

Chapter 2

Questionnaire and Transformation

Know thyself.

– Inscription on the temple to Apollo at Delphi, ascribed to Solon

You can hardly expect to understand your working group or its members without understanding yourself first. This chapter intends to give you insight into your own preferences and potentials. The method described for achieving this is powerful enough to extend to the understanding of your colleagues, or even to the organization of your team as a whole (Chap. 4). It also lays a foundation for selecting a good new team from a large set of equally qualified candidates, a topic to be developed fully in Chap. 3.

2.1 The Cognitive Questionnaire

Stanford's computer input program, upon which the formation and organization of cognitively diverse teams is based, employs the twenty items of the questionnaire in Table 2.1. For more psychologically valid results the program randomizes the orders of both the questions and the responses.

2.1.1 Questionnaire

Here the questions and responses have been grouped to make discussion and scoring easier. Interpretations of the four categories will follow afterward.

If the input program is not at hand, you can use the questionnaire to estimate which modes you prefer – your “cognitive pattern” – and determine scores to be employed for placing you well on a team. Often this questionnaire has been used right in class, the filling out and scoring taking no more

Table 2.1 Cognitive mode questionnaire

Circle zero, one or two alternatives for each of 20 questions.					
Be careful with signs!					
Energy Direction: Outward or Inward					
EI1	You are more:	(e)	sociable	(i)	reserved
EI2	You are more:	(e)	expressive	(i)	contained
EI3	You prefer:	(e)	groups	(i)	individuals
EI4	You learn better by	(e)	listening	(i)	reading
EI5	You are more:	(e)	talkative	(i)	quiet
EI difference: $\Sigma e - \Sigma i = EI$ _____					
Orientation: Structured or Flexible					
JP1	You are more:	(j)	systematic	(p)	casual
JP2	You prefer:	(j)	planned	(p)	open-ended
	activities:				
JP3	You work better	(j)	with	(p)	without
			pressure		pressure
JP4	You prefer:	(j)	routine	(p)	variety
JP5	You are more:	(j)	methodical	(p)	improvisational
JP difference: $\Sigma j - \Sigma p = JP$ _____					
Information COLLECTION process: Facts or Possibilities					
SN1	You prefer the:	(s)	concrete	(n)	abstract
SN2	You prefer:	(s)	fact-finding	(n)	speculating
SN3	You are more:	(s)	practical	(n)	conceptual
SN4	You are more:	(s)	hands-on	(n)	theoretical
SN5	You prefer the:	(s)	traditional	(n)	novel
SN difference: $\Sigma s - \Sigma n = SN$ _____					
DECISION-making process: Objects or People					
TF1	You prefer:	(t)	logic	(f)	empathy
TF2	You are more:	(t)	truthful	(f)	tactful
TF3	You see yourself as	(t)	questioning	(f)	accommodating
	more:				
TF4	You are more:	(t)	skeptical	(f)	tolerant
TF5	You think judges	(t)	impartial	(f)	merciful
	should be:				
TF difference: $\Sigma t - \Sigma f = TF$ _____					

than half an hour. Even if you have used the input program, you may wish to fill out the questionnaire just to understand what is being measured and to double-check your program scores (Exercise 2.1).

The questionnaire asks you to choose between the two alternatives given for each item. For example, the first item is (Table 2.2):

Table 2.2 Typical questionnaire item

EI1	You are more:	(e)	sociable	(i)	reserved
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Most people will simply choose one or the other and circle the letter (e) or (i). But the choice also includes the option of selecting both alternatives if you really do use them with about the same frequency. You may also leave both blank if an item is unclear or if both choices seem unlikely, situations that might occur especially if English is not your native language.



2.1.2 Mind-Set

It would be mistaken to regard the questionnaire as a quiz or test of competence. It is rather an assessment of what you usually like to do, which of course may not be what is expected of you in most college courses, especially at examination time. It is better to record your natural preferences rather than what you might think your family or teachers expect of you. Being honest with yourself is most likely to get you a team assignment as close as possible to what you really like to do and are probably good at. Kidding yourself is asking for trouble.

2.1.3 Calculations

Each choice adds or subtracts a point or two to half or all of the eight mode scores in the squares of Table 2.3. But rather than compute item-by-item, just add up the responses within each of the top four sections and record

Table 2.3 Cognitive mode scores
Compute and record **non-negative** scores below.

