“Suddenly I get into the zone”: Examining discontinuities and nonlinear changes in flow experiences at work

Lucia Ceja and Jose Navarro

Abstract

Work-related flow is defined as a sudden and enjoyable merging of action and awareness that represents a peak experience in the daily lives of workers. Employees’ perceptions of challenge and skill and their subjective experiences in terms of enjoyment, interest, and absorption were measured using the experience sampling method, yielding a total of 6,981 observations from a sample of 60 employees. Linear and nonlinear approaches were applied in order to model both continuous and sudden changes. According to the R^2, AICc, and BIC indexes, the nonlinear dynamical systems model (i.e., cusp catastrophe model) fit the data better than the linear and logistic regression models. Likewise, the cusp catastrophe model appears to be especially powerful for modeling those cases of high levels of flow. Overall, flow represents a nonequilibrium condition that combines continuous and abrupt changes across time. Research and intervention efforts concerned with this process should focus on the variable of challenge, which, according to our study, appears to play a key role in the abrupt changes observed in work-related flow.

Keywords

Work-related flow, nonlinear dynamics, cusp model, linear regression model, employee well-being

Introduction

Employee well-being is a dynamic process that undergoes continuous changes. As employees go through positive and negative experiences, they are continuously shifting from positive to negative states of consciousness (Beal and Ghandour, 2011; Heller et al., 2006). Consequently, when employee well-being is studied longitudinally over short periods of time (e.g., days, weeks, or months), it presents continuous fluctuations and changes across time (e.g., Ilies et al., 2010; Sonnentag and Ilies, 2011; Xanthopoulou et al., 2009). Likewise, several studies have found that employee flourishing tends to behave in a nonlinear way (Ceja and Navarro, 2009, 2011; Guastello et al., 1999; Losada and Heaphy, 2004). Ergo, organizational researchers are increasingly favouring a nonlinear dynamical systems approach, which considers nonlinearity and discontinuous change, to study employee happiness and well-being (e.g., Ceja and Navarro, 2009, 2011; Guastello, 2002; Karanika-Murray and Cox, 2010).

Although employee well-being has been described as presenting continuous changes over time, there is still a need to model these fluctuating dynamics. Catastrophe theory (Thom, 1975; Zeeman, 1977) can offer an appealing approximation for understanding these dynamical changes (Ceja and Navarro, 2011). It has provided successful approximations for other organizational processes, such as work motivation (e.g., Guastello, 1987), employee turnover (e.g., Sheridan, 1985; Sheridan and Abelson, 1983), decision making (e.g., Wright, 1983), personnel selection (e.g., Guastello, 1982), organizational change (e.g., Bigelow, 1982), and competitive dynamics (e.g., Kauffman and Oliva, 1994). However, scholars have not yet tested such models directly in work/health relationships.

The present study aims to extend the current conceptualization of work-related flow by integrating the catastrophe theory and the flow theory. The integration of both theories provides the ground for capturing the qualitative narrative where flow presents abrupt and discontinuous changes in a quantitatively testable framework. This integration represents an important step for gaining a deeper understanding regarding the process of optimal experience at work as a nonequilibrium condition where we may find more than one point of equilibrium. Likewise, this enriched conceptualization of work-related flow can have important implications for organizational practice, in other words, managers should perceive discontinuous and sudden changes as something naturally occurring when their employees enter and exit the state of work-related flow. Specifically, the aims of the present study are twofold. The first aim is to examine whether the relationship between perceived challenge and skill and the quality of employees' experiences in terms of enjoyment, interest, and absorption exhibits the occurrence of sudden changes, as captured in the qualitative narrative on what constitutes flow. The second aim is to study whether, for those cases of high levels of flow, the cusp catastrophe model is especially successful at modeling the sudden and discontinuous changes that emerge in the process of work-related flow.

Flow at work: A sudden and enjoyable merging of action and awareness

Flow theory provides one of the most widely cited explanations of enjoyable subjective experience in a wide variety of activities. *Flow* refers to a "sudden and enjoyable merging of action and awareness in that actions follow each other spontaneously and unselfconsciously, yet there remaining a careful monitoring of feedback in relation to one's goals" (Rathunde and Csikszentmihalyi, 2006: 479). Likewise, Csikszentmihalyi (1975, 1990) defines the experience of flow as a sudden moment where everything "just clicks" or a state of "being in the zone," when affective and cognitive modes are perfectly synchronized, giving rise to people's greatest performances and personal bests. In the organizational context, and according to the conceptualization of flow used in the present study, Bakker (2005) defines work-related flow as a short-term peak experience at work that is characterized by absorption, work enjoyment, and interest.

