Estimating the Size of the Gifted/Talented Population From Multiple Identification Criteria

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"How many are gifted or talented?" Although very important, this question has received little attention from most scholars in gifted education. Four major variables are identified that directly impact prevalence estimates: (a) the type of definition endorsed—disjunctive or conjunctive, (b) the number of abilities/characteristics included, (c) the minimum selection threshold chosen, and (d) the correlations observed between the abilities included. A range of values was determined for the last three variables. By combining these values, we produced four tables of prevalence estimates, which reveal how these variables interact and how they affect the "how many" question. The results show that both the type of definition endorsed for the giftedness or talent concepts and the selection ratio have a crucial impact on the prevalence estimates. The authors argue that gifted education will never be recognized as a proper scientific field unless its scholars reach a consensus on both the definition and prevalence issues.

How many individuals can be labeled gifted or talented? This question, commonly called the prevalence issue, appears quite simple, deceptively so. As we will see below, so many considerations need to be made that no simple answer can be given. The present article aims to explore some of the factors that affect the answer and show how interactions between them modify prevalence estimates. Common sense and simple statistical knowledge do reveal basic rules. For instance, the higher (more selective) the cutoff value chosen (e.g., top 15%, top 5%, or top 1%), the smaller the number of individuals labeled gifted and talented. Similarly, if giftedness and talent can take many forms (e.g., intellectual, social, artistic, athletic), the prevalence will increase as the number of domains or fields increases. Or, if two criteria are highly correlated, those who excel in one of

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them will also excel in the other, thus reducing the total number of individuals excelling in either ability, as opposed to uncorrelated abilities. Beyond these simple common sense observations lie much more complex considerations. We intend to explore some of them and look at how the manipulation of relevant variables (e.g., number of abilities, cutoff value, correlations between abilities) affects the resulting prevalence of gifted and talented persons.

Status of the Prevalence Issue

According to Gagné (1993, 1998a), the prevalence issue is extremely important, not only theoretically, but also politically, as well as practically. *Theoretically*, the concepts of giftedness and talent belong to the class of normative concepts. Such concepts circumscribe subgroups of people who differ from the norm through specific characteristics, like income (poverty, affluence), weight (obesity, emaciation), age (adolescents, seniors), and so forth. As originally pointed out by Francis Galton (1892/1962), appropriate definitions of such concepts require clear operational criteria for membership or exclusion. In his study of family relationships between eminent people, he defined *eminence* as presence among the top 1:4,000 Englishmen in terms of celebrity through accomplishments in science, politics, and arts. *Politically*, the "how many" question is crucial because of its frequency in discussions with media people and the general public; many among them want to know if giftedness and talent manifest themselves exceptionally (e.g., geniuses or prodigies) or rather commonly (the "everyone is somehow gifted" assertion). *Practically*, perceived prevalence directly impacts identification policies and procedures, and, consequently, budget expenditures for enrichment programs.

In spite of its crucial importance, the prevalence issue has received little attention in the gifted education literature. Bélanger (1997) noted that textbooks either ignore the subject completely (Coleman & Cross, 2001; Gallagher, 1985; Passow, 1979; Piirto, 1994) or mention it only briefly (Borland, 1989; Clark, 1997; Horowitz & O'Brien, 1985; Renzulli & Stoddard, 1980; Webb, Meckstroth, &

Tolan, 1982). Neither the term *prevalence* nor any synonyms ever appear in the Subject Index of any of them. Indeed, only one scholar, Gagné (1993, 1998a) has deemed important an examination of the question in depth. Why have so few researchers and scholars analyzed the prevalence issue? We believe that the complexity of the problem, as well as its sophisticated mathematical underpinnings, explain in large part the general silence on this subject. Moreover, as we will see below, every answer requires that its proponent make a somewhat arbitrary choice, something that very few scholars seem ready to do. Gagné's (1993) initial discussion of the prevalence issue covered very well the main hurdles that block a clear and simple answer to the "how many" question. The present text focuses on the four major parameters that professionals need to consider if they want to estimate with some precision the prevalence of gifted and talented individuals. It is worth noting that each of these four parameters is directly influenced by the way scholars in the field of gifted education define the concepts of giftedness and/or talent.

Major Parameters of Prevalence Estimation

The four most relevant factors that directly affect prevalence estimates are (a) the size of the minimum threshold, (b) the number of different forms of giftedness and talent considered simultaneously, (c) the conjunctive or disjunctive character of the definition adopted, and (d) the correlations between the various abilities assessed.

The Minimum Threshold

Most normative concepts are operationalized through quantitative measurements expressed on continuous scales: IQ scores, weights in pounds, income in dollars, age in years, and so forth. When faced with continuous quantitative measures, professionals must decide, somewhat arbitrarily, where to place the boundary between membership and nonmembership. For instance, nutritionists decided some years ago to adopt the body mass index (BMI) to measure normal and abnormal weight in populations. On a scale that ranges from a low of about 16 and a high well above 60, they agreed to place the normal range between the values 20 and 24.9, use the values 25 to 29.9 to operationally define overweight, and to associate obesity with any value equal or superior to 30 (National Institute of Health, 1998). These nutritionists could have chosen other cutoff values; the important point is that a group of professionals decided to agree on a set of values and make them the yardstick for all their analyses. The BMI index is by no means perfect, yet it still remains a very practical measure, allowing all kinds of comparisons (e.g., between age groups, genders, nations, and so forth). Similar agreements have been made in other fields. Think of the decision by statisticians to fix at .05 the minimum significance level, that of law enforcement agencies to specify the minimum amount of alcohol in the blood confirming impaired driving behavior, or the efforts of economists to identify minimum levels of income that mark the threshold between poverty and sustenance.

