Chapter 2
On the Measurement and Conceptualization of Flow

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Abstract This chapter introduces in chronological order the three main measurement methods–the flow questionnaire, the experience sampling method, and the standardized scales of the componential approach–that researchers developed and used in conducting research on the flow state. Each measurement method and underlying conceptualization is explained, and its strengths and limitations are then discussed in relation to the other measurement methods and associated conceptualizations. The analysis reveals that, although the concept of flow remained stable since its inception, the models of flow that researchers developed in conjunction with the measurement methods changed substantially over time. Moreover, the findings obtained by applying the various measurement methods led to corroborations and disconfirmations of the underlying models and hence provided indications on how to interpret and possibly modify flow theory. The final section outlines new directions for developing more valid and useful measurement methods that can help to advance the understanding of flow, its antecedents, and its consequences.

Theory, Models, and Measurement Methods

Engeser and Schiepe (see Chap. 1) argued that the definition of flow has changed very little since Csikszentmihalyi's (1975/2000) original formulation in 1975, and that there is strong agreement among researchers on the definition itself. Yet, they pointed out that there is a certain level of disagreement among researchers as to how flow should be measured. Indeed, over the past 35 years, researchers have kept developing and validating new measurement tools for flow, and modifying and revalidating established ones, which indicates that a gold measurement standard for

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flow has yet to be achieved. How is it possible to have agreement on a concept and disagreement on how to go about measuring it? This apparent paradox is not uncommon in the history of psychology and can be understood by recognizing that the path from the theoretical definition to the operationalization of a construct goes through the intermediate process of modeling.

A theory, such as flow theory, essentially is a set of interrelated constructs—including their definitions—and propositions that describe systematically the relationships among the constructs with the purpose of explaining and predicting a range of measurable outcomes. A measurement method, such as the experience sampling method (ESM), is an apparatus and a technique for using it that is designed to measure some—but not necessarily all—theoretical constructs in order to test some predictions made by the theory. When researchers use a measurement method in order to test specific predictions derived from a theory, they typically simplify the theory and condense it into a simpler and more precise model. The model can be an authentic mathematical model, which states relationships among constructs in the form of equations, or simply a graphic representation, such as a conceptual diagram, a path diagram, or a flow chart. Modeling is helpful because it reduces the gap between words and numbers and hence allows testing abstract relationships expressed in natural language on real-world data using statistics. Yet, because it implies a somewhat arbitrary interpretation and simplification of the underlying theory, researchers may end up adopting different models in their research and hence disagreeing on how certain constructs should be measured.

To some extent, this is what has happened in the field of flow research. Therefore, a historical approach is adopted in this chapter. In the following three sections, each major measurement method and underlying conceptualization (i.e., the modeling) is explained, and its strengths and limitations are then discussed in relation to prior measurement methods and conceptualizations. The last section outlines some novel directions of methodological research that will hopefully lead to a more accurate, complete, and integrated modeling and hence a gold measurement standard for flow.

Capturing Flow in Special Endeavors

Description of the Measurement Method

The interviews that Csikszentmihalyi (1975/2000) conducted with participants from a wide range of occupations produced a wealth of textual descriptions of the flow experience in various domains of human endeavor. Some of the most insightful and clear descriptions of flow were then selected and condensed to create the first measurement method for flow, the flow questionnaire (FQ; Csikszentmihalyi and Csikszentmihalyi 1988b). The FQ proposes definitions of flow and asks respondents to recognize them, describe the situations and activities in which they experi-

ence flow, and rate their subjective experience when they are engaged in flow-conducive activities. Understanding how this is achieved requires entering the "nuts and bolts" of the instrument.

Box 2.1 shows the key sections of the FQ. Section 1 presents three quotes that vividly describe the flow experience. Section 2 requires just a yes/no answer and hence allows classifying participants into flow-ers (i.e., those who experienced flow in their lives) and non-flow-ers (i.e., those who did not experience flow in their lives). The following sections are directed only to flow-ers. Section 3 asks them to freely list their flow-conducive activities. Section 4 asks participants who reported two or more flow-conducive activities to select one activity that best represents the experience described in the quotes, that is, the best flow-conducive activity. Section 5 asks respondents to rate their subjective experience when they are engaged in the best flow-conducive activity and in other activities, such as work or being with family, using Likert-like scales. The scales include expressions that had emerged from interviews, such as "I get involved" and "I enjoy the experience and the use of my skills," and the two cornerstone variables of flow theory, "challenges of the activity" and "your skills in the activity."

Box 2.1 The Key Sections of the Flow Questionnaire (Adapted from Csikszentmihalyi and Csikszentmihalyi 1988b, p. 195)

1. Please read the following quotes:
   My mind isn't wandering. I am not thinking of something else. I am totally involved in what I am doing. My body feels good. I don't seem to hear anything. The world seems to be cut off from me. I am less aware of myself and my problems.

     My concentration is like breathing I never think of it. When I start, I really do shut out the world. I am really quite oblivious to my surroundings after I really get going. I think that the phone could ring, and the doorbell could ring or the house burn down or something like that. When I start I really do shut out the world. Once I stop I can let it back in again.

     I am so involved in what I am doing. I don't see myself as separate from what I am doing.
2. Have you ever felt similar experiences?
3. If yes, what activities were you engaged in when you had such experiences?
4. Please write here the name of the activity—among those you quoted, if any—which best represents the experience described in the three quotations, that is, the activity where you feel this experience with the highest intensity.
5. On the next pages, there are a number of items referring to the ways people could feel while doing an activity (e.g., ratings on the activity quoted in section 4, work or study, or spending time with the family). For each item, please tell us how you feel doing each of these activities.
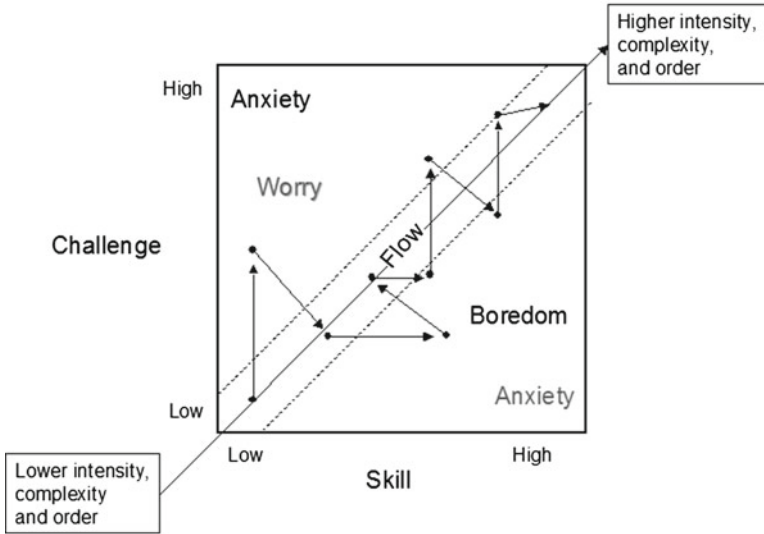
Fig. 2.1 The first model of the flow state (Adapted from Csikszentmihalyi 1975/2000)

The First Model of the Flow State

The FQ is a way to approach the empirical study of flow as represented by the first graphic model of the flow state (Csikszentmihalyi 1975/2000, p. 17), which is reproduced with some additions in Fig. 2.1. The model partitions the world of experience in three main states—flow, anxiety, and boredom—that are represented as nonoverlapping areas of a challenge by skill Cartesian space. The flow state is posited to occur when there is an equivalent ratio of perceived challenges from the activity to perceived skills in carrying out the activity. This can occur when both challenges and skills are low, when both are medium, and when both are high: in all these cases, there is a balance of challenges and skills, and hence a person should be in flow. Yet, not all flow states are the same: when achieved in high-challenge/high-skill situations, flow will be more intense, ordered, and complex than when it is achieved in low-challenge/low-skill situations (Csikszentmihalyi, personal communication, 1987).

The anxiety state is posited to occur when the perceived challenges from the activity exceed the perceived skills in carrying out the activity, whereas the boredom state is posited to occur when the perceived skills in carrying out the activity exceed the perceived challenges from the activity. As Engeser and Schiepe pointed out (see Box 1.2), Csikszentmihalyi later removed the "anxiety" label for situations in which skills are very high and challenges are very low and no longer referred to "worry" for situations in which skills are very low and challenges are medium, so that the model of Fig. 2.1 was later simplified into the threefold partition flow–anxiety–boredom. In the second edition of his 1975/2000 book, Csikszentmihalyi renamed

"boredom" as "boredom/relaxation," indicating that a situation of overcontrol may be either aversive or mildly hedonic depending on personal and situational factors.

