The Difference between Gifted and Ordinary Children in Jordan in their Use of Intuitive Rule "More A- More B".

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Abstract

The primary purpose of this study was to examine the difference between gifted and ordinary students in Jordan in their use of intuitive rule "More A-More B". Participants of the study consisted of (240) students divided into two groups (120 gifted, and 120 ordinary students) completed I used a questionnaire including 8 tasks relates to the rule "More A- More B". An analysis of variance was carried out for correct responses for intuitive rule " More A- More B" with the factors giftedness (ordinary, gifted) and grade level (10^{th} 11^{th} 12^{th} grades). Results indicate that there is a significant differences were between gifted and ordinary students in their responses to tasks embedded in rule "More A-More B: The gifted students gave more correct responses than the ordinary students ($F=13.9$, $p<0.01$).

Keywords: Gifted**,** Ordinary Children, Intuitive Rule "More A-More B".

Literature Review

The literature review includes two parts: Intuitive rules and giftedness.

Intuitive Rules:

In Chapter 1, I briefly presented the theory of the intuitive rules, relating to its main characteristics. Here I shall first discuss the similarities and the differences between this theory and other, main approaches that are commonly used in mathematics and science education regarding students' ways of thinking. Then I shall describe, in more details, of the intuitive rule " More A- More B".

Intuitive Rules and Other Theories

Many teaching and learning theories assume that knowledge about children's conceptions and ways of thinking could significantly improve science education. This has been the main motive for intensive research on students' conceptions and reasoning in the context of mathematics and science education. Most of this research has been content specific and aimed for detailed descriptions of particular alternative concepts and reasoning. A major common finding was that students hold persistent of alternative conceptions and misconceptions, which are not in line with the scientific notions.

I shall start by referring to the theory of Piaget and his followers (e.g., Flavell, 1963; Lawson, 1995; Piaget, 1969; Piaget & Inhelder, 1974; Shayer & Adey, 1981). Piaget identified the forms of reasoning required to provide correct responses to given tasks, arguing that incorrect responses result from the lack of required cognitive schemes. This influential approach accounts for and predicts many incorrect responses that students of particular ages provide to given tasks.
It does not, however, account for the variability in student's responses to tasks, which according to these theories demand the very same logical scheme (e.g., the phenomenon of horizontal decalage). The main difference between Piaget's theory and the intuitive rules theory is that Piaget analyzed the tasks according the logical schemes that are required for providing correct responses. The intuitive rules theory, however, analyzed the task in reference to the nature of the task (e.g., comparison, successive division) and the salient, external features of the tasks.

An approach that was developed in mathematics and science education, in reaction to Piaget's attempts to identify content-free forms of reasoning, is the alternative conception paradigm (e.g., Tall & Vinner, 1981; Driver, 1994). This approach aimed at providing detailed descriptions of certain particular alternative conceptions. According to it the child takes an active, constructive role in the knowledge acquisition process and brings to the learning situation alternative, internally coherent, robust and persistent conceptions. Yet there is evidence that students tend to respond inconsistently to tasks related to the very same mathematical or scientific concept, evidence that are in contrast with the alternative conception paradigm (Clough & Driver, 1986; Svensson, 1989; Tirosh, 1990; Tytler, 1998a, 1998b). The main difference between the alternative approach theory and the intuitive rules theory is that the alternative approach theory analyzed the tasks according the scientific conceptions that are required for providing correct responses. The intuitive rules theory, however, is a domain- general approach and analyze the task in reference to the nature of the task (e,g., comparison, successive division) and to salient, external features of the tasks.
An approach that is essentially similar to the alternative conception one was developed by Fischbein (1987). His main contribution was the assertion that students' scientific and mathematical alternative conceptions are intuitive. He characterized the nature of intuitive thinking and identified primary and secondary intuitions in different scientific and mathematical content domains. The main characteristics of intuitive responses according to Fischbein are self – evidence, perseverance, coerciveness and immediacy (Fischbein, 1987). Fischbein's work was embedded in specific content areas, assuming that the intuitions regarding these content areas are developed through specific experience related to these content domains.
The intuitive rules are also self – evident, coercive and immediate. Yet, unlike Fischbein's intuitions, the intuitive rules are not embedded within a specific, content domain.
Another approach refers to one content domain (i.e., physics) and attempts to find communalities in students' responses within this domain (e.g., Andersson, 1986; Viennot, 1985). One representative if this approach is Andersson (1986). He analyzed children's responses to a large group of tasks related to temperature and heat, electricity, optics and mechanics. He identified a common core in them, which he called the experiential gestalt of causation, and he posited that this gestalt consists of an agent, instrument, and an object. The agent directly, with his/her own body, or indirectly, with the help of an instrument, affects the object. Through repeated testing and investigating in the world, this experiential gestalt is reinforced, and the child discovers quantitative relationships between causes and effects: the greater the efforts he makes the greater the effect on the object: The harder the swings is pushed, the higher it goes; the harder the ball is thrown, the further is travels. These responses are in accordance with the first intuitive rule "More A – More B", and could be regarded as specific instances of it, in the context of physics.