Unfortunately, that kind of consensus has not yet reached gifted education. In the case of intellectual giftedness, which is commonly measured with IQ tests, minimum thresholds proposed over the years have ranged from lows of approximately 1% (e.g., Terman, 1925) to highs of more than 20% (e.g., Renzulli, 1986), with many values proposed between these extremes. Such a large variability, no less than 20 fold between extremes, seriously questions the clarity of existing definitions of giftedness and talent. According to Gagné (1993), two modal tendencies appear to stand out: a selective perspective exemplified by very low percentages (below 5%), and a liberal approach where the proposed estimates hover around 10% or 15%. In an effort to rally both groups to some consensus, Gagné (1998a) proposed a metric-based system of intensity levels whose minimum threshold is fixed at 10% and labeled *mildly*. Within this top 10% of mildly gifted or talented persons, Gagné's differentiated model of giftedness and talent (DMGT) recognizes four progressively more selective subgroups. They are labeled *moderately* (top 1%), *highly* (top 1:1,000), *exceptionally* (top 1:10,000), and *extremely* (top 1:100,000). It is too early to see if that proposal will attract a large group of adherents. In the meantime, we must acknowledge a diversity of viewpoints on the question of the minimum threshold.

The Number of Criteria

The complexity of the prevalence question increases significantly when definitions of giftedness, and the ensuing identification criteria, include multiple abilities or traits. Most published definitions identify multiple traits (e.g., Davis & Rimm, 1994; Gagné, 1985, 2003; Gardner, 1983/1994; Marland, 1972; Renzulli, 1986; Shriner, Ysseldyke, Gorney, & Franklin, 1993; Sternberg, 1986; Tannenbaum, 1983). In some cases, the number of criteria remains small, like in Sternberg's distinction of three forms of giftedness associated with the three major components of his triarchic theory of intelligence (metacomponents, performance components, knowledge-acquisition components), or Tannenbaum's four categories of talent (scarcity, surplus, quota, anomalous). In other cases, their number increases significantly, like in Gardner's (1983/1994) seven distinct intelligences, or in Gagné's (1985, 2003) four domains of giftedness (intellectual, creative, socioaffective, sensorimotor), each of them subdivided into multiple subdomains. The more numerous the forms of giftedness or talent, the larger the population of gifted and/or talented persons; as mentioned earlier, when more ability domains are recognized, it stands to reason that more individuals can excel in at least one of them. But, as described below, there is one special situation where that common sense rule does not apply.

The Conjunctive and Disjunctive Perspectives

Multitrait definitions of giftedness (or talent) differ not only with regard to the specific number of traits covered by each one; they also differ with regard to the way these traits are dealt with. Borland (1989) distinguished two opposite types of multitrait definitions: (a) *conjunctive* definitions, where giftedness requires the simultaneous (A *and* B *and* C) possession of distinct characteristics or abilities, like Renzulli's (1986) combination of above-average abilities, creativity, and task commitment; and (b) *disjunctive* definitions of giftedness, where giftedness and/or talent can take different forms (A *or* B *or* C), like Gardner's multiple intelligences or Gagné's four giftedness domains.

These two types of definitions have opposite impacts on prevalence estimates. Assuming an identical minimum threshold, for instance the top 10% for each trait or criterion, conjunctive definitions lead to decreasing prevalence values as the number of criteria increases: most of those who survive the first cutoff score (A) will not survive the second (B), and most of the A and B survivors will fail to exceed the third threshold (C). As the number of criteria included in the definition and identification process increases, the resulting number of individuals labeled gifted or talented will soon become uselessly small. In the case of disjunctive definitions, the impact is reversed; if giftedness can manifest itself as A or B or C, then the resulting population of persons labeled gifted or talented will increase with each new criterion or category added. One begins with the top 10% on criterion A, then adds all those not already chosen who excel on B, and so forth with each additional criterion. Taylor (1973) applied this reasoning in the context of his theory of multiple talents; assuming his eight talents to be uncorrelated, he estimated that 99% of the members of a population would be identified as above average (top 50%) on at least one of these eight abilities. With a much stricter 10% selection ratio, the corresponding prevalence would still be 57%. In other words, more than half of the population would be among the top 10% in at least one of his talents. As John Carroll's (1993) seminal work has so clearly shown, most mental abilities are correlated to some extent, and these correlations have a significant impact on prevalence estimates. Taylor acknowledged the importance of that problem, but did not address it.

Correlations Between Criteria

Correlations between some abilities can be very low, for instance between physical and cognitive abilities; they also can be quite strong, especially when we compare abilities belonging to the same domain. To understand the impact of correlated criteria on prevalence values, let us look at the most simple situation, that of two abilities. If these two measures are uncorrelated, then an identical top 10% threshold applied to each of them will lead to either 1% identified as gifted in both (conjunctive definitions) or 19% identified in either of them (disjunctive definitions).[1] If, on the other hand, these two criteria are perfectly correlated, then the same individuals—the top 10%—will be selected with criteria A and/or B; in that special case, disjunctive and conjunctive definitions will lead to the same result. It follows that, when abilities are partially correlated, the gap between the two prevalence indices—here 18%—will decrease toward zero as the correlation increases. It is easy to imagine how complicated the estimation process will become as the number of criteria increases, because each pair of criteria within the group will have a different correlation than the other pairs.

Operational Goals

Now that the four major parameters for prevalence estimation have been identified and their individual impact coarsely described, it becomes easier to pinpoint the practical goals of this study. First, we aim to identify a statistical equation that will allow the simultaneous manipulation of various values of the four parameters and observe how they affect the theoretical prevalence of gifted and talented individuals. For example, how does a progressive increase in the average correlations between abilities affect the prevalence values when all other parameters are controlled? Or, how does the prevalence increase in a disjunctive situation when the number of measured abilities increases, again controlling for the other parameters? These manipulations will lead to four tables of statistical data, two each for disjunctive and conjunctive situations respectively. We aim to show (a) how these tables can help professionals predict the impact of different identification procedures on the ensuing percentage of identified gifted (or talented) students and (b) what these tables reveal about the practical impact on prevalence issues of diverse conceptions of giftedness and talent.

Method

We present in this section the range of values chosen for each of the three continuously variable parameters, as well as the best available statistical equation to effect the desired manipulations.