Finally, Csikszentmihalyi (1975/2000) viewed the model as the experiential map through which a person "walks" in the quest of flow of ever growing complexity: the shown trajectories represent the hypothetical walk of a person who starts an endeavor in a state of low-complexity flow, crosses into the anxiety and boredom states, and eventually reaches a state of high-complexity flow.

Strengths and Weaknesses

The potential for application of the FQ can be evaluated in respect to the model of Fig. 2.1. The FQ has four main strengths. First, it provides a single and clear definition of flow that identifies with no ambiguity the diagonal region of the model and can be used to estimate the prevalence of flow (i.e., the percentage of people in specific populations that experience flow in their lives) as a single construct, and hence it allows studying differences in prevalence across genders, age groups, occupations, or cultures. The flow quotes capture directly *merging of action and awareness* (e.g., "I don't see myself as separate from what I am doing"), *centering of attention* (e.g., "my concentration is like breathing I never think of it"), and *loss of self-consciousness* (e.g., "I am less aware of myself and my problems") and implicitly *autotelic nature*, *feeling of control,* and *coherent, noncontradictory demands and feedback*. In all, the quotes seem to capture the kernel of the construct, as defined by Csikszentmihalyi (1975/2000) in 1975.

Second, unlike the approaches presented in sections "Capturing Flow in Daily Experience" and "The Componential Approach: Capturing Flow as a Multidimensional State-Trait Variable" of this chapter, the FQ does not "impose" flow to respondents, that is, it does not arbitrarily assume that everybody experiences flow in general or in a specific context. An important implication is that participants who would be classified as non-flow-ers based on the FQ because they did not recognize the proposed flow quotes could obtain an artificial flow score on standardized flow questionnaires simply because they reported some level of concentration or absorption—which per se do not signify flow—when engaged in the target activity. Therefore, the FQ may be considered a more valid method for measuring the prevalence of flow.

Third, because it asks respondents to freely list the activities in which they experienced flow, the FQ can be used to estimate the prevalence of flow in specific contexts. For example, Moneta (2010, in press) used a two-step procedure to assess the prevalence of flow in work: in the first step, independent judges coded the listed activities into either "work" or "leisure"; in the second step, participants were classified into those who (a) do not experience flow (non-flow-ers), (b) best experience flow when engaged in a work activity (work flow-ers), and (c) best experience flow when engaged in a leisure activity (leisure flow-ers).

Finally, by virtue of asking flow-ers to rate various facets of subjective experience as well as the levels of challenge and skill perceived when they were engaged

Box 2.2 Quotes Used to Capture "Shallow" and "Deep" Flow (Moneta 2010)

"Shallow" Flow

- "My mind isn't wandering. I am totally involved in what I am doing and I am not thinking of anything else. My body feels good… the world seems to be cut off from me… I am less aware of myself and my problems."
- "My concentration is like breathing… I never think of it… When I start, I really do shut out the world."
- "I am so involved in what I am doing… I don't see myself as separate from what I am doing."

"Deep" Flow

- "I am really quite oblivious to my surroundings after I really get doing in this activity."
- "I think that the phone could ring, and the doorbell could ring or the house burn down or something like that…"
- "Once I stop I can let it back in again."

in their best flow-conducive activity, the FQ allows testing whether flow occurs when challenges and skills are in relative balance with each other and whether subjective experience is more positive in the flow state than in the anxiety and boredom states.

The FQ has three main weaknesses. First, do the flow quotes constitute a single description of the flow state? In an ongoing study (Moneta 2010, in press), the original flow quotes were streamlined and divided in two separate sections of the FQ, one designed to measure a shallower flow and the other a deeper flow,[1] as shown in Box 2.2.

The quotes of "deep" flow differ from those of "shallow" flow in that they emphasize the condition of isolation from the environment that is central to the construct of flow. A sample of 393 workers located in the United Kingdom and from a wide range of occupations was cross-classified according to whether they had both types of flow, only one type, or neither one, as shown in Table 2.1. Although the majority of participants ($n = 250$, 63.6%) provided concordant answers, a third of the sample ($n = 130$, 33.1%) experienced shallow flow but did not experience deep flow, and a small group ($n = 13$, 0.3%) experienced deep flow but did not experience shallow flow. As such, the quotes seem to constitute a reasonably homogeneous set, with the caveat that a flow state characterized by a strong sense of isolation from the environment is less prevalent than, and perhaps qualitatively different from an ordinary flow state. Yet, because deep flow and shallow flow appear to be somewhat

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[1] The separation of quotes was suggested by Antonella Delle Fave in 1997 (personal communication).

Table 2.1 Cross-classification of 393 workers in the United Kingdom based on whether they experienced shallow flow and whether they experienced deep flow

Shallow flow	Deep flow		
	No	Yes	Total
No	115	13	128
Yes	130	135	265
Total	245	148	393

distinct phenomena, mixing shallow flow quotes with deep flow quotes creates uncertainty as to exactly what a respondent's yes/no answer refers to.

Second, the FQ does not allow measuring the intensity or level of flow in specific endeavors. Although it is possible to infer whether a flow-er experienced flow in a specific activity (e.g., work) by checking whether that activity appears in the list of flow-conducive activities, the FQ does not allow measuring how intense flow was in that activity. Section 5 of the FQ contains scales measuring intensity of experience when engaged in a flow-conducive activity, irrespective of whether one experiences flow while engaged in that activity; because people experience flow only a percentage of times when they perform a flow-conducive activity, such intensity measures do not specifically tap flow intensity in that activity. Moreover, if a flow-er reports no flow-conducive activity in the target category (e.g., work), it is still possible that the participant experienced flow in the target activity but simply forgot listing the activity. Therefore, the FQ is useful primarily for assessing prevalence of flow in general, and it is open to the risk of false negatives when used to estimate prevalence of flow in specific contexts of activity.

Finally, the FQ does not allow a straightforward assessment of how perceived challenges of the activity, perceived skills in the activity, and the ratio of the two variables influence the occurrence of the flow state. This is because participants are asked to indicate their *average* challenge and skill levels in the best flow-conducive activity, and hence they are not necessarily reporting challenge and skill levels when in the flow state. The problem is that an average rating also is affected by the frequency with which flow—versus other states, such as anxiety and boredom, which are associated with other challenge/skill ratios—is experienced in the best flow-conducive activity. Therefore, the FQ is not a method of choice for testing the core tenet of flow theory and for investigating the dynamic "walks" in the challenge by skills Cartesian space that are represented in the model of Fig. 2.1.

Overall Assessment

In all, the FQ is a good measurement method for studying the prevalence of flow, but it is a limited measurement method for investigating the effects of challenges and skills on subjective experience, and it cannot measure the intensity of flow in

general and in specific endeavors. The measurement methods presented in the next two sections can be viewed as attempts to overcome such limitations.

Capturing Flow in Daily Experience

Description of the Measurement Method

The empirical test of flow theory in respect to everyday life experience became possible with the introduction of the ESM (Csikszentmihalyi et al. 1977; Csikszentmihalyi and Larson 1987). The ESM is a measurement method designed to infer the time budget (i.e., the sequence and times in which individuals are in specific states) in everyday life and the associated variation of subjective experience. The ESM seeks a random sampling of the population of experiences in respect to activities and contexts of action and associated subjective feelings. The ESM pursues the goal of ecological validity by studying subjective experience while participants are acting in their natural environments. The ESM consists of administering a questionnaire to a sample of participants repeatedly over random time intervals during their daily activities. The ESM is designed to overcome mnemonic distortions and *post hoc* rationalizations by asking appropriate questions just when the participants are engaged in their daily activities.

The original form of the ESM (Csikszentmihalyi and Larson 1987) gathers eight self-reports per day in response to electronic signals randomly generated by pagers that respondents wear for a week. After each signal, participants provide their answers on the experience sampling form (ESF). Figure 2.2 shows sample sections and items of the ESF.