EI - JP + 2SN = ES _____	EI - JP - 2SN = EN _____	-	EI + JP + 2TF = ET _____	EI + JP - 2TF = EF _____
EXPERI- MENT	IDEATION		ORGANI- ZATION	COMMU- NITY
				
- EN = IS _____	- ES = IN _____	-	- EF = IT _____	- ET = EF _____
KNOW- LEDGE	IMAGI- NATION		ANALYSIS	EVALU- ATION

INFORMATION COLLECTION

DECISION-MAKING

the differences where indicated. The algebraic signs are crucial, so follow the difference formulas carefully. For example, 2 (e) responses and 3 (i) responses would give an EI difference of $2 - 3 = -1$.

Each mode has a three-term formula giving the score for the mode. For example, the upper left “Experiment” mode has the equation $EI - JP + 2SN = ES$ with a short line ____ following the mode identifier ES . If the score is positive, record it on the line provided. If it is negative, leave the mode score blank, instead recording the positive absolute value on the line for the complementary mode diagonally opposite. This complementary mode is IN for the example. A mode score of -3 for the ES mode in the upper left corner would be recorded as a positive 3 in the IN mode square below and to the right, diagonally opposite the ES square. The ES square would remain blank, the convention being that negative scores are not written down. It is understood that any blank modes represent negative scores easily obtained if needed by taking the positive score diagonally opposite and changing its sign to negative. Mode scores of zero are recorded in both the mode square and in the complementary square diagonally opposite, where the score will also be zero.

Only four such calculations are needed. It is convenient although not essential to proceed from left to right through the extraverted (E) modes in the top row. The maximum possible score for any mode is 20; scores will usually be single-digit.

There are three ways, all mathematically equivalent, to write a mode score. In the example, the positive form “ $IN\ 3$ ” would be the most usual, although the negative form “ $ES - 3$ ” would sometimes be needed in an equation. A third, more awkward form would combine the variable (EI in the example) with its algebraic value, here “ $EI - 3$ ”.

2.1.4 Mode Pattern

The scores, written in positive form separated by commas – $EN\ 1, IN\ 3, ET\ 5, IT\ 2$ for example – constitute the “mode pattern” for the person filling out the questionnaire. Modes with zero scores may be omitted. In this book the modes will be written in the order $ES, IS, EN, IN, ET, IT, EF, IF$ following the order of the mode squares from upper to lower and left to right. Notice that this ordering does not necessarily put complementary modes next to each other.

The mode patterns are the key elements in team formation and organization. These can begin as soon as patterns have been collected for all members of the pool of people to be made into teams. If you are eager to do this

without further discussion of the questionnaire, skip the rest of the chapter and go directly to Chap. 3 on team formation. The rest of Chap. 2 deals with psychological interpretations of the questionnaire variables in terms of Jung’s personality theory, construction of the questionnaire, and proof of the questionnaire’s validity.

2.2 Interpreting the Questionnaire Variables

2.2.1 Energy Direction: Jung’s Attitudes Extraversion *E* and Introversion *I*

Just before World War I, the physician-psychologist Carl Gustav Jung engaged in weekly discussions in Vienna with Sigmund Freud and Alfred Adler, older founders of psychoanalysis. Watching Freud and Adler dispute whether neurosis comes primarily from outside influence or internal conflict, Jung conceived the concepts of “extraversion” and “introversion”, describing Freud as an “extravert” and Adler as an “introvert”. Extraversion may be regarded as the flow of psychic energy *outward* toward the exterior world. In contrast, *introversion* draws psychic energy *inward* toward one’s interior psyche. These energy directions are measured by the first set of five questionnaire items. The second set of questions will partition them further into two useful subclassifications of psychic energy. Each of these subclasses

Table 2.4 Jung’s cognitive modes

Extraverted Sensing $ES =$ $E + P + 2S$ EXPERI- MENT	Extraverted iNuition $EN =$ $E + P + 2N$ IDEATION	-	Extraverted Thinking $ET =$ $E + J + 2T$ ORGANI- ZATION	Extraverted Feeling $EF =$ $E + J + 2F$ COMMU- NITY
Introverted Sensing $IS =$ $I + J + 2S$ KNOW- LEDGE	Introverted iNuition $IN =$ $I + J + 2N$ IMAGI- NATION	-	Introverted Thinking $IT =$ $I + P + 2T$ ANALYSIS	Introverted Feeling $IF =$ $I + P + 2F$ EVALU- ATION

INFORMATION COLLECTION

(C-DOMAIN)

DECISION MAKING

(D-DOMAIN)

will be partitioned again, the first by the third set of questions; the second, by the fourth set. The eight partitions resulting will determine the cognitive modes.