A second attempt to find commonalities in students' responses to tasks in physics was made by Viennot (1985). She looked for a formulation of casual reasoning that would be broad enough to cover many kinds of physical systems. She suggested that students tended to answer as if they had in mind a "conceptual structure" or "a way of reasoning" described by "IF (set of situations) Then (features of response). An example of this can be found in Engle (1982) and Sere (1982) who reported that in a situation involving vessels containing air under pressure with no movement, students commonly argued that the air does not push and that there is no pressure. They concluded that these students responded as if they had in mind the rule "pressure only has meaning if there is a displacement". The rules that these researchers refer to relate to "If - Then" reasoning in the context physics. The intuitive rules, however, refer to different types of rules that are defined by the nature of the task, and are not specific to one content area.

In sum, the intuitive rules, unlike other theoretical approaches to students' reasoning in science and mathematics, are defined according to students' responses to tasks, and according to the logical or the conceptual analysis of the task. For instance, the intuitive rule "More A - More B" is defined according to this type of responses, given to comparison tasks, related to different conceptual or logical tasks.

My study is embedded within the theory of Intuitive Rules. This theory suggests that students' responses to mathematical and scientific tasks are determined by intuitive schemes which are activated by specific external features of the tasks. These intuitive rules are activated when students are asked to respond to many mathematics, physics, biology, and chemistry tasks. The resulting responses are often incorrect. The essential claim of the intuitive rules theory is that human responses are determined mainly by irrelevant external features of the tasks and not by related concepts and ideas (Stavy & Tirosh, 2000).

I shall briefly describe and discuss the intuitive rule: "More A –More B"

More A – More B

The intuitive rule "More A – More B" is reflected in students responses to tasks in which two objects which differ in a certain salient quantity A are described ($A_1 > A_2$). Students are then asked to compare the objects with respect to another quantity B ($B_1 = B_2$ or $B_1 < B_2$). In these cases a substantial number of students responded inadequately according to the rule "More A (the salient quantity) – More B (the quantity in question)".

a. Optical Illusion

I shall provide some examples of situations in which the application of this rule result in incorrect responses.

Consider this figure

In some situations what we perceive consistently differ from what is correct, and this may be referred to as an optical illusion. There are many examples of them, and a long history of experimentation and theories designed to account for them. It is important to note that the idea of optical illusion presupposes that the object or pattern concerned would be perceived differently under other conditions. For example, the apparent length of line is altered by adding oblique lines, known as fins, to both ends.

This is called the Muller-Lyer illusion (as described in the figure above), and it is an instance of the distortion of the perceived geometry of simple plane figures (Wade & Swanston, 1991). Nearly all optical illusions are the result of training our eyes to adjust to the pattern of our surroundings. We are able to make observations and comparisons only by experience. When we observe things to which our senses have not adjusted, they appear as illusions. Some illusions, however, may occur as a result of the physical characteristics of the eyes (Brandes, 1983). One example of such an illusion is illustrated in the figure above (Muller-Lyer illusion).

When one looks at these two lines, one can not overcome the impression that the lower line segment is longer, although both have the same length. This well known optical illusion can be interpreted as an instance of the use of the rule. More A– More B when A is the length of the whole object in each drawings and B is the length of the line segment. In spite of the fact that it is possible to directly observe the actual equality in the length of the two line segments, the difference in the total length of the drawings forces us to think that “The longer the object, the longer the line segment”. Even after being told (or after measuring) that the two line segments do have the same length, it is next to impossible to overcome the first impression of inequality.

b. Time

Children’s understanding of the concept of time is often analyzed via their ability to compare the duration of pairs of events. In a series of studies, Piaget (1969) found that children aged 4 – 9 judged time by the events that occurred during the time span in question. He noted that when two events involve different speeds, the child considered the time span of the faster event to be longer. In the same way, when two actions conclude with different amounts produced, the child attributed the longer duration to the event that produced more. In a typical Piagetian experiment, two toy cars were made to run for the same duration on parallel tracks. Children often claimed that “the car which stopped further ahead ran for more time” or that “the car that ran faster ran for more time”. These responses are in line with the intuitive rule: More A (further, faster) - More B (more time).

c. Conservation

Conservation of quantities

Let us examine this task:

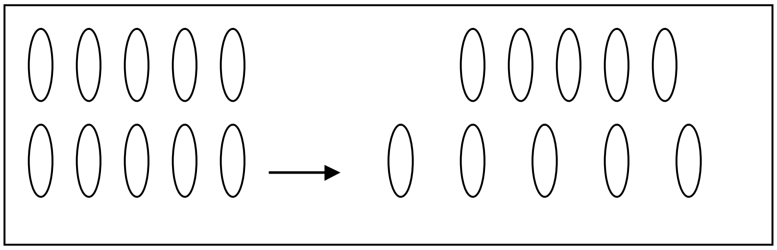
Two identical cups contain equal amounts of water. The water in one of these cups is poured into another cup, which is taller and narrower.

Is the amount of water in the first cup equal to the amount of water in the narrower and taller cup? If not, in which cup there is more water? why?.