The ESF contains 13 categorical items and 29 scaled items. The categorical items serve to reconstruct the activity (main activity, concurrent activities, and content of thought), the context (date, time beeped, time filled out, place, companionship, and influential facts which have occurred since the last pager signal), and some aspects related to motivation and interest (reasons for the activity, sources of physical discomfort, wished activity and companionship if different from the current ones, and comments). Except for reasons for the activity and companionship, the categorical items are open-ended and have to be coded by the researcher after collecting the data. The scaled items are designed to measure the intensity of a range of subjective feelings. Sixteen items are ten-point scales coded from zero (not at all or low) to nine (very or high); they measure the following variables: concentration, difficulty in concentrating, feeling good, feeling self-conscious, feeling in control, living up to the person's expectations, living up to the expectations of others, physical discomfort, challenges from the activity, skills in the activity, importance of the activity to the person, importance of the activity to others, and importance of the activity to the person's overall goals, success in the activity, wish to be doing something different, and satisfaction. The remaining thirteen scaled variables are

Date:	Time Beeped:	Time Filled Out:	am/pm

As you were beeped …
What were you thinking about? _____
Where were you? _____
What was the MAIN thing you were doing?_____
What other things were you doing? _____
WHY were you doing this particular activity?
             ☐I had to   ☐I wanted to do it ☐I had nothing else to do

Indicate how you felt about the main thing you were doing:

	low								high
Challenges of the activity	0 1	2	3	4	5	6	7	8	9
Your skills in the activity	0 1	2	3	4	5	6	7	8	9
Was this activity important to you?	0 1	2	3	4	5	6	7	8	9
Were you satisfied with how you were doing?	0 1	2	3	4	5	6	7	8	9

Describe your mood as you were beeped:

	very	quite	some	neither	some	quite	very	
Alert	O	o	.	-	.	o	O	Drowsy
Happy	O	o	.	-	.	o	O	Sad
Active	O	o	.	-	.	o	O	Passive
Involved	O	o	.	-	.	o	O	Detached

Fig. 2.2 Selected sections and items of the experience sampling form (ESF) (Adapted from Csikszentmihalyi and Larson 1987, p. 536)

Likert scales, coded from one to seven, with the following positive poles: alert, happy, cheerful, strong, active, sociable, proud, involved, excited, open, clear, relaxed, and cooperative.

The ESM is a more complex measurement method than typical standardized questionnaires that are administered on a single occasion. This has both positive and negative consequences. On the positive side, the ESM allows investigating a wider range of phenomena. On the negative side, the data collected using the ESM are prone to biases that need to be carefully controlled for in the statistical analysis. Box 2.3 examines two important sources of bias affecting the ESM data and statistical strategies used to control them.

Box 2.3 Potential Biases of the ESM Data and Statistical Strategies Used to Control Them

The data gathered using the ESM have the structure of person-specific streams of experiential data points. These streams exhibit two potential sources of bias that have to be controlled for in data analysis. First, the scaling of the experiential variables differs between participants so that a value of 5 on a 1–9 scale may represent a high score for a participant who tends to give low ratings across situations and times and a low score for a participant who tends to give

Box 2.3 (continued)

high ratings across situations and times. Csikszentmihalyi and Larson (1984) addressed this problem using individual standardization, an approach that many other researchers adopted in their ESM studies. For example, consider the variable challenge. Each participant's vector of raw scores of challenge is individually standardized as follows: (a) the mean value and standard deviation of the vector is computed, and (b) the mean value is then subtracted from each raw score and the difference is divided by the standard deviation. As such, a value of z-challenge for an observation represents the extent—measured in standard deviation units—to which that observation departs from the weakly mean of challenge for that participant. Using z-scores in lieu of raw scores removes individual differences in scaling under the assumption that participants experienced the same overall level of challenge throughout the week of the study.

Second, because participants are allowed to defer filling out an ESF after receiving a signal or not to fill it out at all if the activity they are engaged in at the time of signal does not allow, the number of data points differs between participants so that traditional techniques for the analysis of repeated measures cannot be used on the beep-level data. The majority of studies addressed this problem using individual aggregation (for a comprehensive explanation see Larson and Delespaul 1992 and Hektner et al. 2007). For example, consider again the variable challenge as measured in two contexts, work and leisure. Each participant's vector of raw scores of challenge is individually aggregated by calculating the mean of z-challenge for those observations that occurred when the participant was working and the mean of z-challenge for those observations that occurred when the participant was engaged in leisure activities. As such, each participant has just one aggregate score for work (i.e., mean z-challenge of work) and one aggregate score for leisure (i.e., mean z-challenge of leisure). Using individually aggregated scores in lieu of beep-level scores removes individual differences in number of observations and hence allows the use of standard statistical techniques for repeated measures at the expense of loss of information from the data.

The Quadrant Model

In the first large-scale application, Csikszentmihalyi and Larson (1984) administered the ESM to a sample of 75 high-school students in the Chicago area and analyzed how the quality of subjective experience varies as a function of four contexts of activity: life in the family, companionship with friends, solitude, and life in class. They found that those contexts yield quite different patterns of average values of subjective experience variables. Life in the family is associated with feeling happy but aggravated by lack of concentration and involvement; companionship with friends yields higher happiness and involvement but still a low concentration;
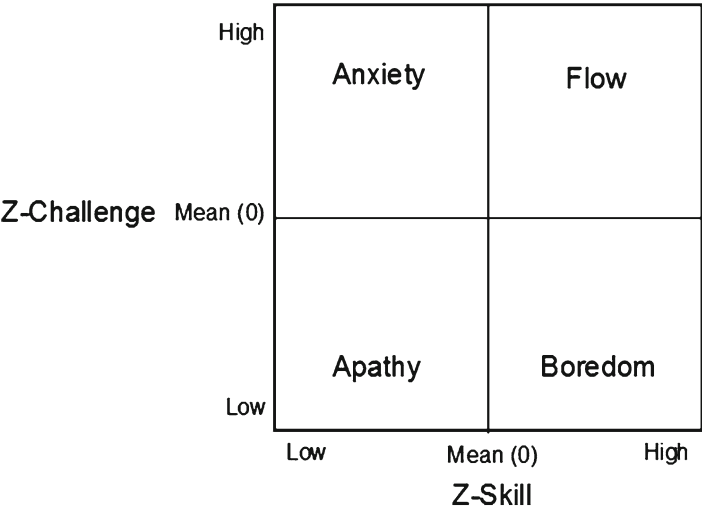
Fig. 2.3 The quadrant model of the flow state (Adapted from Csikszentmihalyi and LeFevre 1989)

solitude yields poor experience in respect to happiness and involvement but higher concentration; school life yields unhappiness but high concentration and average involvement. Csikszentmihalyi and Larson interpreted these patterns in terms of flow theory, that is, by analyzing the types of activities that are carried out within each of these contexts in respect to the levels of challenges and skills that they involve, but they could not test the theory because they had not included the challenge and skill scales in the ESF. Nevertheless, the provided interpretations were so interesting that stimulated researchers to find ways to use the ESM to test the core predictions made by flow theory.

Csikszentmihalyi and LeFevre (1989) administered the ESM to a sample of 78 workers in Chicago with the main aim of disentangling the effects on the quality of subjective experience that are due to being in flow from those that are imputable to being engaged in work or leisure. They pursued the goal by introducing a new model and operationalization of the flow state, the quadrant model, which is shown in Fig. 2.3. The model partitions the world of experience in four main states—flow, anxiety, boredom, and apathy—that are represented as quadrants of a challenges by skill Cartesian space in which both axis variables are standardized with the 0 value representing the weakly mean. The model represents flow as a state in which a participant perceives challenge and skill greater than the weekly average and in relative balance with each other.