Parameter Values

Concerning the minimum cutoff score, the literature review indicates a range varying between very strict thresholds (e.g., Terman's [1925] IQ of 135, or top 1%) and very generous ones (e.g., Renzulli's [1986] 20% cutoff for his Talent Pool members). To limit the size and complexity of the tables, we kept only four cutoff percentages judged closer to existing values, namely 2%, 5%, 10%, and 15%. Percentages (or percentiles) were adopted because they apply to any type of measure, including IQ scores (Gagné, 1998a). Concerning the second parameter, the number of abilities, most identification systems do not exceed five or six criteria. We did find a few studies that included more than 10 variables. For instance, Gagné (1998b) used 19 different ability assessments from peer nominations, and Feldman and Bratton (1980) used 20 ability and motivation measures for all students. These were research situations instead of real identification situations. Consequently, we chose four values (2, 3, 5, 10) that cover most practical identification procedures. The third parameter, the disjunctive/conjunctive dichotomy, needed no additional specifications. Finally, we chose the values for the last parameter, namely correlations between pairs of ability measures, by taking into account Carroll's (1993) findings. In his refactoring of more than 500 ability databases, he did not observe correlation values higher than .71. Consequently, we chose four correlation levels, from .1 to .7 with .2 intervals.

Statistical Equation

Before beginning our search for a statistical equation capable of handling simultaneously different values of the four parameters, we defined what would constitute a mathematically adequate solution. This ideal equation should have the following capabilities: (a) take into account a different cutoff score for each measure; (b) handle multiple criteria, up to at least 15; (c) adjust itself to nonnormal score distributions (e.g., the negatively skewed school grade distributions or Likert-type scales, the negatively decelerated scales typical with peer-nomination scores); (d) be applicable to both disjunctive and conjunctive situations; and (e) take into account the diversity of the correlation matrices for all pairs of ability measures. We rapidly discovered that our list of requirements exceeded by far the flexibility of any statistical equation ever proposed to estimate the prevalence of special populations. For instance, Burns (1983) conducted the only known study of prevalence to have used this type of mathematical model. However, he circumscribed his analysis to the simplest multivariate distribution, the binormal (two normally distributed variables), including, of course, just one correlation coefficient. We did find the equation of a function that met most of our requirements, except nonnormality (item "c" above; Johnson & Kotz, 1972).[2] Unfortunately, because some variables were represented by matrices (e.g., cutoff scores, correlation matrices), there was no known way to compute the integral of such a complex function. And, these integrals were essential to produce prevalence estimates. Consequently, we had to "cut corners" and look for an existing solution that would meet as many requirements as possible, hopefully the most important ones.

Gupta (1963) offered the only potentially applicable solution.[3] But, that equation required us to put aside most of our initial requirements. The equation did apply to any number of abilities and could adapt to both conjunctive and disjunctive situations. On the other hand, it could handle only situations where (a) the same selection ratio was used for all variables, (b) the same correlation was assumed for all pairs of variables, and, of course, (c) all variables were normally distributed. Because nothing else was available, we decided to try that equation and check its applicability by comparing the estimates obtained with prevalence indices gathered from a real database. The data came from peer and teacher nominations used to identify more than a dozen different abilities (see Gagné, 1998b, for methodological details). This empirical validation revealed that the estimated prevalence indices based on the Gupta formula were almost perfectly correlated ($r = .99$)

with values obtained from that database. It is worth noting that the data's statistical characteristics (e.g., high positive asymmetry, very heterogeneous correlations) were far from meeting the equation's strict assumptions. Moreover, that empirical study revealed that a small bias appeared only when the number of abilities exceeded six, a rare occurrence in practical identification situations. Finally, because the slight bias observed had its origin in nonnormal score distributions, its practical impact was judged minimal because the most common identification measures (IQ tests and standardized achievement tests) are distributed more or less symmetrically.

That equation became the core of a BASIC program designed to manipulate systematically each of the three interval-scaled parameters; it used Simpson's numeric integration method (Youse, 1978). The program yielded prevalence estimates for conjunctive situations (A *and* B *and* C); we mathematically derived the corresponding prevalence values for disjunctive situations.[1]

Results

The four tables of values described in this section correspond to two pairs of distinct perspectives. The first pair separates disjunctive approaches to the definition of giftedness or talent (Tables 1 and 2) from conjunctive ones (Tables 3 and 4). Within each pair, we will distinguish situations in which the overall prevalence is not predetermined (Tables 1 and 3) from situations where some organization, usually the state, the school board, or the program coordinator, has decided a priori how many students "are" gifted and/or talented in the schools under their supervision (Tables 2 and 4).

Disjunctive Situations

The following two tables of data apply to identification situations in which students will be labeled gifted or talented if their performance exceeds the cutoff score on any instrument included in a multiple ability test battery. For instance, school districts that choose to adopt either Gardner's (1983/1994) multiple intelligence theory or

Gagné's (2003) differentiated model of giftedness and talent as their identification framework would typically make their initial estimates with either of the two following tables.

Table 1: Open Prevalence. Table 1 presents total prevalence estimates in the form of percentages for various combinations of the three major parameters. Each of the percentages in that table answers the following question: "How many individuals (students) would be identified as gifted and/or talented in at least one specific ability (gift or talent) if we selected the top X% on each of Y abilities with an average correlation level of Z?" As mentioned in the Method section, the selection ratio X varies between 2% and 15% (4 sections of the table), Y varies between 2 and 10 ability measures (4 columns), and the average correlation Z varies between .7 and .1 (4 rows). Thus, each cell in the table represents a different combination of the three parameters X, Y, and Z, and the table covers all possible combinations of the values chosen.

Within the disjunctive perspective, the major rule involves the impact of the number of assessed abilities on the prevalence of giftedness and talent. If there are more ways for students to be judged gifted or talented (e.g., intellectually, socially, musically, technically, athletically), then more of them will deserve either label, assuming that all other parameters are kept constant. That rule manifests itself strongly in every row of Table 1. For instance, with only two ability measures correlated at the .5 level and a selection ratio of the top 5% (second section), the resulting prevalence is 8.8%; add three more ability measures with approximately the same correlations and the percentage almost doubles to 16.6%. Double the number of abilities assessed from 5 to 10 and the prevalence of identified gifted and/or talented students will reach almost 25%.