This is a typical conservation task. Conservation refers to the understanding that quantitative relationships between two objects remain invariant (are conserved), in the face of irrelevant changes. When asked to compare the (equal) amount of water in the two differently shaped cups, children up to the age of about five or six paid attention only to the relative heights of the water in the two cups arguing that “there is more water in the taller cup” (Piaget, 1965, 1952). This response is in line with the intuitive rule: More A (taller) - More B (water).

Conservation of numbers

Piaget (1965, 1952) studied children's dependence on length and density when asked to compare the number of objects in two rows containing the same number of objects.



Young children pay attention to the relative lengths of the two rows. Rows of the same length were said to have the same number of objects, and longer rows were said to contain more objects than shorter rows. Some older children based their judgment on the relative density of the two rows, stating that the denser row was more numerous. These two responses are in line with the intuitive rule More A (length of row / density of row) - More B (number of objects).

2.2 Giftedness

This study aims to investigate the differences in performance between gifted students and ordinary students in their use of intuitive rule "More A- More B". In the previous section I reviewed the literature on intuitive rules. In this part I review the second element in the study regarding talented and ordinary students. More specifically I refer to historical aspects of giftedness, definitions of giftedness and ways to identify gifted students.
An important investigation was started by Terman who published a five volume report on the selection of about 1000 children with an IQ of above 140 which were selected from a population of one quarter of million children in California, and follow-up study for a period of 25 years. The study continues today with investigations of the children and grandchildren of the original sample,. This was considered (and still is) the most important investigation of giftedness ever done.
Among the many findings, the following ones are of importance. Gifted students have higher ability in performing their school assignments and duties. They are more intellectually developed than their classmates. They do well in all school subjects. The percentage of gifted students who attended graduate studies is higher than the percentage of ordinary students (Davis and Rimm, 1985).
Terman, and Odeh, (1959) studies, as well as those of Gallgher (1979) showed that the physical characteristics of gifted children are better than those of their normal peers.

The launch of the first space investigation by the Soviets, which demonstrated the Russian superiority in this area, promoted the interest in the best promising minds in the United States. Special programs for selecting and training gifted children multiplied and the field rather neglected till then, started to flourish.

In the last decades many researchers study various aspects of giftedness. Such studies featured methods of early diagnosis and assessment of the gifted and ways of caring for and giving guidance to the gifted. This indicates recognition of the need for special attention to this group. Universities and research centers in the world are showing a lot of interest in this field. Scientists and resources are recruited to develop experimental studies.

In the mid-1960s, an exciting gifted education movement began in the United States, one which includes federal and state legislation, special funds, new programs, and very high interest and commitment by teachers, administrators and educational researchers (Davis and Rim, 1985; Anastasi and Foley, 1959). Currently, this field is growing in importance in the education domain, as more and more programs are created to highlight this domain.

Academic coursework was telescoped for bright students. College courses were offered in high schools; foreign languages were taught in elementary schools. Public and private funds were earmarked for training in science and technology. Acceleration and ability grouping were used, and efforts were made to identify gifted and talented minority students. New mathematics and science curricula were developed, most notably the School Mathematics Study Group (SMSG), Physical Science Study Committee (PSSC), and Biological Science Curriculum Study (BSCS). Virtually all large school systems have initiated new programs. Many individual schools and even individual teachers, not waiting for formal district action, initiated special services and training for gifted children. At that time many researchers developed diagnostic tests, ways of evaluating specific programs for gifted students, and many related articles were published (Davis and Rimm, 2004).

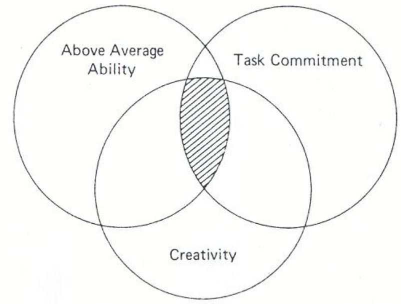
The field of gifted education continues to evolve toward the close of the twentieth century. Advancements in education and psychology brought empirical and scientific credibility to this field. Research on mental inheritance, subnormal children, construction of instruments to measure both the sub and super normal, and their realization that graded schools could not adequately meet the needs of all children.

Recently, the National Association for gifted children published a report in which it was claimed that the needs of gifted students are not adequately met (Colangelo, Assouline and Gross, 2004). Consequently, a call was made for additional research on giftedness and support for gifted children.

Many definitions appeared to explain what is meant by a gifted child. Some of the definitions concentrated on the mental ability while other definitions concentrated on high academic achievement. Some definitions concentrated on creativity and on personal and mental characteristics. The American psychologist Lewis Terman was the first to use the term “gifted”. Terman (1916, 1925) focused on developing and administering the Stanford-Binet Intelligence Scale, based on the earlier work in France by Binet. Terman offered his well-known premise, which essentially stated that the gifted and talented individuals are those who scored at the top 3% of the population on the Stanford-Binet Scale (Brown, Renzulli, Gubbins, Siegle, Zhang and Chen, 2005).

