of a specific content area—in this case, language.

Can Analogies Have Content Relevance?

The content relevance of test items is an important aspect of the validity of the test as a whole—the degree to which the test actually measures what it is intended to measure. One type of validity that relates directly to the content of the MAT analogy items is content validity—the degree of correspondence between the contents of the test and the logical and curricular domains intended to be measured.

MAT analogy items have been designed and constructed to measure knowledge, skills, and abilities considered necessary for success in American graduate schools.

Solving MAT analogy items requires both the cognitive skills involved in recognizing analogical relationships and background knowledge that American college students acquire through undergraduate general education and general reading and experience.

Each MAT analogy involves terms representing ideas from a specific content area that are related to one another in a specific analogical relationship.

The following table lists the content areas and analogical relationships represented in MAT items.

Copyright © 2021 NCS Pearson, Inc. All rights reserved.

MAT Content Areas	
General (life experience, general reading, work)	
Humanities (art history, comparative religion, ethics, history, literature, modern and classical languages, philosophy, music, visual arts)	
Language (composition and rhetoric, grammar, word connotations, word meanings, word parts, word pronunciations and sounds)	
Mathematics (algebra, arithmetic, finance, geometry, numbers, probability, statistics)	
Natural Sciences (astronomy, biology, chemistry, earth science, ecology, environmental science, geology, physical geography, physics, public health)	
Social Sciences (anthropology, civics, criminology, economics, education, geography, political science, psychology, sociology)	
MAT Analogical Relationships	
Semantic (word meanings)	1. Similarity/Contrast (synonyms, definitions, similarities, antonyms, contrast, differences) 2. Intensity (size, degrees, magnitudes, extents) 3. Completion (parts of expressions, split phrases, words)
Classification (hierarchical relationship, classification, inclusion)	1. Category (member/class, class/member of class, subordination, hierarchy) 2. Membership (members of same class or category, coordination) 3. Whole-to-part, part-to-whole
Association (characterization, affiliation)	1. Object/Characteristic (attribute, description, lacking quality, source, component, location, setting) 2. Order (sequence, reciprocal, by-product, transformation) 3. Agent/Object (cause/effect, creator/creation, function of, action taken by, purpose for, tool used by)
Logical/Mathematical (mathematical, phonetic)	1. Mathematical (logical/mathematical equivalence, numerical fractions, multiples) 2. Phonetic (letter patterns, sound patterns, rhymes, homophones, similar sounds)

Examples of MAT Analogies

The following examples illustrate items that address the general content areas and types of analogical relationships found on the MAT. Each example begins with a description of the content area being illustrated, then provides a sample analogy involving that content, and finally identifies the relationship type and provides an explanation of the item.

- **General:** These items involve terms, concepts, and information not necessarily associated with a specific content area, but reasonably assumed to be common knowledge among undergraduates and other educated adults from general reading and exposure to American culture.

Napoleon : Pergola :: (*a*. baker, *b*. general, *c*. lumber, *d*. trellis) : Carpenter

Association (Agent/Object): This analogy makes no sense if *Napoleon* is thought of as the French general and emperor. However, a napoleon is also a pastry. Therefore, a napoleon (the pastry) is made by a baker, just as a wooden pergola is built by a carpenter.

- **Humanities:** These items involve terms, concepts, and information from one of the branches of knowledge primarily concerned with human culture, which may include the fields of history, the arts, literature, philosophy, or other fields commonly considered humanities.

(*a*. consciousness, *b*. consequence, *c*. participation, *d*. philosophy) : Pragmatism :: Experience : Phenomenology

Association (Object/Characteristic): Pragmatism is a school of philosophy based on the principle that an idea or proposition should be judged primarily on its practical consequence. Phenomenology is a school of philosophy that attempts to examine and describe human experience of phenomena.

- **Language:** These items involve aspects of English grammar, usage, or vocabulary, primarily the understanding of word or word part meanings and the ability to recognize the relationships between those meanings.

Copyright © 2021 NCS Pearson, Inc. All rights reserved.

Annoy : Enrage :: Enlarge : (*a*. augment, *b*. exaggerate, *c*. increase, *d*. reduce)

Semantic (Intensity): To enrage is to annoy, but to a greater degree. The correct answer should then be the word that means to enlarge, but to a greater degree—exaggerate. This is an example of an item that requires an examinee to distinguish fine shades of meaning between terms and to see that the difference between the words *annoy* and *enrage* is one of degree.

- **Mathematics:** These analogies include concepts from number theory, arithmetic, algebra, or geometry. Analogy items with math content may use numbers, words, symbols (e.g., $\angle$, $\perp$, π) or combinations of these. For some of these items, an examinee may also have to use computation to determine the value of the missing term.

$2^3 : 2^2$ :: (*a*. 2, *b*. 4, *c*. 6, *d*. 8) : 4

Non-Semantic (logical/mathematical equivalence): The relationship in this analogy is that 2 cubed equals 8, just as 2 squared equals 4. Solving this analogy involves the recognition that the values forming the analogy represent one number and its cube and another number and its square, and the math skill of cubing and squaring numbers.