The main difference between this and the first model of the flow state (see Fig. 2.1) is the addition of the "apathy" state, which is posited to be the least positive of the four states. Therefore, the original claim that flow occurs when challenges and skills are in relative balance with each other independently of their level was abandoned in favor of a more complex representation. In order to achieve flow, two

conditions need to be satisfied: (a) there is balance between challenges and skills, and (b) both challenges and skills are greater than their weekly average.
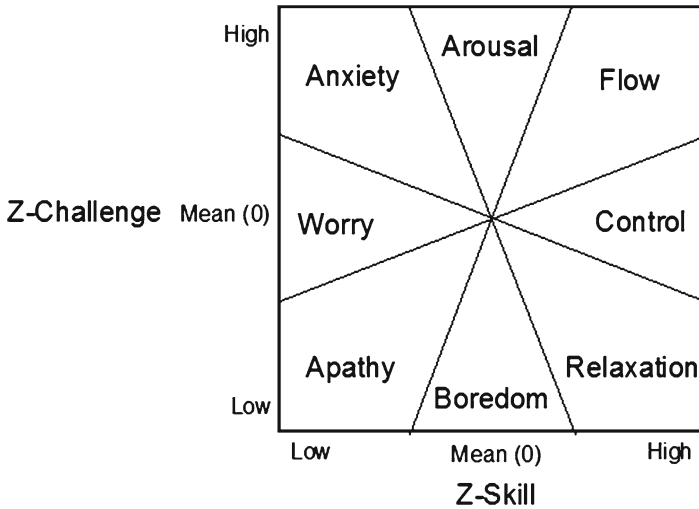
Strengths and Weaknesses of the Quadrant Model

The quadrant model has two main strengths: it is a simple classification system, and it allows performing disarmingly simple tests of the core predictions made by flow theory. For example, Csikszentmihalyi and LeFevre (1989) estimated an ANOVA model in which subjective experience was the dependent variable, and flow (flow, nonflow) and activity (work, leisure) were the within-participants factors. Flow turned out to explain considerably more variance in subjective experience than activity, thus corroborating the hypothesis that the quality of subjective experience is more influenced by flow than by context of activity.

The quadrant model has two main and interrelated weaknesses. First, it is an approximate classification system, particularly for what concerns the region allocated to the flow state. In the original model (see Fig. 2.1), the flow region was represented as a narrow diagonal stripe, whereas in the quadrant model, it includes medium-challenge/high-skill and high-challenge/medium-skill points. Second, the flow state region is overinclusive. If the variables of challenges and skills were uncorrelated, about 25% of the beep-level observations would be classified as flow. Because the correlation between challenges and skills ranges from moderate to fair in most samples, more than 25% of the beep-level observations are actually classified as flow when using the quadrant model. This figure is by far too optimistic and at odds with estimates than can be derived from the FQ.

The Experience Fluctuation Model

In an attempt to provide a more accurate and realistic classification system, Massimini and colleagues (Massimini and Carli 1988; Massimini et al. 1987) proposed the Experience Fluctuation Model (which is often referred to as the "channel model" or the "octant model"), which is shown in Fig. 2.4. The model partitions the world of experience in eight main states that are represented as arc sectors ("channels") of 45° each of a challenge by skill Cartesian space in which both axis variables are standardized with the 0 value representing the weakly mean. Similar to the quadrant model (see Fig. 2.3), the model represents flow as a state in which a participant perceives challenge and skill greater than the weekly average and in relative balance with each other. The main differences from the quadrant model are that the channel model provides a narrower operationalization of the construct of challenge/skill balance and a more detailed characterization of the nonflow states.

Fig. 2.4 The experience fluctuation model of the flow state (Adapted from Massimini et al. 1987)

Strengths and Weaknesses of the Experience Fluctuation Model

The main strength of the channel model stems from the rich and robust empirical findings it generated. Massimini et al. (1987) administered the ESM to a sample of 47 Italian high-school students in Milan in order to investigate the variation of subjective experience across channels. The eight channels were considered as eight levels of one within-participants factor. Eighteen facets of experience were treated as dependent variables, each in a separate analysis. Univariate *F*-testing was used to ascertain whether the variation of the mean *z*-scores of each dependent variable across the eight challenge/skill conditions was overall significant. Flow theory was substantially corroborated in that (a) the *F*-test was highly significant for each of the dependent variables, showing that the challenge/skill ratio is influential for all facets of experience, (b) for 14 dependent variables (78%), the maximum occurred in the condition high-challenge/high-skill (flow), (c) for nine dependent variables (50%), the minimum occurred in the condition low-challenge/low-skill (apathy), and (d) every time the maximum and the minimum of a dependent variable did not fall in the conditions high-challenge/high-skill and low-challenge/low-skill, respectively, it fell in an adjacent sector. Furthermore, *t*-testing was performed to detect, for each dependent variable, the conditions in which the mean *z*-scores differed from the week average. The *t*-test relative to the condition high-challenge/high-skill reached significance for 12 dependent variables (67%), further supporting the hypothesis that in the situations defined as high-challenge/high-skill, the quality of subjective experience is significantly better than average. These findings were substantially replicated across age groups, cultures, and life domains (Carli et al. 1988; Csikszentmihalyi 1990, 1997; Delle Fave and Bassi 2000; Delle Fave and Massimini 2005; Haworth and Evans 1995).

Although superior to the quadrant model, the channel model shares with it two key limitations. First, there are problems with the operationalization of flow-conducive situations as characterized by "above-average" levels of challenge and skill. Such operationalization rests on the strong assumption that participants would rate the challenges and skills perceived while doing a specific activity with reference to a global standard of measurement that is common to all activities. Keller and Landhäußer (see Chap. 3 of this volume) discuss in depth this assumption and question its tenability on conceptual and empirical ground.

Second, both the quadrant model and the channel model are classification systems, and hence they do not allow testing the implicit assumptions underlying the classification itself. In particular, the superiority of the flow channel over the other channels was universally interpreted as being due to the equivalent ratio of perceived challenges from the activity to perceived skills in carrying out the activity. Yet, is the balance of challenges and skills needed to explain the pattern of findings? A number of researchers found, somewhat independently of each other, that the answer is no. They adopted a regression modeling approach and first considered a standard additive model in which experience is the dependent variable and challenge and skill are the predictors:

$$\text{experience} = \beta_0 + \beta_1 \text{challenge} + \beta_2 \text{skill} \qquad (2.1)$$

If the regression coefficients of challenge β_1 and skill β_2 are both positive and of equal size, then the quality of experience will be highest in the flow channel and lowest in the apathy channel, and will decrease as one rotates, either clockwise or anticlockwise, from the flow channel to the apathy channel. Thus, such model and its simple variants—obtained by changing the relative size of the two coefficients—would account for all the findings gathered using the quadrant and channel models. This raises a problem: the regression model 1 considers challenge and skill as two independent predictors, each contributing to experience independently of the other; therefore, there is no need to invoke the concept of balance in order to explain the findings. Thus, all the interpretations of the findings were speculative at the time they were put forth.

The Regression Modeling Approach

Once it became clear that neither the quadrant model nor the experience fluctuation model could be used to test key predictions made by flow theory, researchers set out to develop a regression modeling approach with three aims: (a) to ascertain if the balance of challenges and skills matters, (b) to identify a model of subjective experience that is estimated using the ESM data, as opposed to a classification model that somewhat arbitrarily allocates observations to channels or quadrants, and (c) to use the estimated model, as opposed to an imposed model, in order to identify the optimal challenge/skill ratio and the extent to which the effects that

challenges, skills, and their balance have on subjective experience vary between individuals. The concomitant development of multilevel or hierarchical linear modeling (e.g., Goldstein 1995; Bryk and Raudenbush 1992) made possible to estimate the models more efficiently than previously done. Because the technique allows to control for incomplete streams of repeated observations and individual differences in scaling (for comprehensive explanations of how this is achieved with ESM data see Moneta and Csikszentmihalyi 1999 and Conti 2001), the regression models were estimated on raw, beep-level scores without having to resort to individual standardization and aggregation (see Box 2.3).

The first aim was addressed by adding the challenge by skill cross-product (Ellis et al. 1994; Moneta 1990) or the absolute difference of challenge and skill to the regression model 1 (Moneta and Csikszentmihalyi 1996; Pfister 2002), or using quadratic terms of challenge and skill following a rotation of the predictor axes (Moneta 1990; Moneta and Csikszentmihalyi 1999). Because these different models have comparable statistical fit to the data, the simplest, the absolute difference model, is chosen here for illustrative purpose:

$$\text{experience} = \beta_0 + \beta_1 \, \text{challenge} + \beta_2 \, \text{skill} + \beta_3 \, |\text{challenge} - \text{skill}| \qquad (2.2)$$