A second rule involves the impact of the selection ratio, which is the percentage of those set aside by the cutoff score as gifted or talented. As we move down Table 1 through the four cutoff sections, note how the prevalence estimates associated with any row/column intersection increase, and do so rather steeply. For instance, the 8.6% estimate for the .3/5 intersection at the top becomes 19.3% in the second section, then 34.0% and 46.0% for the last two sections respectively. In other words, if we maintain constant at .3 the average

Table 1
Estimated Prevalence Values (in %) of Gifted/Talented Individuals Within a Disjunctive Perspective as a Function of Four Selection Ratios (SR), Four Quantities of Ability Measures (*N* abil.), and Four Average Correlation Levels (Av. *r*)

	N abil.			
Av. *R*	**2**	**3**	**5**	**10**
		SR = 2%		
.7	3.4	4.4	6.1	8.9
.5	3.7	5.1	7.5	12.0
.3	3.8	5.5	8.6	14.8
.1	3.9	5.8	9.3	17.3
		SR = 5%		
.7	8.0	10.3	13.5	18.5
.5	8.8	11.8	16.6	24.7
.3	9.3	13.0	19.3	30.7
.1	9.6	13.9	21.6	36.9
		SR = 10%		
.7	15.3	19.0	24.0	31.1
.5	16.8	21.8	29.2	40.3
.3	17.8	24.2	34.0	49.5
.1	18.7	26.2	38.7	59.5
		SR = 15%		
.7	22.2	26.9	33.0	41.3
.5	24.2	30.8	39.7	52.2
.3	25.8	34.1	46.0	62.8
.1	27.2	37.2	52.4	74.0

level of the correlations between the five measures used, increasing the cutoff point from 2% to 15% multiplies by five the percentage of identified students.

Finally, as we go down any column, within any section of Table 1, we observe that the prevalence estimates increase significantly. It means that, as the correlations between the abilities assessed decrease, fewer individuals have high scores on more than one ability; consequently, the percentage of "new" gifted or talented persons increases. That effect, which has a limited impact when only two or three abilities are assessed, becomes much more significant when there is a large number of abilities as can be seen by comparing the two leftmost columns with the rightmost one.

One way to become more familiar with Table 1 is to simulate a real-life identification situation. Imagine a gifted and talented (G/T) district coordinator who endorses a disjunctive definition of giftedness and talent, like those of Gardner or Gagné. She plans to obtain three different ability measures from all students in grade 3, for instance a group IQ test, a standardized achievement test, and a creativity test. Our educated guess would be that these three measures would be correlated about .5 on average. Faithful to her disjunctive beliefs, the program coordinator adopts a 5% selection ratio for each measure, then adds up the total. How many children would thus be identified? Using Table 1 data, that scenario would give a total prevalence estimate of 11.8 % (second section, second column, second row). In other words, a 5% selection ratio applied to three moderately correlated tests will give a disjunctive prevalence estimate more than twice as large.

The data in Table 1 can be applied to parts of tests. For example, the Survey Battery of the Iowa Tests of Basic Skills (ITBS; Hoover, Dunbar, & Frisbie, 2001) is composed of three 30-minute subtests: Reading, Language (e.g., spelling, punctuation, usage), and Mathematics. We can expect that their scores are correlated close to the .7 level. School districts usually keep only the total score as a general index of academic achievement. But, most students do not perform equally well on all three subtests. If, instead of retaining only the top 10% on the global score, we decided to select all those who achieved among the top 10% on any of the three subtests, how many would become "academically talented" according to that disjunctive criterion? The answer is 19% (see Table 1), almost twice as many.

Table 2
Estimated Per Ability Selection Ratios (in %) of Gifted/ Talented Individuals Within a Disjunctive Perspective as a Function of Four Target Prevalence Values (TP), Four Quantities of Ability Measures (*N* abil.), and Four Average Correlation Levels (Av. *r*)

	N abil.			
Av. *R*	2	3	5	10
		TP = 2%		
.7	1.2	0.9	0.6	0.4
.5	1.1	0.8	0.5	0.3
.3	1.0	0.7	0.4	0.2
.1	1.0	0.7	0.4	0.2
		TP = 5%		
.7	3.0	2.3	1.6	1.0
.5	2.8	2.0	1.3	0.7
.3	2.6	1.8	1.1	0.6
.1	2.6	1.7	1.0	0.5
		TP = 10%		
.7	6.3	4.9	3.5	2.3
.5	5.7	4.2	2.8	1.6
.3	5.4	3.8	2.4	1.3
.1	5.2	3.5	2.2	1.1
		TP = 15%		
.7	9.8	7.7	5.7	3.8
.5	8.9	6.5	4.4	2.6
.3	8.3	5.8	3.7	2.0
.1	7.9	5.4	3.3	1.7

Table 2: Predetermined Prevalence. Table 2 typically applies to identification procedures in which an administrative decision was initially taken to predetermine the gifted and talented population as a spe-

cific percentage of the total school population. The reasons for such a decision may vary from philosophical, to political, to financial; the important consideration is that the program coordinator must structure her procedure around that constraint. If she endorses a disjunctive view of giftedness and talent and wants to identify a diverse population in terms of abilities, then Table 2 data will help her estimate the percentage of students to select for each ability assessed so that the total will add up to the preestablished target population. The question most relevant to Table 2 could thus be stated as follows: "Considering that local policy requires to identify as gifted and/or talented students X% of the school population, if I want to identify students in Y different ability areas that are correlated on average at the Z level, what will be the approximate percentage of students to select for each of these abilities so that they will add up to X, my predetermined global selection ratio?" Offering 64 different answers, each cell in Table 2 gives the estimated cutoff percentage for each ability, depending on one of four assessment battery sizes (columns), one of four average correlation levels (rows), and with regard to one of four distinct prevalence targets (sections).

Because of the very different perspective adopted in Table 2, most of the cell data show opposite trends from those in Table 1. For instance, instead of increasing, the values from left to right decrease. It stands to reason: in order not to exceed the fixed target prevalence, the more abilities we decide to assess, the fewer top scorers we need from each ability area. Similarly, the values decrease down each column within each of the four sections. When abilities are closely related, one needs more individuals per ability to attain the target because many of those selected with Ability B will already have been chosen with Ability A. The selection ratio decreases as the tests become less correlated. The most predictable trend is the growth in percentages from section to section; the larger the target group, the more top scorers within each ability will contribute to that overall gifted and talented population.