Other definitions of gifted children reflect changes in attitude towards their performance in society and their social value. These definitions do not consider mental ability as the only measure in defining the gifted child. Other kinds of performance are also considered. Academic achievement, creative thinking, special talents and personal characteristics are examples of these other important measures. This approach is considered by Newland (1976), Heward and Orlansky (1980) and Marland (1972).

Renzulli (1979) in his three-ring definition (see figure below), defined the gifted child as an individual with high mental and creative ability and an ability to commit her/himself to the performance of required assignments.



Renzuli, Reis, and Smith (1981) argued that a gifted person is one that contributes to society in three critical characteristics: high creativity, high motivation, and above average (but not necessarily high) intellectual ability.
This multi- talented approach, which considers a number of measures in defining the gifted child was adopted by the United States Office of Education, and enacted into law by the US Congress in the Gifted and Talented Children's' Act. The definition states that gifted children and, whenever applicable, youth who are identified at the pre-school, elementary, or secondary level as possessing demonstrated or potential abilities that give evidence of high performance capability in areas such as intellectual, creative, specific academic or leadership ability or in the performing and visual arts, and who by reason thereof require services or activities not ordinarily provided by the school.

By 1988, this definition had been adopted into legislation by 39 US States since it defined giftedness more broadly than simply in terms of IQ, while also offering many services to different kinds of gifted and talented children (Milgram, 1989).

The past three decades witnessed substantial theoretical efforts to define the construct giftedness. Borland's (1989) defines giftedness as those students in a given school or school district who are exceptional by virtue of markedly greater than average potential or ability in some area of human activity generally to be the province of the educational system and whose exceptionality demands special-education needs that are not being met adequately by the regular core curriculum (Stephens & Karnes, 2000).

Cassidy and Hossler (1992) argued that gifted students are those that perform at remarkably higher levels than others of their age, experience, or environment .These children exhibit high performance capacity in intellectual, creative, and or artistic areas and unusual leadership capacity, or excel in specific academic fields. They require services or activities not ordinary provided by the schools .Outstanding talents are present in children and youth from all cultural groups, across all economic strata and in all areas of humans endeavor (Bonner, 2000; Maker, 1996).

Clark's (1997) giftedness definition is as follows: "Giftedness is a biologically rooted concept that serves as a label for a high level of intelligence and indicates an advanced and accelerated development of functions within the brain including physical sensing, emotion, cognition, and intuition. Such advanced and accelerated function may be expressed through abilities such as those involved in cognition creativity, academic aptitude, leadership, or the visual or performing arts (Clark, 1997).

As stated previously, it is reasonable to expect that gifted students, due to their knowledge of mathematics and science, to their logical abilities and to their more developed control mechanisms, will be able to overcome the impact of the intuitive rules and to provide more accurate responses to tasks known to elicit incorrect, intuitive responses in line with the intuitive rules. This issue is addressed in the current study.

Statement of the Problem:

Many teaching and learning theories assume that knowledge about children's conceptions and ways of thinking could significantly improve science education. This study aims at examining the differences between gifted and ordinary students in Jordan in their use of the intuitive rule "More A-More B". The goals of this study are to explore the following:

1. Are there significant differences between gifted and ordinary students in their use of the intuitive rule "More A- More B"?.

Methodology

Sample

Students from two schools in the Hashemite Kingdom of Jordan participated in this study. The first school is The Jubilee School for Gifted Students and the second school is Amina Bint Wahab school for ordinary students.
This sample of students consists of 240 students divided as follows:
Gifted students: This group consists of 3 grades (10-12), 40 children from each grade.
Ordinary students: This group consists of 3 grades (10-12), 40 children from each grade.

Instrument

A questionnaire including 8 tasks related to the intuitive rule was developed for this study. Eight questions relate to the intuitive rule " More A- More B".

Procedure

The following steps were taken:

To begin with, the researcher received permission from the Ministry of Education in Jordan, and from the administration of Al-jubilee school for gifted students, and Amina Bint Wahab School for ordinary students to conduct the interviews in the two schools.

The students of the two groups (gifted and ordinary) were told about the nature of the study. Before meeting with the students, the school received permission from the students' parents to participate in this study. This study was implemented during two months, in the second term of the academic year 2000 / 2001. The researcher interviewed each student. Each interview took 30 to 35 minutes. The researcher demonstrated the tasks. The students' answers were audiotaped and transcribed.

Data analysis

After transcribing the interviews, I related to two variables: the judgment, and the justification. I did it for each task.
The judgments were first labeled as correct, incorrect or no response for each task. Then, a more subtle coding was used for the incorrect judgments: Incorrect judgments in-line with the relevant intuitive rule and other, incorrect judgments.