Psychologists refer to introversion and extraversion collectively as “psychological attitudes”, roughly following the Webster’s dictionary definition of “attitude” as “... a position ... meant to show a mental state ...”. Each extreme will be known as a “pole” of the “*EI* variable”, terminology used throughout this book. More specifically, *E* and *I* will be called “Jung’s attitudes” in this text to distinguish them from a second set of attitudes measured by the second set of questions.

Table 2.4 restates Table 2.3 to give the mode formulas in terms of single variables (e. g., *E* and *I*) rather than combined (*EI*) variables. In this way it shows clearly how *E* and *I* are distributed among the eight modes. The top (*E*) modes are said to be the “extraverted modes”; the bottom (*I*) modes the “introverted” ones. The adjectives “extraverted” and “introverted” are echoed in the mode designations. Equally interesting distributions of the other six variables *J*, *P*, *S*, *N*, *T* and *F* will be discussed later.

2.2.2 Information Collection and Decision-Making

Jung soon realized that his first conceptions of extraversion and introversion needed refinement. Extraversion or introversion could certainly change according to whether it was involved in collecting information or in making a decision. The psychic energy of extraversion would then be the sum of an extraverted information Collection energy, symbolized by *EC*, and an extraverted Decision-making energy *ED*. Introversion energy *I* is partitioned similarly. Note the prefix “*c*-” to abbreviate “information Collection”; “*d*-” will similarly stand for “Decision-making”.

All variables associated with information collection, – *EC*, *IC* and others yet to be defined – will reside collectively in what will be called the “*c*-domain”. For decision-making a similar “*d*-domain” containing *d*-attitudes *ED* and *ID* is defined. Notice then that whereas in Table 2.4 the extraverted *c*-attitude *ES* is at the top left of the *c*-domain, the introverted *c*-attitude *IN* is on the lower right. Similarly, *EF* is in the *d*-domain upper right whereas *IT* is lower left.

Keywords proposed for the domain attitudes are “Exploration” for *EC*, “Focus” for *IC*, “Control” for *ED* and “Appraisal” for *ID*. Be imaginative in using keywords in various contexts. For example, a person with a “control” attitude may be considered either “controlled” or “controlling” depending on the situation.

2.2.3 Orientation: Briggs Attitudes Structure *J* and Flexibility *P*

Although Jung conceived the idea of partitioning the attitudes into information collection and decision-making domain attitudes, neither he nor his followers ever devised a way to measure them as they had the attitudes *I* and *E*. Figure 2.1 suggests how this measurement might be accomplished. Notice that whereas the variable *J* occurs in the *extraverted decision-making* modes *ET* and *EF*, it shows up in the *introverted information collection* modes *IS* and *IN*. Conversely, *P* turns up in the *extraverted info collection* modes *ES* and *EN* and in the *introverted decision-making* modes *IT* and *IF*. Figure 2.1 illustrates this graphically. The *J*-modes are enclosed with dashed lines to contrast with the *P*-modes surrounded by solid lines.