As a concrete example, let us use again the situation described in the preceding section. Our program coordinator, who harbors a disjunctive view of giftedness and talent, wants again to assess three distinct abilities with tests that she knows to be moderately ($r = .5$) correlated. She has been given—or has given herself—a target prevalence of 10%. With this information in hand, she can estimate from Table 2 that she will just reach her target by selecting the top 4.2% scorers on each ability measure. The fact that 3 x 4.2% does not add up to 13.6% but to 10% follows of course from the fact that, due to the moderate correlations between the measures, many students will be selected on more than one ability measure.

Conjunctive Situations

The two tables of data presented in this section include essentially the same prevalence estimates as those in the first two tables, with one exception: They target identification situations in which the administrators try to implement a conjunctive definition of giftedness and talent. The best known of such definitions is Renzulli's (1986) "Three-Ring" definition of giftedness, "Gifted behavior consists of behaviors that reflect an interaction among three basic clusters of human traits—these clusters being above average general and/or specific abilities, high levels of task commitment, and high levels of creativity" (p. 76). Sternberg (2005) recently proposed his wisdom, intelligence, creativity, synthesized (WICS) model. He states

> According to this model, wisdom, intelligence, and creativity are sine qua nons for the gifted leaders of the future. Without a synthesis of these attributes, someone can be a decent contributor to society, and perhaps even a good one, but never a great one. (p. 327)

Another would be Gagné's (2003) intellectually gifted, academically talented (IGAT) population. Gagné argues that most school districts select such "bright *and* achieving" students for their gifted programs because the two most common identification instruments are group IQ tests (for the IG part) and standardized achievement tests (for the AT part). Tables 3 and 4 parallel the same dichotomy as in the previous section, namely open versus predetermined prevalence.

Table 3: Open Prevalence. The appropriate question for the Table 3 data slightly differs from the Table 1 question: "How many individuals (students) would be identified as gifted and/or talented *in each of*

Table 3
Estimated Prevalence Values (in %) of Gifted/Talented Individuals Within a Conjunctive Perspective as a Function of Four Selection Ratios (SR), Three Quantities of Ability Measures (*N* abil.), and Four Average Correlation Levels (Av. *r*)

	N abil.		
Av. *R*	2	3	5
	SR = 5%		
.7	2.0	1.1	0.6
.5	1.2	0.5	0.2
.3	0.7	0.2	0.0
.1	0.4	0.0	0.0
	SR = 10%		
.7	4.7	3.0	1.7
.5	3.2	1.6	0.6
.3	2.2	0.7	0.1
.1	1.3	0.2	0.0
	SR = 15%		
.7	7.8	5.3	3.3
.5	5.8	3.1	1.3
.3	4.2	1.6	0.4
.1	2.8	0.6	0.0

a combined set of abilities if we selected the top X% on each of Y abilities with an average correlation level of Z?" Or, said differently: "If we measure Y different abilities (Y = 2, 3, 5) that have a Z (.7 to .1) average correlation between them, how many students will meet a preselected cutoff value of X (SR = 5%, 10%, 15%) *on each of the chosen abilities*?" The options offered for the three parameters have been slightly modified to delete implausible situations. For instance, Parameter X, the selection ratio applied to each ability measure, now varies between 5% and 15% (three sections) because a selection ratio of 2% would produce prevalence levels well below 1%, which we judged overly selective. Similarly, the maximum number of abilities measured, Parameter Y, has been reduced to 5 (three columns) because no definition exists that requires conjunctive excellence on more than half a dozen distinct characteristics in order to receive the gifted or talented label. The average correlation Z still varies between .7 and .1 (four rows).

As should be expected, the cell data in Table 3 differ markedly from those in Table 1 by their small size. As argued in the introduction, the conjunctive approach is much more selective in identifying gifted and/or talented individuals; one needs to excel simultaneously in more than one area. The impact of the selection ratio remains the same: The higher it is per ability, the more people will be found who meet the other criteria. The growth in values from section to section down Table 3 shows that phenomenon quite clearly. Moreover, increasing the number of abilities measured has the expected effect of radically decreasing the ensuing prevalence. Take, for instance, a pool of people who have been identified as the top 15% on one ability measure. As shown in the bottom part of the table, only 4.2% will remain if we look, among them, for those who also excel at the same level (15%) on a second, slightly correlated (r = .3) ability. That percentage will drop to 1.6% if we add a similarly correlated third ability and to just 0.4% (4:1,000) when the number of abilities increases to five. If we were to start with an initial selection ratio of 10% instead of 15%, the resulting percentages for 2, 3, and 5 abilities would become 2.2%, 0.7%, and 0.1% respectively. Finally, Table 3 shows the significant impact of test correlations on the resulting prevalence. For instance, let's try to find individuals who excel (top 15%) simultaneously on three distinct abilities. If these abilities are closely related (r = .7), the resulting prevalence is 5.3%; in other words, a third of the initial group of 15% on any one ability will remain as those who excel on these three closely related abilities. But, if the three assessed abilities are just slightly correlated (r = .1), then the resulting prevalence drops to 0.6%, *nine times* fewer individuals than with closely correlated measures. The percentages drop even more when the initial selection ratio is reduced to 10% or 5%; in this last case, with three slightly correlated abilities, the probability of finding individuals who excel (top 5%) simultaneously on three of them is about 4:10,000 or just one person in a school population of 2,500 students.

As a concrete example, imagine that a school district coordinator for gifted and talented services decides to apply rigorously Renzulli's (1986) three-ring definition of giftedness. That person would need to measure independently each of the three components of his conception (above-average ability, creativity, task commitment), then select those who exceed a predetermined cutoff percentage on each of these three criteria, logically the same cutoff for each measure. We could expect that measures of these three concepts would be modestly correlated, probably not much more on average than .3. Table 3 shows that if that coordinator were to use a cutoff of 5% for each ability, she would end up with only 0.2% students (1:500) exceeding the cutoff scores on all three measures. Even with a much more generous selection ratio of 15%, the resulting prevalence would reach only 1.6%, about 1:60. Indeed, among the 36 values presented in Table 3, only three exceed the typical 5% used as a benchmark prevalence level in a majority of school districts, and two of them require the measure of closely related abilities (r = .7).