The justifications were categorized for each task for each student according to previous categorization of these tasks (Stavy and Tirosh, 2000). New types of responses were categorized by me. These responses were given to my two supervisors without my categorizations and they coded them separately.. We then discussed the categorization of these responses and came to an agreement on the few responses that were categorized differently (about 5% of all the data). The frequencies of the judgments and of the related justifications for each task for each group (gifted, ordinary) for each grade level (10^{th}, 11^{th} , 12^{th}) were then calculated.
The means of correct responses and standard errors for the intuitive rule "More A-More B". for each group and for each grade level were calculated (see Table 2 in Results). An analysis of variance was carried out for correct responses for this intuitive rule with the factors giftedness (ordinary, gifted) and grade level (10^{th} 11^{th} 12^{th} grades).

Results

In this part I shall first provide a general description of the results. Then, I shall describe the results relating to the intuitive rule "More A-More B".

Comparison between Gifted and Ordinary Students in different grades

As mentioned before, students from grades 10, 11 and 12 from the two groups (gifted and ordinary) were given various tasks related to the intuitive rule "More A-More B".

Table 1 provides information about the means and the standard deviation of correct responses by rules and grades of both the gifted and the ordinary students. An analysis of variance was carried out for correct responses for the intuitive rule "More A-More B" with the factors giftedness (ordinary, gifted) and grade level (10^{th} 11^{th} 12^{th} grades). The only significant differences were between gifted and ordinary students in their responses to tasks embedded in rule "More A-More B: The gifted students gave more correct responses than the ordinary students ($F=13.9$, $p<0.01$).

Table 1: Means (and standard errors) of Correct Responses to the Intuitive Rule "More A- More B" by Grade and Giftedness (in %).

Giftedness	Ordinary				Gifted			
Grades / Rules	Total	10	11	12	Total	10	11	12
Rule 1	59 (9.9)	56 (10.1)	59 (10.4)	58 (9.7)	89 (2.8)	89 (3.3)	95 (2.3)	91 (4.3)

Intuitive rule: " More A – More B " Results for each task

Eight tasks refer to the intuitive rule "More A – More B".

I shall describe students' judgments and justifications related to each of the tasks: the results related to each group (gifted, and ordinary group), and to each grade level (10, 11, 12).

1.1 Algebraic Expression Task

This task was introduced to gifted and to ordinary students in grade levels 10 to 12. The students were asked to compare algebraic expressions. The correct answer to this task is: Impossible to determine. The incorrect, intuitive response is for example, 4X>2X as 4 is greater than 2.

Table 2 shows that high percentages of the gifted and the ordinary students at all grade levels correctly responded to this task. The main justification, given in all grade levels was "We don't know what is the value of x, so it is impossible to determine" (see Table 3). The high percentages of correct responses may result from the fact that all the students studied about simplifying algebraic expressions and therefore they provided correct responses to the task.

The incorrect common response to this task was: "we start with larger numbers we will get larger values". This response was is in line with the first intuitive rule "More A- More B". The students pointed at the expressions that had the larger coefficient (for instance, 4X in the case of the expressions 4X and 2X), and argued that this expression is larger.

Table 2: Distribution of responses (in %) by group, and by grade, to the Algebraic Expression Task

	Ordinary			**Gifted**		
Grades	**10**	**11**	**12**	**10**	**11**	**12**
(n) Responses	(40)	(40)	(40)	(40)	(40)	(40)
1. Impossible to determine*	85	90	90	97.5	100	100
1. We don't know what the value of x is, so it is impossible to determine	85	90	90	97.5	100	100
2. The expression with larger coefficient is larger	12.5	5	10	2.5	0	0
1. We start with larger numbers, so we will get larger values	12.5	5	10	2.5	0	0

*Correct Answer

1.2. Vertical Angles Task

In this task students were presented with two straight lines that intersect at a point M. The drawn arms were unequal. They created two equal, vertical angles: angle α. with relatively short arms and angle β with relatively long arms. The students were asked if angle β is smaller than / equal to / larger than / angle α.

The correct answer to this task is: The two angles are equal. The majority of the students in both groups correctly answered that the two angles were equal. The main justifications were "The two angles are in front of each other by head". It should be noted that the teachers in The Hashemite Kingdom of Jordan teach this topic in elementary schools and deal with it again in secondary schools. Moreover, teachers in The Hashemite Kingdom of Jordan use the idiom of two heads touching each other for explaining the equality of two vertical angles. Another argument was: "The two angles intersect in the same point" (see Table 3).

The percentages of incorrect responses were very low in both groups. The main claims were that angle β is larger because "it has longer arms and lines" or "it is wider and has more area". These incorrect responses are in line with the intuitive rule "More A – More B"

Table 3: Distribution of Responses (in %) by Group and by Grade to the Vertical Angles Task

	Ordinary			**Gifted**		
Grades	**10**	**11**	**12**	**10**	**11**	**12**
(n) / Responses	(40)	(40)	(40)	(40)	(40)	(40)
1. Angle β is equal to angle α*	85	90	75	87.5	100	90
1. The two angles are in front of each other by head	62.5	65	42.5	80	90	50
2. The two angles intersect in the same point	17.5	20	27.5	7.5	10	40
3. It's the same point for the two angles this is mathematical rule	17.5	5	5	---	---	---
2. Angle β is larger	15	10	25	12.5	---	10
1. It has longer arms and lines	10	7.5	7.5	12.5	---	10
2. It is wider and has more area	5	2.5	17.5	---	---	---

* Correct answer

1.3. Temperature Task

This task was presented to gifted and ordinary students in grade levels 10 to 12. Students were presented with two cups containing equal amounts of water. The temperature in each cup was 30^{o}C. The water from the two cups was poured into an empty third cup, and students were asked to judge the temperature in the combined cup. The correct answer to this task is: The temperature will be 30^{o}C in the third cup.