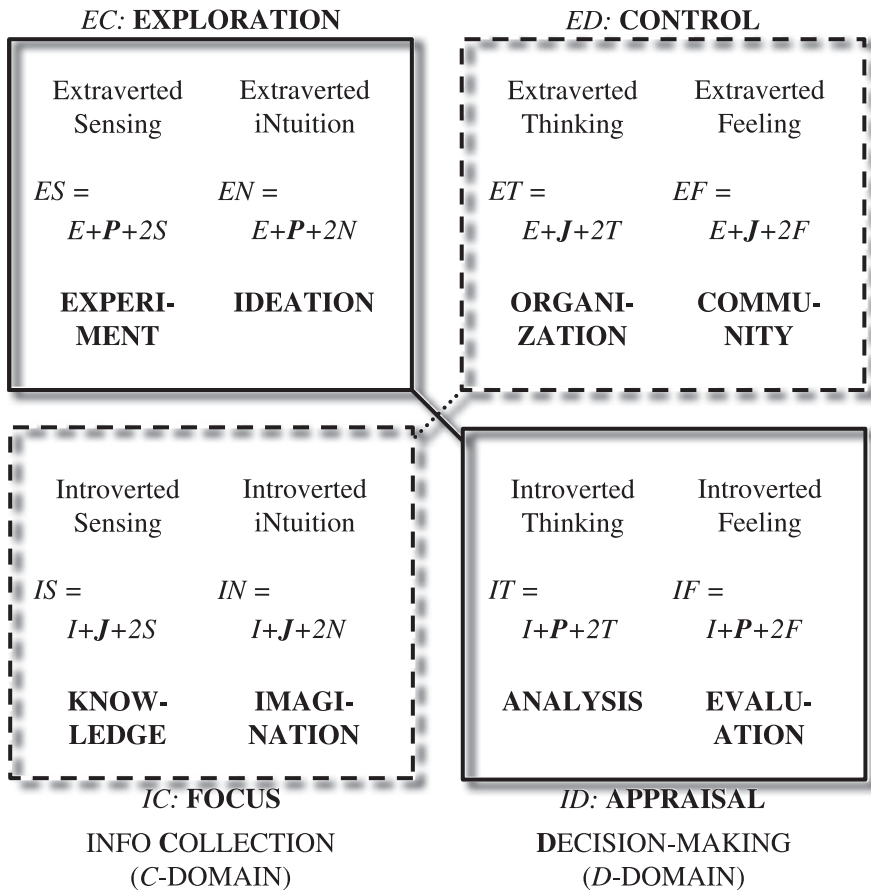


Fig. 2.1 The Briggs attitudes

It happened that Katherine Briggs, contemporary with Jung but at first not aware of his work, developed the set of questions needed. She labeled the corresponding variables “Judgment” *J* and “Perception” *P*, words that are insufficient in the current context because they do not refer to the introverted modes at all. Here they are described respectively by the keywords “Structure” and “Flexibility”, which cover introverted modes as well as extraverted ones although unfortunately not mnemonic. Typologists who followed Briggs eventually realized these relations, recording verbal versions of them in Myers et al. (p. 44). In her honor these variables will be termed “Briggs” attitudes, or “orientations” to distinguish them from the earlier “Jung” attitudes *E* and *I*.

A verbal interpretation of Briggs’ terminology using domain attitude keywords would regard the Judgment attitudes as “Control” (*ED*) for active (extraverted) decision-making and “Focus” (*IC*) for passive (introverted) information collection. Both involve a liking for “Structure”, the keyword given jointly to these attitudes. The Perception attitudes would then be “Exploration” (*EC*) for active (extraverted) info collection and “Appraisal” for passive (introverted) decision-making. These both require “Flexibility”, the joint keyword chosen for them here.

2.2.4 Info Collection Functions Sensing *S* and iNtuition *N*

Jung further partitioned information collection energy into two “(psychological) functions” called Sensing *S* and iNtuition *N*. These functions are complementary. Sensing uses the five senses to collect facts hands-on in the here-and-now and from the past, whereas iNtuition employs the mind to conceive present and future possibilities. Through extraversion and introversion both *S* and *N* form cognitive modes as shown in Table 2.5a. The Sensing modes *ES* and *IS* are in the left column of the info Collection domain; the iNtuition modes *EN* and *IN* make up its right column.

Notice that these new variables involve only two modes each, only half as many as the four modes touched by each of the attitudes *E*, *I*, *J* and *P*. This situation is compensated for by the coefficient 2 multiplying both *S* and *N* in the mode formulas.

2.2.5 Decision-Making Functions Thinking *T* and Feeling *F*

Finally Jung partitioned the decision-making modes according to how the decisions are made: Thinking *T* versus Feeling *F*. The Thinking way of