The predictor |challenge–skill| is the absolute difference between challenge and skill, which can be equal to 0 (if challenge equals skill) or greater than 0 (if challenge and skill differ in any way). Its coefficient β_3 represents the effect of the imbalance of challenge and skill on experience. The model is fully consistent with the theory if the following conditions are all satisfied: (a) $\beta_1 > 0$, (b) $\beta_2 > 0$, and (c) $\beta_3 < 0$. The first two conditions imply that both challenge and skill have a positive linear effect on experience. The third condition implies that the imbalance of challenge and skill has a negative linear effect on experience. Box 2.4 provides a graphic representation and interpretation of the model. In all, this and similar models, when estimated on ESM data, can either corroborate or disconfirm key predictions made by flow theory.
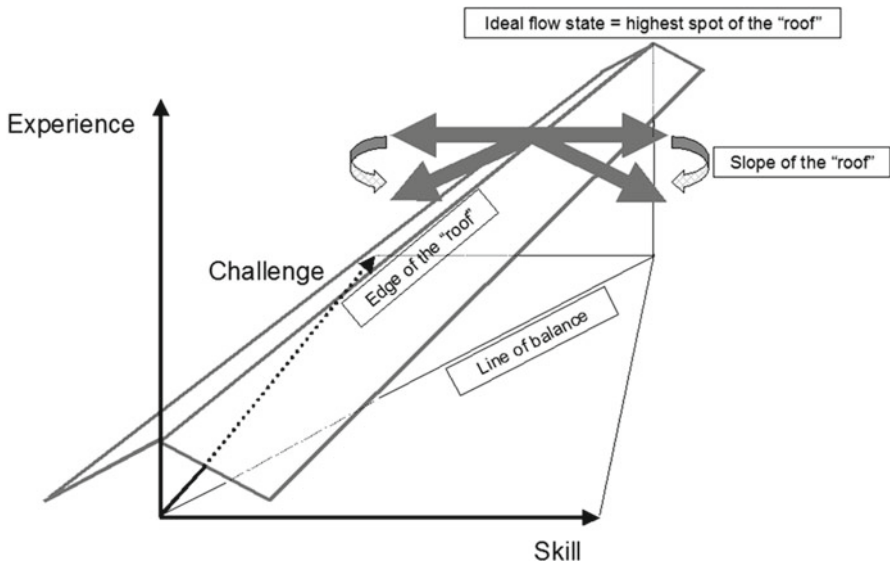
Box 2.4 Graphic Representation of the Absolute Difference Model (Adapted from Moneta and Csikszentmihalyi 1996; Pfister 2002)

Graphically, the regression model 2 represents a surface on a three-dimensional Cartesian space in which experience is the vertical axis and challenge and skill are the horizontal axes. In the ideal case in which challenge and skill have identical and positive coefficients ($\beta_1 = \beta_2 > 0$) and the absolute difference of challenge and skill has a negative coefficient ($\beta_3 < 0$), the surface will look like a roof, as shown in Fig. 2.5. The edge of the roof (i.e., the line where the two sloped planes of the roof intersect each other) represents the optimal challenge/skill ratio. In this ideal case, the edge of the roof is perpendicular to

Box 2.4 (continued)

the diagonal line of balance of the challenge by skill plane (i.e., each point of the edge corresponds to an observation in which challenge equals skill). If the linear effect of challenge is greater than that of skill ($\beta_1 > \beta_2$), the edge of the roof will rotate horizontally towards the challenge axis, whereas if the linear effect of skill is greater than that of challenge ($\beta_1 < \beta_2$), the edge of the roof will rotate horizontally towards the skill axis. The effect of the imbalance is represented by the slope of the roof: the steeper the slope, the greater the negative effect of the imbalance of challenge and skill. If the slope of the roof is null, then the roof will just be an inclined plane with no edge, and hence there would be no optimal challenge/skill ratio. The ideal flow state can be operationalized as the absolute maximum of the surface, which in this case is on the edge of the roof, perpendicular to the observation for which both challenge and skill achieve their maximum.

Fig. 2.5 The three-dimensional representation of the absolute difference regression model of the flow state (Adapted from Moneta and Csikszentmihalyi 1996)

Strengths and Weaknesses of the Regression Modeling Approach

The main strength of the regression approach stems from the specific empirical findings it generated, which could not be generated using the quadrant and channel models. First, it was found that many facets of subjective experience—such as

concentration, interest in the activity, enjoyment of the activity, or happiness—are predicted by challenge and skill independently as well as by their relative balance; therefore, balance has an effect on the quality of experience over and above the effects of challenge and skill, although the effect of balance is small compared to the independent effects of challenge and skill (Moneta and Csikszentmihalyi 1996).

Second, the regression coefficients of challenge, skill, and the balance of the two were found to differ between facets of experience in such a way that the optimal ratio was about 1:1 for some facets (e.g., involvement), biased towards higher levels of challenge for others (e.g., concentration), and biased towards higher levels of skill for yet other variables (e.g., happiness) (Moneta and Csikszentmihalyi 1996); therefore, there seem to be different optimal challenge/skill ratios, and hence optimization of experience requires trade-offs between facets of experience.

Third, the model fitted better and was more consistent with theoretical predictions in achievement contexts than in nonachievement contexts (Moneta and Csikszentmihalyi 1996); therefore, the theory would appear to be more applicable when achievement goals and opportunities are salient. Fourth, the effects of challenge, skill, and the balance of the two differed across individuals (Moneta and Csikszentmihalyi 1996, 1999) so that, for example, balance has a strong, positive effect on some individuals, and no effect or even a negative effect on other individuals; therefore, the theory would appear to be fully applicable only to some individuals.

Finally, the effects of challenge, skill, and balance were found to be linked to personality traits—such as trait intrinsic motivation and interdependent self-construal (Moneta 2004b), situational variables—such as goals, interests, importance of the activity, and state intrinsic motivation (Csikszentmihalyi et al. 2005; Ellis et al. 1994; Rheinberg et al. 2007), and culture (Moneta 2004b); therefore, the theory would need to be expanded to account for conceptual relationships with other psychological theories. In all, these studies corroborated the kernel assumptions of flow theory and provided indications on how to further develop the theory.

Although the regression models constitute an advancement in respect to the quadrant and channel models, they share with them three key limitations. First, as Ellis et al. (1994) pointed out, many of the investigated facets of experience are not clearly connected to the flow construct and hence cannot be regarded as indicators of flow. In particular, variables like "wish to do the activity," "active," or "sad–happy" have never been theorized to be an integral part of the flow experience. Moreover, the construct validity of the scales used to tap the investigated facets of experience has never been assessed by standard psychometric methods, such as exploratory and confirmatory factor analysis (EFA, CFA).

Second, in all applications, the key predictors challenge and skill were measured by only one item each. This is obviously unacceptable from a psychometric stand.

Finally, there is a conceptual problem with the construct of challenge. Rheinberg et al. (2007; cf. Rheinberg 2008) argued that in addition to challenge and skill, also the perceived difficulty level or "demands" of the activity should be assessed because challenge implies a compound of difficulty and skill. For example, an easy task can be very challenging to a novice, and a difficult task can be unchallenging to an expert. Although Pfister (2002) found similar effects of the difficulty/skill and

challenge/skill ratios on the quality of experience, the construct of difficulty may be relevant when achievement motivation is taken into account. According to Atkinson's (1957) model, people with more achievement motivation prefer tasks of medium difficulty, in which there should be a balance between difficulty and skill, whereas people with less achievement motivation prefer tasks of low difficulty, in which skill should be greater than difficulty. Therefore, difficulty is an item that, together with others tapping the constructs of challenge and skill, should be considered for inclusion in future developments of the ESM.

Overall Assessment

In all, the ESM proved to be superior to the FQ for the purpose of measuring the flow state in daily life and for testing hypotheses concerning the effects that challenge, skill, and their balance have on flow. Yet, the ESM somehow "imposes" flow on respondents and hence is inferior to the FQ for the purpose of measuring prevalence of flow. Finally, the ESM scales developed to date do not achieve satisfactory levels of content validity, and their construct validity is largely unknown. The measurement methods presented in the next section can be viewed as attempts to overcome the latter limitation.

The Componental Approach: Capturing Flow as a Multidimensional State–Trait Variable

Description of the Measurement Method

The methods for measuring flow presented in the previous sections were definitely original at the time they were developed, and they proved to be innovative in generating many insightful and robust findings. However, they are far from being psychometrically sound. For this reason, some researchers set out to construct and validate questionnaires that would measure flow to the standards required by traditional test theory. Several scales were developed pursuing essentially the same aim (e.g., Engeser and Rheinberg 2008; Keller and Bless 2008; Schüler 2010). This section will focus on the scales developed by Jackson and Eklund (2002, 2004a). These scales are consistent with Csikszentmihalyi's (Jackson and Csikszentmihalyi 1999) componental view of flow, measure flow both as a state and as a trait and are the most frequently used in research and practice, particularly in the sports context.