The majority of the gifted and the ordinary students correctly answered that the temperature of the water in the combined cup is 30^{o}C (see Table 4).
The incorrect judgments were justified with reference to the amount of water, namely “the more water-the warmer”. Thus the students tended to respond in line with the intuitive rule More A – more B". These responses were often accompanied by an arithmetic calculation (e.g. 30^{o}C +30^{o}C =60^{o}C). It should be noted that the concept of temperature is usually taught in elementary schools.

Table 4: Distribution of responses (in %) by group, and by grade, to the Temperature Task

	Ordinary			**Gifted**		
Grades	**10**	**11**	**12**	**10**	**11**	**12**
(n) Responses	(40)	(40)	(40)	(40)	(40)	(40)
1. Temperature is 30^{0}C*	82.5	82.5	85	97.5	95	82.5
1. Two cups are in the same temperature 30^{o}C	67.5	55	45	72.5	75	45
2. Just quantity increased	7.5	17.5	35	20	20	37.5
3. Didn’t change the water	7.5	10	5	5	-	-
2. Temperature is 60^{0}C	17.5	17.5	15	2.5	5	17.5
1. 30^{o}C +30^{o}C =60^{o}C	12.5	10	12.5	2.5	5	12.5
2. We will get 60^{o}C from the two cups	5	7.5	2.5	-	-	5
3. **Others**	-	5	2.5	-	-	-

* Correct answer

1.4. Polygon task

Two identical rectangles were presented, each consisting of a small square at the upper right corner, and a polygon. The small square was removed from the upper right corner of rectangle of one of the rectangles. A polygon was obtained. The students were asked: Is the perimeter of the obtained polygon smaller than / equal to / larger than / the perimeter of the original rectangle?

The correct answer to this task is: The perimeter of the polygon is equal to that of the rectangle.

The vast majority of the gifted students correctly responded that the perimeter of the polygon is equal to the perimeter of the rectangle (see Table 5). About half of the ordinary students gave correct response, namely that the perimeters in both the rectangle and the polygon are equal. Gifted and ordinary students reasoned this by "it is the same length of lines in both if you go around and around all edges", " It is the same lines, you compensated this - it is equal".

The students gave two types of incorrect responses. First type: The polygon has smaller perimeter than the rectangle because "The rectangle has larger area so, it is bigger". Second type: The perimeter of the polygon is larger than the rectangle, because "The number of lines in the polygon is 6 but in the rectangle just 4". These incorrect responses were given by the students in all grade levels and are in line with the intuitive rule More A – More B. This task is the first task in which there are substantial differences between the responses of ordinary and gifted students. About half of the ordinary students provided correct responses while almost all gifted students gave correct answers. The topic of area and perimeter of geometrical shapes is taught in Jordan in elementary schools. Thus the differences between the performances of the two groups could not, probably be explained by differences in instructions. A possible explanation is the differences in the reasoning abilities of the two groups. This task is basically conservation of perimeter task and in order to provide a correct response it is necessary to overcome the interference of the change in area and to concentrate on the perimeter only.

Table 5: Distribution of Responses (in %) by Group and by Grade to the Polygon Task

	Ordinary			Gifted		
Grades	**10**	**11**	**12**	**10**	**11**	**12**
(n) Responses	(40)	(40)	(40)	(40)	(40)	(40)
1. The Perimeter of the polygon is equal to that of the rectangle*	35	40	50	97.5	100	85
1. It is the same length of lines in both, if you go around, around all edges	30	37.5	30	75	65	70
2. It is the same lines. It doesn't change any thing	5	2.5	20	22.5	35	15
2. Polygon has smaller perimeter than the rectangle	27.5	45	30	0	0	5
1. Rectangle has larger area so its bigger	27.5	45	30	0	0	5
3. Polygon has larger perimeter than the rectangle	15	5	15	2.5	0	7.5
1.The number of lines in the polygon is 6 but in the rectangle 4 lines	15	5	15	2.5	0	7.5
4. **I don't know.**	22.5	10	5	0	0	2.5

*Correct answer

1.5. Size of Cell Task

The students were asked: Is the size of a muscle cell of a mouse bigger than /equal to / smaller than a muscle cell of an elephant?.The correct answer to this task is "equal to".
High percentages of gifted students provided correct answers to this task. The correct responses rely on their formal biological knowledge about cells. Students explained that the size of animal cells is equal and that they we learned this at school (see Table 6).

About half of the ordinary students incorrectly claimed that the larger animal has larger cells. Common justifications at all grade levels were "according to the dimensions of an elephant, and those of a mouse, it is obvious that the muscle cell of a mouse is smaller than that of a muscle cell of an elephant "and that "an elephant is larger and huge". This incorrect responses were given by the students are in line with intuitive rule "More A – More B".