Table 4: Predetermined Prevalence. Just like in Table 2, the identification situation covered by Table 4 assumes an administrative decision to select a predetermined percentage of gifted and talented students; the total prevalence is not the outcome of the identification process, but its starting point. The question then becomes: "Considering that local policy requires to identify as gifted and/or talented students X% of the school population (the target prevalence), if my conjunctive definition implies the measure of Y different abilities (columns) that are correlated on average at a Z level (rows), what approximate percentage of students will we select for each of these abilities (cell data) so that all students within that targeted percentage exceed the chosen selection ratio on every Y measure?" Compared with the data in Table 2, we made only one modification, namely the elimination of Y = 10, again because we know of no conjunctive definition requiring simultaneous excellence in so many distinct abilities.

The most striking feature in Table 4 is the large size of most percentages in the cell data. It had to be expected from the observa-

Table 4
Estimated Per Ability Selection Ratios (in %) of Gifted/Talented Individuals Within a Conjunctive Perspective as a Function of Four Target Prevalence Values (TP), Three Quantities of Ability Measures (*N* abil.), and Four Average Correlation Levels (Av. *r*)

	N abil.		
Av. *R*	**2**	**3**	**5**
	TP = 2%		
.7	5.1	7.5	10.9
.5	7.1	11.6	18.3
.3	9.5	16.8	27.7
.1	12.5	23.3	39.2
	TP = 5%		
.7	10.5	14.4	19.5
.5	13.5	20.0	28.6
.3	16.8	26.2	38.6
.1	20.4	33.1	49.3
	TP = 10%		
.7	18.2	22.8	29.8
.5	22.0	29.9	39.7
.3	25.8	36.4	49.2
.1	29.6	43.0	58.5
	TP = 15%		
.7	24.9	30.8	37.9
.5	29.1	37.6	47.7
.3	33.0	44.0	56.6
.1	36.8	50.1	64.6

tions made in the analysis of Table 3; when the abilities considered increase (Y) and are not closely related (Z), we need a very large pool of participants to pinpoint those few who simultaneously excel in many of them. Multiple giftedness or talent is not a very common phenomenon. For instance, in order to find in a school population a subgroup of 10% whose members outperform all other students on each of just three modestly (r = .3) correlated criteria, like those in Renzulli's (1986) three-ring definition, the cutoff score for each criterion would need to be a very generous 36.4%. In other words, if we select the top 36% on each of three ability measures—a very generous threshold by any definition— only 10% of them will belong to that top 36% on all three measures. Even with measures that are more closely related (r = .5), we would still need to select the top 30% on each measure to be sure that 10% of them will be among the selected on all three measures.

Discussion

We stated at the beginning of this article that the prevalence question looked deceptively simple but was in fact very complex. Yet, many scholars regularly give offhand responses to the question, responses similar to the well-known statement made by Marland (1972) more than three decades ago: "It can be assumed that utilization of these criteria for identification of the gifted and talented will encompass a minimum of 3 to 5 percent of the school population" (p. 4). That statement left much room for ambiguity, even if we put aside the expression "a minimum of." For instance, nowhere in the report was it clearly specified if that "3 to 5 percent" had to be divided more or less equally among the six categories of achievement and/or potential ability identified (general intellectual ability, specific academic aptitude, creative or productive thinking, leadership ability, visual and performing arts, and psychomotor ability), giving each a prevalence ratio of approximately 1%, assuming of course some overlap between abilities. This is just one example of the recurring ambiguities observed in the literature when the prevalence question is broached.

The message we have tried to convey in this text is not just the complexity of the prevalence issue but, more usefully, what major issues need to be addressed in order to generate agreement among a majority of scholars and professionals concerning this question. The results of our mathematical manipulations reveal that the most important issue, in terms of its impact on prevalence estimates, is the definition used.

Impact of Definitions

Two parameters in our study were directly related to definitional issues: (a) the disjunctive/conjunctive dichotomy, and (b) the number of abilities covered by the definition. These two parameters cannot be dissociated because the first one logically implies the presence of more than one characteristic. Indeed, when giftedness is defined simply as high-level intelligence, as is the case with many existing definitions (e.g., Morelock, 1996; Piirto, 1994; Robinson, 2005; Sternberg, 1986), then the prevalence problem reduces to the choice of an appropriate selection ratio or minimum threshold. Although closely related, the two definition-related parameters will be discussed here separately.

Disjunctive/Conjunctive Perspectives. Recall that disjunctive definitions (A *or* B *or* C) explicitly endorse multiple forms of giftedness and/or talent, whereas conjunctive ones (A *and* B *and* C) associate giftedness (or talent) to a combination of multiple characteristics manifested at a high level. Let's look at their divergent impact at a very basic level. Gagné (2003) argued that most students participating in enrichment activities within the K–12 educational system are identified with two major instruments: (a) an assessment of their intellectual giftedness (IG), usually with a group-administered IQ test, and (b) a measure of their academic talent (AT) using either school grades or standardized achievement tests. He thus labeled the "IGAT student" the typical participant in most gifted education programs across the United States and Canada. Let us assume that (a) a large number of school districts use only these two assessment instruments and (b) that some use them disjunctively (high scores on IG *or* AT) and others conjunctively (high scores on both IG *and* AT). How would the prevalence figures differ? Research has shown that these two measures correlate more or less at the .7 level (Jensen, 1998). If each school district chose a 5% selection ratio for each test, the one adopting a disjunctive definition would end up with a G/T population of 8% (see Table 1), whereas the corresponding percentage in the conjunctive district would be only 2% (see Table 3). In other words, using an identical selection threshold, four times as many students would be either IG or AT than those being IGAT (IG and AT). In our view, a 4:1 ratio represents a huge discrepancy in the size of the gifted or IGAT population. If other socially significant characteristics (e.g., poverty, obesity, alcoholically impaired behavior) were measured with such looseness, there would be a general outcry from the public and the media.