Jackson and Marsh (1996) and Jackson and Csikszentmihalyi (1999) described flow as a state characterized by nine components: focused concentration on the present activity (concentration), sense of control over one's actions (control), merging of action and awareness (merging), autotelic experience (autotelic), loss of

self-consciousness (self-consciousness), loss of time awareness or time acceleration (time), clear proximal goals (goals), unambiguous feedback (feedback), and dynamic balance between challenge and skill (balance). These components can be regarded as correlated dimensions of the flow construct that can trade off in determining the intensity or level of flow. If the level of all components is highest, a person will be in a most intense, complex, and ordered flow state. If some components reach highest level whereas others reach only medium or low levels, the contributions to flow of the different components will trade off in producing a flow state that will be overall less intense, complex, and ordered than the ideal flow state.

Jackson and Eklund (2002, 2004a) applied the componential view of flow to measure flow as a state, a broad trait (i.e., the tendency to experience flow frequently and intensely across a wide range of situations), and a domain-specific trait (i.e., the tendency to experience flow frequently and intensely in specific contexts of activity). They developed, refined, and validated two standardized questionnaires: the Flow State Scale-2 (FSS-2), which measures intensity of flow as a state, and the Dispositional Flow Scale-2 (DFS-2), which measures intensity of flow as either a general trait or as a domain-specific trait. The item content of the two questionnaires is similar. As is it is customary in test construction, the main difference between the state and trait questionnaires resides in the initial instructions given to participants: the state questionnaire asks participants to answer the questions thinking of the specific activity they just completed, whereas the trait questionnaire asks participants to answer the questions thinking of their general experience across situations and times or of their average experience when they are engaged in a context of activity (e.g., work or leisure). Both the state and the trait questionnaires have good psychometric properties (Jackson and Eklund 2002, 2004a).

The Componential Model

Construct validity is a key property of any measurement method, and it is customarily assessed using CFA. The specific way CFA is applied fully clarifies the model that was used to construct the measurement method. Jackson and Eklund (2002, 2004a) estimated two CFA models, and they used the same pair of CFA models for the data provided by the state questionnaire and the data provided by the trait questionnaire.

The first model is the nine-factor model with correlated factors shown in Fig. 2.6. This is a classical test theory model in which nine intercorrelated latent facets of the construct of flow cause responses on the measured indicators; that is, the behaviors described by the items of the questionnaire are manifestations of nine latent facets. This model represents flow as a multifaceted construct.

The second model is the single-factor model shown in Fig. 2.7. This is a classical test theory model in which the latent construct of flow causes responses on the measured indicators; that is, the behaviors described by the items of the questionnaire are manifestations of a single latent construct. This model represents flow as a single construct.
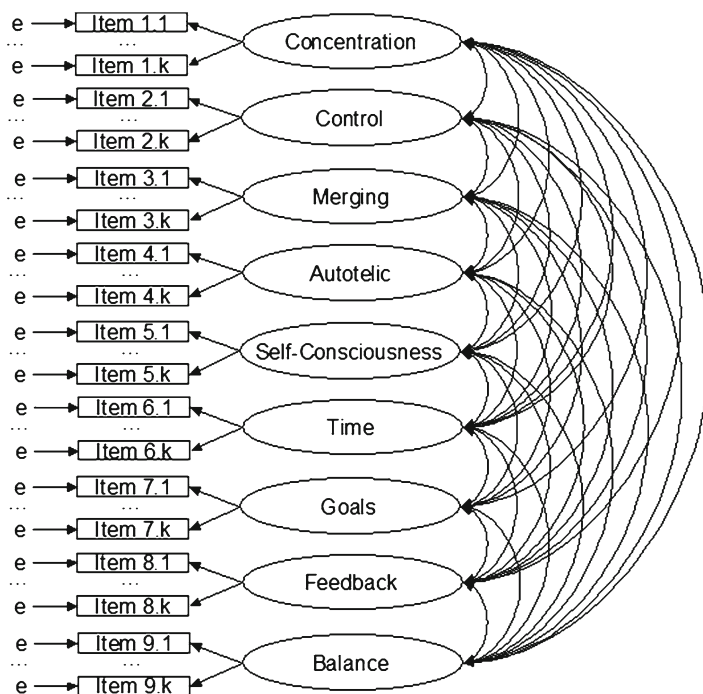
Fig. 2.6 The nine-factor measurement model for the Jackson and Eklund (2002, 2004a) Flow State Scale-2 and Dispositional Flow Scale-2. e = measurement error
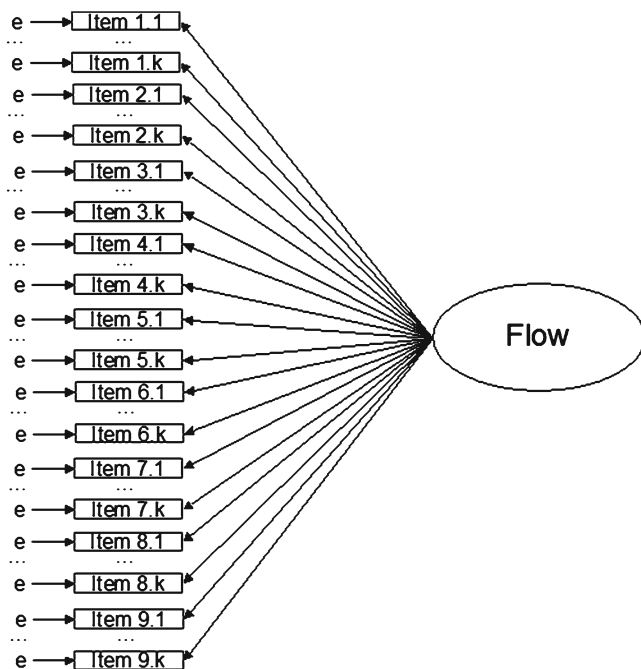
Fig. 2.7 The one-factor measurement model for the Jackson and Eklund (2002, 2004a) Flow State Scale-2 and Dispositional Flow Scale-2. e = measurement error

Which of the two models should be adopted? Jackson and Eklund (2002, 2004a) found that both models have good statistical fit, but the nine-factor model fits better than the single-factor model. Therefore, they recommended using nine subscale scores, each measuring a somewhat distinct component of flow, in research. Yet, they acknowledged the parsimony and theoretical usefulness of an overall scale score to measure flow as a single construct.

Strengths and Weaknesses

The componential approach has two main strengths. First, it provides a comprehensive characterization of flow that is by far more complete than that provided by the FQ and the ESM. Second, it provides measures of flow that are psychometrically more valid and reliable than those provided by the FQ and the ESM. In all, the componential approach achieves the psychometric standards that flow research needs in order to earn full recognition in the field of psychology.

The componential approach has three main and interrelated weaknesses. First, like the ESM, it "imposes" flow on all respondents, even if some would be classified as non-flow-ers using the FQ. As such, both the componential approach and the ESM are inferior to the FQ for the purpose of estimating the prevalence of flow.

Second, the componential approach as implemented in the FSS-2 and DFS-2 assumes a model of flow that contradicts the various models that researchers have adopted in conjunction with the FQ and the ESM, in that it has to date ignored the distinction between antecedents of flow (i.e., factors that can, under some circumstances, cause flow) and indicators of flow (i.e., experiences and behaviors that are, under some circumstances, caused by flow). In particular, the balance of challenge and skill was consistently regarded as an antecedent of flow in research using the FQ and the ESM, whereas it is considered a component of flow in the model that drove the development of the FSS-2 and DFS-2.