Another type of incorrect responses, not in line with the intuitive rule, was "a muscle cell of an elephant is smaller". This response was given by a very small number of students. The main justification was "mouse is smaller in size than an elephant, mouse needs larger cells". This might reflect the tendency to make compensation, namely to argue that since the mouse is smaller it needs larger cells.

Table 6: Distribution of responses (in %) by group, and by grade, to the Size of Cell Task

	Ordinary			Gifted		
Grades	**10**	**11**	**12**	**10**	**11**	**12**
(n) Responses	(40)	(40)	(40)	(40)	(40)	(40)
1. **Equal***	47.5	50	40	75	85	75
1. All animal cells are equal	47.5	50	40	75	80	70
2. We learn this, all cells are the same	---	---	---	---	5	5
2. The muscle cells of an elephant are larger	40	42.5	57.5	22.5	15	2.5
1. An elephant is larger and huge	40	42.5	57.5	22.5	15	2.5
3. The muscle cells of an elephant are smaller	12.5	5	2.5	2.5	---	---
1. Mouse is smaller in size than an elephant so a mouse needs larger cells	12.5	5	2.5	2.5	---	---

* Correct Answer

1.6. Free Fall Task

Students were presented with two matchboxes, one full of sand, and the other empty. The two boxes were held at the same height above the ground, in the same manner. Students were asked to imagine that the two boxes are dropped at the same time and to determine if the matchbox full of sand would hit the ground before / at the same time / after the empty matchbox. The description was accompanied with showing two boxes of matches. The correct answer to this task is: The full matchbox will hit the ground at the same time as the empty one.

High percentages of the gifted students in grade levels 10 and 11 correctly responded that the two matchboxes will hit the ground at the same time. The percentages of correct responses were lower at the grade 12 possibly because students in this school study about free fall in grade 10, and thus in grade 10 and 11 the knowledge of the learned information is more intensive than in grade 12 and can better compete with the impact of the intuitive rule. The percentages of correct responses of the ordinary students were relatively low.

Two types of justifications were presented by students in both groups to their correct response: “same acceleration of gravity and therefore they will reach the ground at the same time” and “it is the same height, therefore they will reach the ground at the same time” (see Table 7). The incorrect answers were in line with the intuitive rule ”More A – More B”, namely that the heavier matchbox would hit the ground first, because “the heavier the faster”, “gravity will be larger on the full match box” and “mass of iron is larger”.

Table 7: Distribution of responses (in %) by group, and by grade, to the Free Fall Task

	Ordinary			**Gifted**		
Grades	**10**	**11**	**12**	**10**	**11**	**12**
(n) Responses	(40)	(40)	(40)	(40)	(40)	(40)
1. Will hit the ground at the same time*	35	42.5	47.5	85	100	65
1. Same acceleration of gravity	32.5	42.5	37.5	70	95	62.5
2. Its the same highest	---	---	---	15	5	2.5
3. Others	2.5	---	10	---	---	---
2. Full match box will hit the ground first	65	57.5	52.5	15	0	35
1. Because it is heavier it is faster	32.5	40	40	12.5	---	20
2. Gravity will be larger on the full match box	22.5	5	10	2.5	---	2.5
3. Mass of iron is larger	10	5	---	---	---	12.5
4. **Others**	---	7.5	2.5	---	---	---

* Correct answer

1.7. Probability Task

In this task students were presented with two bags, J and K each containing black and white counters:
Bag J: 9 black, and 3 white - Bag K: 6 black, and 2 white.
Students were asked which bag gives a better chance of picking a black counter. The correct answer to this task is: The probability for picking a black counter is equal in both bags (the ratios between the number of black counters and the number of white counters are the same in both bags).

As can be seen from Table 8, high percentages of the gifted students correctly answered this task. In contrast, the percentages of correct responses of the ordinary students were low. Two types of justifications were given by students at all grade levels to the correct response “It is the same chance 3:1 for each bag”, “Each bag have the same chance because it is the same ratio” (see Table 8).

Most students who provided incorrect responses chose bag J, as more likely to yield a black counter. Most of them reasoned that "There are more black ones in this bag". Most of the incorrect responses are in line with intuitive rule: More A (black counters) – More B (chance to get a black counter).
Other students responded that bag K gives more chance to a black counter and justified this by "There are less white counters in this bag", or "The ratio in bag K to get black counter is 1/6".

A possible explanation to the huge differences between the percentages of correct responses of the gifted and the ordinary students is the differences in the reasoning abilities of the two groups. This task is basically proportional reasoning task. In order to provide a correct response it is necessary to overcome the interference of the numerosities of the black counters, calculate, and compare the ratios.