One could say: "Why don't we just agree on the size of the target population, however it is assessed?" In light of all arguments introduced in the present text, this reaction would just skirt the real problems. For some progress to happen on this question, we believe that scholars and professionals need to reach some agreement; the question is "what precisely should they agree on?" In the above example, an agreement on a target population of, say 5%, would only give the appearance of a solution. Indeed, as shown in Tables 2 and 4, the program coordinator defending the disjunctive (IG or AT) definition would reach that 5% target by selecting the top 3% on each test, whereas the coordinator who believes in a conjunctive definition would obtain her 5% IGAT population by selecting the top 10.5% on each of the two tests and then discarding all those who do not belong to both selected groups. If, for the sake of comparison, both approaches had been applied in either district, would the resulting two groups include the same students? Not at all. It can be estimated statistically, as we did with a Monte Carlo simulation, that the two groups would overlap by approximately 60% (3%/5%). In other words, the conjunctive approach would overlook about 40% (2%/5%) of the disjunctively identified gifted or talented and similarly for the conjunctive group. Pooling both groups, 7% of the total population would be identified as either IGAT (3%), IG only (2%), or AT only (2%). Said differently, for 60% of all students identified (4%/7%), their selection would depend on the definition used. This shows how important the definition is in determining who will be served in an enrichment program.

Number of Abilities/Characteristics. There are many more disjunctive than conjunctive approaches to the definition of giftedness or talent. This is why this section will focus on the impact of the second parameter on disjunctive definitions. The rule is quite simple: All other factors kept constant, as one adds more abilities, the prevalence of gifted or talented individuals increases rapidly, thus producing a more democratized view of the phenomenon of giftedness and talent. This is quite evident in Tables 1 and 2. Scholars who proposed disjunctive definitions should have pointed out the logical consequence of that multiplication of abilities, namely the rapid growth of the gifted/talented population. Alas, as mentioned in the literature review, only Taylor (1973) and Gagné (1993) did so; and Gagné alone has specified that his basic threshold of the top 10% should be applied to each giftedness domain and each field of talent. When one no longer defines giftedness very narrowly, with just intellectual abilities in mind, but adopts a much broader view of human abilities, it becomes easy to reach prevalence levels of 30% or 40%. For instance, just using a moderate selection ratio of 10% and low to moderate correlations (average r = .30) between pairs of abilities, the G/T population will reach almost 1:4 (24%) with just 3 abilities measured and 1:3 (34%) with 5 distinct abilities; with 10 abilities measured, almost 1:2 (49%) of the general population will deserve the label of gifted or talented in at least one of them. Think of it. A coordinator of a gifted programs starts with only the top three students in a group of thirty (10%), and, by assessing just a dozen different abilities, discovers that at least half of the school population deserves to be labeled gifted or talented in "something" meaningful. In fact, these percentages closely parallel those obtained in a study of multiple abilities through peer and teacher nominations (Gagné, 1998b).

Does this mean that with enough different abilities we would reach or approach 100%, thus confirming a common belief that "everyone is gifted?" By no means. There is a limit to the number of distinct human abilities recognized, unless one considers microdistinctions between them (e.g., Carroll, 1993). Gardner (1983/1994) identified seven human "intelligences," and Gagné (2003) recognizes four different giftedness domains, leaving some room for subcategories within each. He does mention that fields of talent are as numerous as human occupations, but excellence in each of them is measured in relation to the population of individuals active in each field. In other words, most individuals in any field of talent (e.g., carpenter, musician, biologist, basketball player, bus/truck driver, machine operator, journalist, salesperson) would be labeled competent, with just the top 10% among them being recognized as talented. It must be pointed out that as the number of measured abilities increases, the proportion of those excelling in domains or fields already measured also increases; thus, new additions to the group progressively decrease toward a practical ceiling. This ceiling effect manifests itself very clearly in Table 1 when one looks at any row from left to right.

The Last Two Parameters

Recall that the last two parameters used in this mathematical study were the selection ratio applied to individual measures and the average correlation between all pairs of measures collected.

The Selection Ratio. The selection ratio is the only variable in the present study whose impact affects both disjunctive and conjunctive definitions identically: The stricter the selection ratio, the smaller the prevalence of gifted/talented individuals will be. If a program coordinator adopts a selection ratio of 10%, she will get five times as many gifted or talented individuals as the other program coordinator who adopts a selection ratio of 2%. The impact of the selection ratio is consequently quite straightforward: With all other factors kept constant, double the selection ratio and you double the population. In reality, the data in the tables show that this rule works less well as the number of measured abilities grows. For instance, compare sections SR = 5% and SR = 10% in Table 1; you will see that the estimates almost double when only 2 abilities are considered (left column), but increase by only 60% or so when 10 abilities are measured (right column).

There is no logical way to pinpoint precisely the “right” value for the selection ratio. As mentioned earlier, some limits will readily lead to general agreement among scholars and professionals. For instance, few would endorse basic thresholds larger than 20% or smaller than 1%. But, as we move these two markers closer to each other, the degree of agreement will progressively crumble at both ends. In other words, there remains a large grey zone where scholarly viewpoints roam free. Still, if gifted education is to gain the status of a scientifically based field of inquiry, we believe that the choice of a basic identification threshold will be among the important questions to address and answer.

Correlations Between Measures. This last parameter in the study can be dealt with rapidly. The methodological limits imposed by our search for a suitable equation affected this variable much more than the three others. Recall that the only practical equation found in the literature (Gupta, 1963) required that we assume equal correlations between all pairs of measures introduced in the mathematical combinations; that certainly does not fit well with real measurement situations. On the other hand, using the database of a large identification study with peer nominations (Gagné, 1998b), we found that the nonrespect of that assumption did not bias significantly the simulated data (Bélanger, 1997); their fit to real prevalence measures created from the database remained very close.

What this parameter reveals, basically, follows common sense: Highly correlated measures will tend to create a high overlap between selected subgroups, whereas uncorrelated measures will create very different subgroups of gifted/talented individuals. Does this affect significantly the prevalence estimates? The answer seems to depend on the number of abilities assessed: The more there are, the stronger the impact of that variable. For instance, with a selection ratio of 2% and just two abilities, variations of the average correlation, from .1 to .7, will reduce the prevalence estimates from 3.9% to 3.4% (see Table 1); if the number of abilities increases to 10, the same variation of the average correlation will lower the prevalence estimate by almost 50%, from 17.3% to 8.9%. Still, practically speaking, unless program coordinators choose very similar (or dissimilar) abilities to measure for identification purposes, the average correlation between pairs should tend to stabilize around a median value close to .4 as the number of measured abilities increases.