Table 2.5 The psychological functions

<i>EC: EXPLORATION</i>		<i>ED: CONTROL</i>	
Extraverted Sensing $ES =$ $E + P + 2S$ EXPERI- MENT	Extraverted INuition $EN =$ $E + P + 2N$ IDEATION	Extraverted Thinking $ET =$ $E + J + 2T$ ORGANI- ZATION	Extraverted Feeling $EF =$ $E + J + 2F$ COMMUNI- TY
-	-	-	-
Introverted Sensing $IS =$ $I + J + 2S$ KNOW- LEDGE	Introverted iNuition $IN =$ $I + J + 2N$ IMAGI- NATION	Introverted Thinking $IT =$ $I + P + 2T$ ANALY- SIS	Introverted Feeling $IF =$ $I + P + 2F$ EVALUA- TION
<i>IC: FOCUS</i>		<i>ID: APPRAISAL</i>	
a. INFORMATION COLLECTION (C - DOMAIN)		b. DECISION-MAKING (D - DOMAIN)	

deciding is to consider only the non-human objects – machines, numbers, cost – among the information collected, whereas the Feeling way is to weigh human factors – people, relationships, emotions – principally. T and F can further be extraverted or introverted, giving rise to two cognitive modes for each function and accounting for the four decision-making modes. As shown in Table 2.5b the Thinking modes ET and IT are in the left column of the Decision-making domain. The Feeling modes EF and IF are in the right column. As did the information Collection functions, the Decision-making functions need a coefficient of 2 to compensate for their representation in only half as many modes as the attitudes.

2.3 Validity of the Questions

How well does the questionnaire measure the four sets of variables used to calculate the mode scores? The best way to measure them is another much longer questionnaire known as the Myers–Briggs Type Indicator or MBTI, which has been doing just this for hundreds of millions of people all over the world over the last half century. Its validity is well documented in Myers et al.

Our questionnaire is not the MBTI, although it covers the same psychological territory. It is derived from statistical studies of correlations between

various MBTI questions. As described by Quenk, Hammer and Majors, these correlations establish five groupings called “facets” for each variable. From a response to any question within a facet the correlation is able to predict accurately the responses to all other items in the same facet. Each of the twenty facet correlations is in effect an abstraction of its facet questions. Each item of our questionnaire is simply a paraphrase of one of the facets discussed by Quenk, Hammer and Majors, who conveniently give names to the poles of each facet.

Take question *EI1* for example: “You are more sociable, or (more) reserved?” This refers to the first facet of the *EI* variable, labeled “Initiating-Receiving” in the description on p. 24 of their book. Compare the first sentence of their Initiating description with that for Receiving.

“Initiating: People at this pole get pleasure from mingling with others in large or small gatherings. . . .”

“Receiving: People at this pole are much more comfortable letting conversations come to them than initiating contact. . . .”

It was then a simple matter to use “sociable” to describe “initiating” and “reserved” for “receiving” to construct item *EI1*. This approach was employed for the other nineteen facets as well. The questionnaire thus gives a facet-by-facet profile of the four variables from which the mode scores are computed.

2.4 Proof of the Mode Score Formulas

It remains to prove that the score formulas correctly transform the questionnaire responses into meaningful cognitive mode scores. Such formality may not interest students content to believe in the questionnaire’s validity based on the authority of their professor; it is the professors themselves who must be convinced.

To understand the proof it helps to visualize any four questionnaire responses *EI*, *JP*, *SN* and *TF* as a point in a four-dimensional “question” space. Similarly, any four mode scores *ES/IN*, *EN/IS*, *ET/IF* and *EF/IT* can be seen as a point in a different four-dimensional “mode” space.

The formulas map response points onto mode score points. Mathematicians would call this mapping a “4 by 4 linear transformation”. Since zeroes for all four responses would produce four zeroes for the mode pairs, the technical adjective “homogeneous” can be added to the description. Each set of four variables is linearly independent, making the transformation “non-singular”. This means that there is exactly one mode score outcome point for every questionnaire response input point.

All this is important because it allows us to use well-established theorems of linear algebra (Strang 1978). These say that such a 4×4 homogeneous transformation is completely determined if correspondences are given between four different pairs of response points and mode score points.

2.4.1 Four Correspondences

Aside from the origins, which for a homogeneous transformation must match automatically, there are four correspondences that come to mind. Each maximum mode score, and there are four of them, should be generated by maximum values of the related questionnaire values. For instance, the highest Extraverted Sensing ES/IN mode score should occur when the questionnaire scores for Extraversion E , Sensing S and Flexibility P are 5, their maximum values. The other three mode scores for EN/IS , ET/IF and EF/IT , needed to complete the description of the 4-dimensional mode point, should vanish for these same three questionnaire values $E = P = S = 5$, supplemented by a fourth value for the remaining variable T . Since T is not involved in the ES mode, a reasonable value for it turns out to be zero. According to the formula $ES = E + P + 2S$, the ES score corresponding to $E = P = S = 5$, $T = 0$ would be 20, making the four mode coordinates $(ES/IN, EN/IS, ET/IF, EF/IT) = (20, 0, 0, 0)$ as required.