Finally, the componential approach can hardly handle what can be called the paradoxes of attention. Csikszentmihalyi (1978) pointed out that states of heightened and focused attention occur in two different contexts: when a person is in flow and when a person is facing an overwhelming threat. Building on this distinction, Engeser and Schiepe (see Chap. 1) consider a hypothetical state in which a person would score high on concentration and low on all other components of flow and argue that such a state could not be called flow. How does the componential approach deal with that case? If one adopts the single-factor measurement model of Fig. 2.7, the overall flow score for that state would be the sum (or the mean) of all the item scores. Because only a small number of items measure concentration, the overall flow score for that hypothetical state would be low. Hence, the impact of this paradox on the componential model is not severe. Yet, consider the diametrical paradox, a hypothetical state in which a person would score low on concentration and high on all other components of flow. That could be the case of a hallucinogenic or even a near-death experience, but arguably not a flow state, because attention is an essential component of executive functioning (Mathews et al. 2004). How does the componential approach deal with that
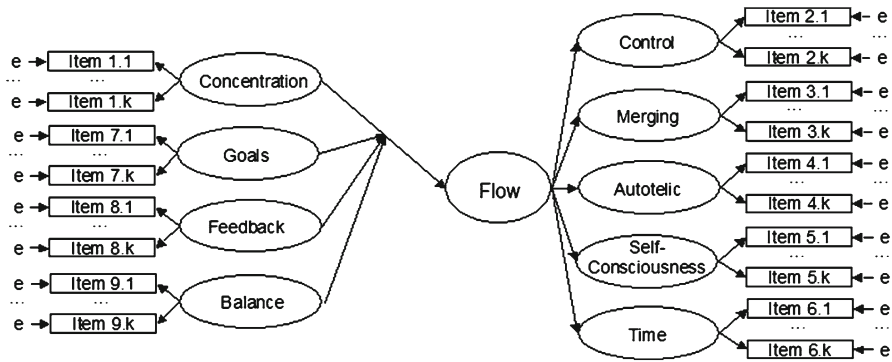
Fig. 2.8 A hypothetical hybrid model of the flow state that separates antecedents and facets of flow and states that the path from concentration to flow is moderated by goals, feedback, and balance. e = measurement error

case? Because only a small number of items measure concentration, the overall flow score for that hypothetical state would be high. Hence, the componential model cannot handle this paradox.

How could the second and third weaknesses of the componential approach be tackled? A possible solution is to shift from a classical test theory measurement model to hybrid models (for a review of classical, composite variable, and hybrid models see Finch and West 1997). For example, consider the model shown in Fig. 2.8. Drawing, with some imagination, from the original formulation of flow theory (Csikszentmihalyi 1975/2000, 1978), the four latent facets concentration, goals, feedback, and balance are defined as antecedents of flow. A second-order measurement model for flow is defined, in which flow is presumed to cause the five latent facets: control, merging, autotelic, self-consciousness, and time. The latent facet concentration is presumed to cause the latent construct flow, and the latent facets goals, feedback, and balance are presumed to moderate the effect that concentration has on flow. If the moderation pattern is antagonistic, the path from concentration to flow will be positive for high levels of the moderators and negative for low levels of the moderators. As such, the model states that concentration fosters flow if goals are clear, feedback is unambiguous, and challenge and skill are high and in relative balance with each other, and that concentration prevents flow if goals are unclear, feedback is ambiguous, and there is an imbalance of challenge and skill. Therefore, this type of hypothetical model can handle the paradoxes of attention. Yet, the specific model presented here may be faulty in many other ways, and hence it is proposed mainly for illustrative purpose.

Overall Assessment

In all, the componential approach has generated methods for measuring intensity or level of flow that are more complete and psychometrically sound than the FQ and

the ESM. Yet, the componential approach cannot measure prevalence of flow and hence is inferior to the FQ in that respect. Finally, the componential models have too simple a structure to account for the complexity of flow.

Directions for Future Methodological Research

The analysis conducted in this chapter suggests four main directions for future research aimed at developing more valid and useful measurement methods for flow. First, as Engeser and Schiepe (see Chap. 1) suggest, there is a need of integration and standardization of the existing measurement methods. Although it still needs conceptual development, the componential approach produced the most complete and psychometrically sound measures of flow, both as a state and as a trait, and hence should inform and guide an improvement of the FQ and the ESM. In particular, the quotes section of the FQ should be expanded to include quotes of all facets that are considered to be expression of flow (i.e., that are theorized to be caused by the latent construct flow); moreover, section 5 of the FQ should be modified to provide a systematic assessment of flow intensity in specific activities. By the same token, the ESM should contain scaled items that tap validly and reliably each facet of flow and each antecedent of flow (e.g., Rheinberg, et al. 2007). Finally, researchers may consider applying and further developing the day reconstruction method (DRM; Kahneman et al. 2004) for the purpose of assessing prevalence and intensity of flow. The DRM assesses systematically significant everyday life events that occurred the day before, with procedures designed to minimize recall bias. As such, the DRM has the potential of capturing brief but intense flow experiences that might instead be missed by the ESM due to its time-sampling structure.

Second, all three main types of measurement methods need to be developed in order to ascertain whether flow is a single construct or a label for a constellation of constructs. Moreover, there is the need of providing evidence of convergent and discriminant validity of each measurement method for flow in relation to measurement methods that were designed to tap other types of optimal experience, such as "peak performance" (Privette 1983) and "peak experience" (Maslow 1964). Section "Capturing Flow in Special Endeavors" showed some evidence supporting the idea that the quotes of the FQ may capture a shallow flow—which may support activities that require social interaction, such as teaching or football playing—and a deep flow—which may support activities for which social interaction would be detrimental, such as chess playing or proving mathematical theorems. Section "Capturing Flow in Daily Experience" reported evidence indicating that the optimal challenge/skill ratio differs across facets of experience, suggesting that there may be different types of optimal experience, such as a high-challenge/medium-skill one that optimizes cognitive efficiency and a medium-challenge/high-skill one that optimizes hedonic tone. This evidence suggests that all three main types of measurement methods for flow should be improved in order to enable them to test the tenet that there is one and only one flow state.

Third, all three main types of measurement methods need to be developed in order to ascertain whether flow and its antecedents are substantially the same across cultures. The FQ was administered to samples from various cultures and provided evidence of cultural invariance (Delle Fave and Massimini 2004). The ESM was administered to Japanese (Asakawa 2004) and Chinese (Moneta 2004b) university student samples and provided evidence of cultural variations in flow models that, however, could be explained based on cross-cultural theories of psychosocial development (Moneta 2004a). The FSS-2 and DSF-2 were translated and validated in various languages (e.g., Kawabata et al. 2008). Although these studies suggest that cultural variation is small, a more basic test has not yet been conducted. The key question is: if we were to repeat the whole process that led to the componential model of flow—starting with interviews and proceeding to the construction of the FQ and componential measurement scales—in a new culture (e.g., the Chinese or Indian cultures), would we identify exactly the same facets of flow and antecedents of flow?

Finally, all three main types of measurement methods need to be developed in order to account for the role of metacognitions in achieving flow. Ceja and Navarro (2011) administered the ESM to measure flow states of employees as they engage in work activities and used dynamical system theory to investigate the patterns of flow occurrence. They found that the dynamic pattern of flow in work is chaotic for the majority of employees and that the different facets of flow are associated with distinct dynamic patterns (i.e., chaotic, linear, and random). These findings indicate that individuals may need a high level of awareness of flow and its antecedents and a strong self-regulation in order to achieve flow in natural environments that are not really designed to facilitate flow, such as open-plane offices and clustered cubicles. Metacognition refers to the knowledge and beliefs about one's own cognitive regulation and the capability to deconstruct and understand them through reflection and problem solving, which in turn enables self-regulation (Flavell 1979). Two key types of metacognitions should be considered in flow research: general metacognitions supporting the correct interpretation of emotional cues and flexible goal restructuring in facing challenges (Beer and Moneta 2010) and specific metacognitions of flow for which we still have no firm conceptual definitions and measurement scales (Wilson and Moneta, in press).

In conclusion, this chapter has shown that following the original formulation of flow theory, researchers developed three main methods for measuring flow, the FQ, the ESM, and the standardized scales of the componential approach. Researchers used each measurement method in conjunction with one or more models, which were somewhat arbitrary interpretations and simplifications of the theory. Researchers interpreted the empirical findings of their studies with reference to the model of flow they had adopted hypothetically, and the gathered evidence provided a mixture of corroboration and disconfirmation of their model, which in turn led to small but important modifications of the theory. This process had some chronological order but was not always linear or perfectly logical. This pattern is common in science, and in the history of psychology in particular, although researchers may differ in the extent to which they are aware of it. The key message of this chapter is that no existing measurement method for flow and associated model is watertight and that a gold

standard for the modeling and measurement of flow is not at close reach. Hopefully, this chapter helped to convince young flow researchers that models and measurement methods are paramount to the development and application of flow theory and hence need continuous improvement.

Study Questions

- What are the main measurement methods for flow? Is one of these methods better overall than the others? If yes, why?

   The main measurement methods for flow are the flow questionnaire, the ESM, and the standardized scales of the componential approach. The chapter suggests that none of these three main measurement methods is overall superior to the others: each one has pros and cons that trade off depending on the specific question the researcher is tackling (see subsections "Overall Assessment" in "Capturing Flow in Special Endeavors," "Capturing Flow in Daily Experience" and "The Componential Approach: Capturing Flow as a Multidimensional State-Trait Variable," and section "Directions for Future Methodological Research" of this chapter). You may, of course, disagree with this conclusion; but if you do, you should state your rationale. For example, if you believe that construct validity is paramount, then the standardized scales of the componential approach would be the likely winners.