Limits of This Mathematical Study

Two major methodological limits must be pointed out concerning the present mathematical study. The first one concerns the fact that we have dealt in this study with very simple and straightforward identification scenarios. The daily life of most G/T program coordinators rarely follows the constraints we defined to produce our four statistical tables. In many (most?) cases, they will have to abide by all kinds of hardly measurable constraints: pressures from parents, teachers, or administrators; transfers from other school districts where other identification procedures were used; pressures to use more psychometrically fragile—but less expensive—measures, like checklists given to teachers and parents; and so forth. Because we are not aware of recent surveys showing the diversity of local identification practices, we hesitate to discuss at length these special problems. One approach that seems somewhat popular, called the "matrix" approach (Borland, 1989; Piirto, 1994), is indirectly covered in this study. The matrix approach uses multiple identification sources and determines for the data from each source a specific—and different—scoring grid (e.g., 5 points for an IQ above 135, 4 points if it is between 131–135, and so forth). These points are added to create a global score for each student; administrators or program coordinators then apply a simple selection ratio to this new integrated ranking. Although the identification procedure begins with multiple measures, the end product becomes a single composite measure and requires nothing more than an appropriate—often predetermined—selection ratio.

The second methodological limit results from our assumption throughout this text that all ability measures used for identification purposes are psychometrically perfect, both in terms of their reliability and validity. Unfortunately, not a single measure of human abilities comes close to this ideal. Even with the best instruments available, namely IQ tests and standardized achievement tests, even the short-term reproducibility of scores from the same instrument barely reaches .9. As for validity measures, the convergent validity coefficients between similar instruments from different publishers will rarely exceed .7. Here is an interesting example. Pearce (1983) compared the scores of a selected group of 59 fifth graders on three well known IQ tests: Wechsler's Intelligence Scale for Children Revised (WISC-R), Raven's Standard Progressive Matrices (SPM), and Meeker's Structure-of-Intellect Screening form for Gifted (SOI-SFG). If we select the top 17% (10/59) on each of the three tests, only two students from her table of individual scores (Table 1 in Pearce, 1983) "make the cut" on all three tests, whereas no less than 22 (37%) emerge among that top 17% on at least one of them. This small-scale example indicates that even our best instruments will give only partly replicable results. Two possible—and complementary—explanations come to mind for these very divergent results. First, the imperfect reliability of each instrument will automatically lower the correlations between the three sets of test scores, thus increasing the disjunctive prevalence and reducing the conjunctive one. Second, the fact that the three tests do not measure exactly the same construct in the same way reduces the correlations between the tests, thus producing the same result as the first explanation. Both explanations add up to increase the gap between the conjunctive and disjunctive percentages.

Conclusion

This study began with a harsh judgment on the way the prevalence issue has (not) been dealt with in the field of gifted education. Then, we presented a series of mathematical combinations, which demonstrated that this question could be analyzed and its parameters circumscribed. The results of these mathematical combinations revealed that the answer to the "How many?" question was far from simple and relied first and foremost on preliminary decisions concerning the nature of the giftedness and talent constructs. These questions could be summarized as follows:

1. Is giftedness (or talent) a unitary concept?
2. If so, what minimum selection ratio would rally a majority of scholars and professionals in the field?
3. If not (unitary), should the concepts of giftedness and talent be defined disjunctively or conjunctively?
4. If a conjunctive definition of giftedness and/or talent was preferred by most, which essential contributive components should be included?
5. If a disjunctive definition was preferred by most, what would be the different manifestations of the giftedness/talent concepts?
6. After answering the two preceding questions, what minimum selection ratio should apply to the components/forms of the type of definition chosen?

Because no effort has yet been made to bring scholars and professionals to address the above questions, it is doubtful that answers will be proposed in the near future. Still, we restate our conviction that the prevalence issue is at the heart of a scientific examination of the giftedness and talent concepts and that the field of gifted education will not rise above its present folkloric status until such questions are addressed—and answered.

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End Notes

1 The conjunctive prevalence (%Cj) of identified individuals corresponds to the product of the selection ratios [Cj% = SR*SR*SR . . .]. To compute the disjunctive prevalence (%Dj), we just subtract from the whole population those who are not identified in a single ability domain [%Dj = 1 – ((1 – SR) * (1–SR) * (1–SR) . . .)].

2 The general function of the multinormal distribution (Johnson & Kotz, 1972) is presented in Equation 1.

$$f_k(x) = \frac{1}{(2\pi)^{k/2}\sqrt{|V|}} \exp\left[-\frac{1}{2}(X\text{-}M)' V^{-1} (X\text{-}M)\right] (1)$$

The "k" parameter the number of abilities, the X matrix allows a different selection ratio for each variable, and the V and |V| matrix represent respectively the matrix of covariances between all variables (similar to correlations) and its inverse. The conjunctive/disjunctive parameter would be taken into account after computing the conjunctive estimate (see End Note 1).

3 Here is a simplification of the function of the multinormal distribution (Gupta, 1963). The lack of matrices allows its integration, thus the computation of prevalence estimates.

$$F_{NA}(CP; \rho) = \int_{-\infty}^{\infty} F^{NA}(a)\ f(x)\ dx\ (2)$$

where
CP = the cutoff point selected in *z* scores for the set of NA dimensions;
r = the correlation between the abilities; it is assumed $\geq$ 0 and similar for all pairs of abilities;
NA = the number of abilities considered.

$$a = \frac{x\rho^{1/2} + CP}{(1-\rho)^{1/2}}$$

f(x) = the density function of the normal univariate distribution, that is:

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-1/2\left(\frac{x-\mu}{\sigma}\right)^2}$$

and

$$F^{NA}(a) = \left(\int_{-\infty}^{a} f(x)\, dx\right)^{NA}$$