Although the first component value $ES/IN = 20$ obviously works because it was computed from the ES formula, the vanishing of the other three must be proven to complete the match. This is accomplished by direct substitution of the questionnaire values into the three formulas for EN , ET and EF , being careful of the signs, noting particularly the new negative formula values $N = J = -5$. The calculations follow:

$$EN = E + P + 2N = 5 + 5 + 2(-5) = 0 ;$$

$$ET = E + J + 2T = 5 - 5 + 2(0) = 0 ;$$

$$EF = E + J + 2F = 5 - 5 + 2(0) = 0 .$$

Thus the formulas indeed match the mode point, where ES is maximum and the other three modes zero, to the questionnaire point where the corresponding questionnaire variables E , P and S are maximum.

The other three extreme mode points are tested similarly, the results being that $E = P = N = 5$, $T = 0$ maps to $EN = 20$ with the others 0, $E = J = T = 5$, $S = 0$ maps to $ET = 20$ with the others 0, and $E = J = F = 5$, $S = 0$ maps to $EF = 20$ with the others 0. This completes the constructive proof

that the formulas map maximum questionnaire values to maximum mode scores. The 4×4 homogeneous transformation generating the mode scores is therefore completely determined, rigorously if not elegantly.

2.4.2 Other Questionnaires

Other questionnaires explore the same Jungian territory and with proper scaling can be used along with or instead of ours. The most accurate is the Myers–Briggs Type Indicator (MBTI), whose numerical “clarity” scores can be used in the same formulas as ours if the MBTI numbers are divided by 6. This scaling is needed because the MBTI numbers range from 0 to 30, whereas ours run from 0 only to 5. Our range was chosen because it generates integers (whole numbers) for the mode scores, whereas the MBTI range does not. This will of course still be true when the integral MBTI questionnaire numbers are divided by 6, but it will be seen in Chap. 3 that these decimal numbers will not cause any difficulty when forming teams.

Another usable questionnaire is the Keirsey–Bates “Temperament Sorter”, which has the disadvantage that its *EI* range is 10 and its *JP*, *SN* and *TF* ranges are all 20. Since our variables all run from 0 to 5, the K–B *EI* score must be divided by 2 and the others by 4. The results of course may not be integers, but as for the MBTI this will not interfere with the team formation methods of Chap. 3. Keirsey also has a 100-item questionnaire on the Internet (Google: HumanMetrics), but its range is not clear at this writing. This is a problem only when other questionnaires are also in use to form teams.

2.5 Concluding Summary

This chapter has presented a Jungian cognitive mode score questionnaire to be used to make teams based on Jung’s personality theory. After giving advice about a good mind-set for filling out the questionnaire, the chapter pointed out that one could use the calculated mode scores immediately to begin forming teams by the methods of the chapter following.

Intending to build the reader’s confidence in the questionnaire’s validity, the rest of the chapter explained and justified the questionnaire. First it briefly interpreted the four categories of questions in terms of easily measured personality descriptions. Along the way influences of the questionnaire variables on the mode scores were developed and discussed. Then it noted that the questions are based on mild abstractions of many more items from the Myers–Briggs Type Indicator (MBTI), a well-tested personality

type instrument. Finally, the mode score formulas were proven by direct computation to map maximum values of the questionnaire variables to appropriate maxima of the mode scores. By the way, this proof establishes the first rigorous QUANTitative version of Jung's entirely QUALitative personality theory.

And now to make teams!

2.6 Exercises

2.1. If you are using a computerized questionnaire, compare the mode scores it gives you with those you obtain from the questionnaire in this chapter. Note any discrepancies and decide which results you prefer.

2.2. Compare your HumanMetrics questionnaire scores with those from either your computerized questionnaire or the questionnaire in this chapter. What scale factor would you apply to make them comparable? Using this factor, compute your HumanMetrics mode scores.

2.3. If you have recent MBTI results, scale them by a factor of $1/6$ and compute mode scores. Compare them to your questionnaire results, computerized or not. Which do you prefer?



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