- Think of one research question about flow and select a measurement method to test it. What criteria did you use in making your choice?

   Once you have listed the criteria, check them against the subsections "Overall Assessment" in "Capturing Flow in Special Endeavors," "Capturing Flow in Daily Experience" and "The Componential Approach: Capturing Flow as a Multidimensional State-Trait Variable" of this chapter and determine by yourself if you have made a sensible choice. As a final check, read the first paragraph of section "Directions for Future Methodological Research" of this chapter and determine by yourself if your research question would require a modification or adaptation of the measurement method you have chosen.

- What are the main strengths and main limitations of the flow questionnaire?

   On one hand, the flow questionnaire is a good measurement method for assessing the prevalence of flow, that is, whether participants sampled from a population (e.g., students or workers) have ever experienced flow in their lives. This is because the flow questionnaire proposes a description of flow and asks respondents to freely report whether or not they had similar experiences. As such, it does not "impose" flow on respondents and does not lead to inflated prevalence rates (see subsection "Strengths and Weaknesses" in "Capturing Flow in Special Endeavors" of this chapter). For this reason, the flow questionnaire can be validly used to compare the prevalence rates of different populations, such as Chinese versus British college students or white-collar versus blue-collar workers.

   On the other hand, the flow questionnaire is a limited measurement method for investigating the effects of challenges and skills on subjective experience

and the intensity of flow in general and in specific endeavors (e.g., work and leisure). This is because the scaled items of section 5 of the flow questionnaire (see Box 2.1) refer to the experience while doing the best flow-conducive activity but do not refer specifically to those instances in which a respondent experiences flow while doing that activity (see subsection "Strengths and Weaknesses" in "Capturing Flow in Special Endeavors" of this chapter). However, these limitations could be overcome by modifying the flow questionnaire (see Box 2.1) (see the first paragraph of section "Directions for Future Methodological Research" of this chapter).

- What are the main strengths and main limitations of the ESM?

    On one hand, the ESM is a good measurement method for studying the flow state in daily life and for testing hypotheses concerning the effects that perceived challenges from the activity, perceived skills in the activity, and the balance of the two perceptions have on the occurrence of flow while engaged in the activity. This is because the ESM gathers repeated measures of subjective experience at random times while participants are engaged in daily activities, minimizing memory bias. For this reason, the ESM can be validly used to test and compare alternative models of how various situational factors (e.g., context of activity or levels of challenges and skills and their balance) and various personal factors (e.g., personality traits, culture, gender, or occupation) conjointly influence the quality of daily experience, including intensity of the flow state (see section "Capturing Flow in Daily Experience" of this chapter).

    On the other hand, the ESM is a limited method for studying prevalence of flow. This is because it somehow "imposes" flow on respondents, as opposed to asking them explicitly to report whether or not they experienced flow at the time they were beeped. Moreover, the ESM uses scales for measuring flow intensity that lack content validity and have unknown construct validity. As such, it does not provide a sound measure of the construct of flow intensity. However, these limitations could be overcome by modifying the ESM (see the first paragraph of section "Directions for Future Methodological Research" of this chapter).

- *What are the main strengths and main limitations of the componential approach?*

    On one hand, the componential approach has generated methods for measuring intensity of flow that have good content and construct validity, and hence are the most psychometrically sound among the available measurement methods. On the other hand, the componential approach is not good for assessing prevalence of flow because it "imposes" flow on respondents and hence leads to inflated prevalence rates. Moreover, the componential approach, as implemented in the FSS-2 and DFS-2, does not distinguish antecedents and facets of flow (see next study question) and has too simple a structure to account for the complexity of the relationships between antecedents of flow and flow itself. Yet, these limitations could be overcome in future developments of the componential scales (see subsection "Strengths and Weaknesses" in "The Componential Approach: Capturing Flow as a Multidimensional State-Trait Variable" of this chapter).

- What is the key difference between "antecedents" of flow and "components" or "facets" of flow?

  Antecedents of flow are internal states and perceptions that precede and foster the flow state but are not themselves expressions of flow. These include, for example, clarity of goals, unambiguous feedback, and perceptions of challenge and skill in carrying out an activity. These factors are theorized to have a causal impact on flow by either increasing the likelihood that flow occurs or by augmenting the intensity of flow.

  Components or facets of flow are internal states and perceptions that represent expressions of flow. These include, for example, merging of action and awareness and loss of time awareness or time acceleration when carrying out an activity. These factors are theorized to be caused by flow (see subsection "Strengths and Weaknesses" in "The Componential Approach: Capturing Flow as a Multidimensional State-Trait Variable" of this chapter).

- How many models of flow have been proposed to date and in which way(s) they differ from each other?

  Many models of flow have been proposed to date. The subset of models presented in this chapter includes the first model of the flow state (see Fig. 2.1), the quadrant model (see Fig. 2.3), the experience fluctuation model (see Fig. 2.4), the absolute difference regression model (see Fig. 2.5), the nine-factor componential model (see Fig. 2.6), and the one-factor componential model (see Fig. 2.7).

  These six models can be grouped into three pairs of similar models. The first model of the flow state and the absolute difference regression model are similar, except for the latter is defined by a mathematical model and can be tested using regression analysis (pair A). The quadrant model and the experience fluctuation model are similar, except for the latter is more detailed (pair B). The one-factor componential model and the nine-factor componential model are similar, except for the former represents flow as a single construct whereas the latter represents flow as nine interrelated constructs (Pair C).

  Pair A and pair B of models are similar to each other in that they explain the occurrence of flow as a function of challenge and skill, whereas pair C of models measures intensity of flow without explaining the causal factors underlying it. Finally, pair A and pair B of models differ in that the latter assumes that flow is more likely to occur when challenge and skill exceed a person's weekly average and do not operationalize—and hence allow testing—the construct of balance of challenge and skill.

- How is the flow state represented in the various models of flow that have been proposed?

  With reference to the previous question and answer, pair A of models represents flow as a state that is more likely to occur when there is a balance of challenge and skill, and it is more intense as the sum of challenge and skill grows. Pair B of models represents flow as a state that is more likely to occur when both challenge and skill exceed a person's weekly average. Finally, Pair C of

models represents flow as either a single construct with nine facets (see Fig. 2.7) or as a nine-faceted construct (see Fig. 2.6).

- Compare the original flow model with the quadrant model, pointing out similarities and differences.

    The most noticeable difference between the quadrant model (see Fig. 2.3) and the first model of the flow state (see Fig. 2.1) is that the former includes the "apathy" state, which is posited to be the least positive state. Therefore, the claim made by the first flow model that flow occurs when challenges and skills are in relative balance with each other independently of their level is modified by the quadrant model as follows. In order to achieve flow, two conditions need to be satisfied: (a) there is balance between challenges and skills, and (b) both challenges and skills are greater than their weekly average.

- Compare the quadrant model and the experience fluctuation model with the absolute difference regression model, pointing out similarities and differences.

    Similarities. The quadrant model and the experience fluctuation model are similar to the absolute difference regression model in that they all explain the occurrence of flow as a function of challenge and skill (see Figs. 2.3–2.5).

    Differences. The quadrant model and the experience fluctuation model are classification systems, in which subjective experience is grouped into distinct states (see Figs. 2.3 and 2.4) as a function of levels of perceived challenge from an activity and perceived skill in conducting an activity. As such, these models assume that the balance of challenge and skill fosters flow but do not allow testing this assumption. Moreover, these models assume that flow occurs only when challenge and skill levels exceed their weekly average, which is somewhat questionable on theoretical and empirical ground (see subsection "Strengths and Weaknesses of the Experience Fluctuation Model" in "Capturing Flow in Daily Experience" of this chapter) and in contradiction with the first model of the flow state (see Fig. 2.1).

    The absolute difference regression model represents flow as a state that is more likely to occur when there is a balance of challenge and skill, and it is more intense as the sum of challenge and skill grows. This model assumes that the balance of challenge and skill fosters flow, and allows testing this assumption controlling for the effects that challenge and skill have on flow independently of each other. Moreover, this model does not assume that flow occurs only when challenge and skill levels exceed their weekly average, and in that it is consistent with the first model of the flow state (see Fig. 2.1).

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