Table 8: Distribution of Responses (in %) by Group and by Grade to the Probability Task

	Ordinary			**Gifted**		
Grades	**10**	**11**	**12**	**10**	**11**	**12**
(n) Responses	(40)	(40)	(40)	(40)	(40)	(40)
1. Same chance*	25	22.5	20	85	90	75
1. It is the same chance: 3:1 for each bag	15	22.5	17.5	65	42.5	57.5
2. Each bag has the same chance because it's the same ratio.	10	---	2.5	20	47.5	17.5
2. Bag J	57.5	62.5	60	10	7.5	12.5
1. In bag J there are more black counters	57.5	62.5	60	10	7.5	12.5
3. Bag K	17.5	15	20	5	2.5	12.5
1. There are less white counters in this bag	10	10	15	5	2.5	5
2. The ratio in bag K to get black counter is 1/6	7.5	5	5	---	---	7.5

* Correct answer

1.8. Length of Line Segment Task

The gifted and the ordinary students were presented with two line segments, AB and CD, (AB was shorter than CD). They were asked if the number of points in line segment CD is smaller than / equal to / larger than the number of points in line segment AB.
The correct response to this task is: The number of points in the longer segment CD is equal to that in the shorter segment AB.
All students, in all grade levels incorrectly claimed that the number of points in line segment CD is larger than in the line segment AB. They claimed that CD contains all the points in line segment AB and additional ones.

These students' responses are in line with the intuitive rule "More A (the length of the line segment) – More B (the number of points)". Although all the students studied that there is an infinite number of points in each line segment, they gave an incorrect response in line with the intuitive rule. This shows the strong impact of the first intuitive rule on students' responses. The responses reflect the idea that the whole is greater than its part.

Discussion:

This study is embedded within the intuitive rule theory "More A-More B". This is the first study, within this framework that attempts to identify the differences between gifted and ordinary students in their use of the intuitive rule. The study was carried out in Jordan.

In this study I explored the extent to which gifted and ordinary students differ in their use of the intuitive rule: "More A – More B". The gifted students performed significantly better than the ordinary students in the tasks related to the intuitive rule "More A – More B". This happens in all but one of the tasks: the line segment task. In this task all students, ordinary and gifted, provided incorrect responses in line with this rule. The responses of the students reflected the idea that the whole is greater than its parts, an idea in line with the intuitive rule "More A- More B". This shows the strong impact of the intuitive rule on ordinary and gifted students' responses.

The finding that gifted students performed significantly better than the ordinary students in the tasks related to this intuitive rule is in accordance with previous findings related to the impact of logical schemes and conceptual knowledge on overcoming the effect of this intuitive rule (Stavy and Tirosh, 2000). Stavy and Tirosh (2000) argued that young children are very strongly affected by this rule, applying it even when information about the equality in quantity B is perceptually given (for instance in the case of the vertical angle task). Later on, when children acquire the relevant logical schemes (e.g., conservation, proportion), they can disregard irrelevant perceptual information in quantity A and correctly judge that B_1 is not necessarily larger than B_2 although A_1 is larger than A_2 (e.g., the polygon task). When children acquire the necessary logical schemes they are still affected by the rule when formal knowledge is a main source for correct responses (e.g., the task of the line segment). More generally, Stavy and Tirosh (2000) suggested that with age and instruction, schemes and bodies of knowledge related to specific tasks are developed or reinforced. Consequently, in respect to these tasks, the intuitive rule "More A – More B" loses its power in favor of other competing adequate knowledge.

Furthermore, it is also possible that with instruction children become aware of the need to examine their initial responses, to consider other factors that might be relevant to the tasks and to avoid conflicting arguments. Thus, they gradually learn the limitations of the use of this rule. I argue that it is possible that the logical schemes and the conceptual knowledge of the gifted students are more developed than those of their ordinary peers and also that their control schemes are more developed and therefore they can overcome this intuitive rule.

However, the judgment provided to correct responses by the ordinary students were not based on the particulate theory of matter but on concrete considerations, and therefore these arguments were not scientifically based. The incorrect responses of the gifted students reflected their abstract reasoning related to infinite processes. Yet the gifted students did not differentiate between mathematical and material objects and considered the sugar as if it was continuous quantity.

Three grade levels participated in this study, 10^{th}, 11^{th}, and 12^{th}. My analysis reveals that the effect of the grade level on students' responses to the intuitive rule tasks was not significant. Hence, it seems that the students kept applying this intuitive rule at more or less the same extent during their years of studies in high school. This suggests that a special intervention is needed to increase students' awareness of the impact of the intuitive rules on their thinking.

Conclusion:

The differences between the performances of the two groups (gifted and ordinary) are significant. While most gifted students, at all grade levels correctly answered all but one of the eight tasks, most ordinary students provided correct responses to three out of the eight tasks. These differences could be attributed to the level of the formal knowledge they acquired in school in mathematics and science, level of development of the logical schemes and to the awareness of the gifted students to the need to control their responses. Most incorrect responses were in line with the intuitive rule More A- more B".

It is notable that all students (gifted and ordinary) incorrectly answered the line segment task. Their responses were in line with the intuitive rule "More A – More B". Although all the students studied that there is an infinite number of points in each line segment, they gave an incorrect response in line with the intuitive rule. This shows the strong impact of the intuitive rule "More A-More B" on students' responses.

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