- **Natural Sciences:** These analogies include terms, concepts, and information from one of the branches of knowledge primarily concerned with nature and the physical world, which may include the fields of biology, chemistry, ecology, physics, or the history of these fields.

Limestone : (*a*. cement, *b*. metamorphic, *c*. sedimentary, *d*. volcano) :: Granite : Igneous

Classification (Category): The last two terms in the stem have a member/class relationship. Granite is an example of igneous rock, and limestone is an example of sedimentary rock.

- **Social Sciences:** These analogies involve terms, concepts, and information from one of the branches of knowledge primarily concerned with human social or cultural behavior, which include the fields of cultural anthropology, economics, political science, psychology, sociology, or the history of these fields.

Date : Letter :: (*a*. fig, *b*. inspection, *c*. event, *d*. sign) : Check

Semantic (Similarity/Contrast): Only when the word *date* is seen as a verb does it become clear that to date a letter is to write the day, month, and year on it and, similarly, to sign a check is to write one's name on it.

Summing Up

MAT analogies involve both content knowledge and analytical reasoning. Content knowledge is required to understand the meanings of the terms in the item, and analytical reasoning is necessary to recognize the analogical relationship between terms.

Many studies conducted over the years have shown positive correlations between MAT scores and subsequent academic performance. In their meta-analysis involving more than 20,000 participants, Nathan Kuncel and colleagues suggest that the MAT is an assessment of general cognitive ability that can be a valid predictor of performance in both academic and work performance settings (Kuncel & Hezlett, 2007a, 2007b; Kuncel et al., 2004). These researchers found moderate to high correlations between the MAT and several indications of graduate school performance, particularly for first-year GPA and comprehensive examination scores. They conclude that the MAT is not only a useful predictor of subsequent grades, but also of other criteria relevant to success in graduate school and work, including evaluations of potential and creativity.

The abilities involved in recognizing analogical correspondences are used by all of us. They are not only important in the world of academics but also in the workplace and in the way each of us understands ourselves in relation to the world. Because the ability to form analogies is an essential part of our intellectual functioning, it makes sense to involve them on assessments of academic potential.

Indeed, the predictive value of MAT scores not only indicates the relevance of the test, but also suggests the relevance of the cognitive abilities involved in correctly solving analogy items.

Copyright © 2021 NCS Pearson, Inc. All rights reserved.

References

Bartha, P. (2019). *Analogy and analogical reasoning.* Stanford Encyclopedia of Philosophy. https://plato.stanford.edu/entries/reasoning-analogy/

Gentner, D., Holyoak, K. J., & Kokinov, B. K. (2001). *The analogical mind: Perspectives from cognitive science.* MIT Press.

Holyoak, K. J., & Thagard, P. (1996). *Mental leaps: Analogy in creative thought.* MIT Press.

Kmiecik, M. J., Brisson, R. J., & Morrison R. G. (2019). The time course of semantic and relational processing during verbal and analogical reasoning. *Brain and Cognition, 129,* 25–34.

Kollias, P., & McClelland J. L. (2013). Context, cortex, and associations: A connectionist developmental approach to verbal analogies. *Frontiers in Psychology, 4,* 857.

Kuncel, N. R., & Hezlett, S. A. (2007a). Standardized tests predict graduate students' success. *Science, 315*(5815), 1080–1081.

Kuncel, N. R., & Hezlett, S. A. (2007b). Supporting online material for standardized tests predict graduate students' success. [Electronic version]. *Science, 315*(5815).

Kuncel, N. A., Hezlett, S. A., & Ones, D. S. (2004). Academic performance, career potential, creativity, and job performance: Can one construct predict them all? *Journal of Personality and Social Psychology, 86*(1), 148–161.

Lohman, D. F. (2004). Aptitude for college: The importance of reasoning tests for minority admissions. In R. Zwick (Ed.), *Rethinking the SAT: The future of standardized testing in university admissions* (pp. 41–55). Falmer Press.

Resing, W. C. M., Bakker, M., Pronk, C. M. E., & Elliott, J. G. (2017). Progression paths in children's problem solving: The influence of dynamic testing, initial variability, and working memory. *Journal of Experimental Child Psychology, 153,* 83–109.

Richland, L. E., & Simms, N. (2015). Analogy, higher order thinking, and education. Wiley Interdisciplinary Reviews: *Cognitive Science: 6*(2), 177–192.

Sternberg, R. J. (1977). *Intelligence, information processing, and analogical reasoning: The componential analysis of human abilities.* Lawrence Erlbaum.

Sternberg, R. J. (1985). *Beyond IQ: A triarchic theory of human intelligence.* Cambridge University Press.

Sternberg, R. J. (1988). *The triarchic mind: A new theory of human intelligence.* Viking.

The New York Times (2006). Forget analogies, reason more, memorize less. https://www.nytimes.com/2006/01/08/education/edlife/forget-analogies-reason-more-memorize-less.html.

Copyright © 2021 NCS Pearson, Inc. All rights reserved.