A main predictor of flow and eight core dimensions have been proposed in the literature. The predictor that has been proposed is the balance between perceived high challenges or opportunities for action and high personal skills; and the eight core dimensions are: a) an intense and focused concentration on the present moment; b) a distortion of temporal experience; c) clarity of goals; d) clear rules and positive feedback about the progress being made; e) a merging of action and awareness; f) a loss of reflective self-consciousness; g) a sense of control over one's actions; and h) an autotelic experience in that the activity is an end in itself (Csikszentmihalyi, 1990; Delle Fave et al., 2011).[1]

According to the flow theory (Csikszentmihalyi, 1975, 1990), a hallmark of flow is a feeling of sudden joy, even rapture, as described by a professional dancer:

> Suddenly everything was perfect; the weather, everything fell into place. It sounds funny and weird, but everything was right. My turns were dead on and the flexibility was there, you know? The heat in the place was hospitable and everyone was in awe of their own performances. (Hefferon and Ollis, 2006:148)

This sudden rapture emerges as a consequence of entering a specific zone where an employee's skills are high and well matched to the opportunities for action (i.e., perceived high challenges); that creates an intense enjoyment, absorption, and interest in the activity at hand (Hektner et al., 2007). In other words, when a work activity provides opportunities for the employee's skills to be used and refined to the utmost, the activity becomes more interesting and enjoyable, and the worker becomes more productive (Demerouti, 2006). The balance between perceived high challenges and high skills, which is referred to as the "golden rule of flow" (Jackson and Csikszentmihalyi, 1999), appears to be a basic condition of consciousness for experiencing flow (Csikszentmihalyi, 1975, 1990). In contrast, when employees perceive incongruities between challenges and skills, experiences of boredom, anxiety, or apathy may result (Csikszentmihalyi, 1990; Massimini and Carli, 1988).

The association between positive subjective experience and perceived skill and challenge has been empirically confirmed in a wide variety of nonemployment settings (e.g., nursing-home residents, see Voelkl, 1990; undergraduate students, see Asakawa, 2004; family interaction, see Rathunde, 1989; leisure activities, see Csikszentmihalyi and LeFevre, 1989; recreational sports, see Stein et al., 1995; daily experience of adolescents, see Moneta and Csikszentmihalyi, 1996). However, fewer studies have examined this association in the workplace context. Csikszentmihalyi and LeFevre (1989) were among the first scholars to find that those employees who perceive high challenges and high skills report more flow in their jobs than employees who perceive low challenges and low skills. Similarly, Eisenberger et al. (2005) found that among achievement-oriented employees, the balance of high skill and high challenge is associated with greater positive mood, task interest, and performance than other skill/challenge combinations.

Furthermore, consistent with flow theory, employees cannot enjoy the same activity with the same intensity more than once (Csikszentmihalyi, 1990). To continue providing optimal experiences, flow activities must constantly be re-created. This is the fact that makes the process of flow a dynamic and developmental phenomenon (Rathunde and Csikszentmihalyi, 2006). Csikszentmihalyi (1990) states that disequilibrium between challenges and skills appears to be inevitable and needs to be continually addressed by the employee. Similarly, Lazarus (1991) emphasizes that coping with work events unfolds dynamically over time, so the same work activity may be a source of distress or positive challenge at different times. In the simplest terms, a worker transforms boredom into flow by finding new challenges and overcomes anxiety by building new skills. This process proceeds in the direction of greater complexity and creates a “rocky road” to the optimal experience.

From this dynamic perspective, flow can be considered an *attractor* in consciousness (Delle Fave et al., 2011). An *attractor* can be defined as the state of a dynamical system toward which the system is pulled in order to evolve (Guastello, 2002). The experience of flow can represent, in this sense, a magnetic pole that attracts employees toward it reiteratively (Csikszentmihalyi, 1990). Moreover, in order to enter the flow state, a sudden phase transition occurs from other non-flow states and can be modeled as a discontinuity. Weber et al. (2009), for example, propose that there is no continuous transition between a nonflow state (e.g., boredom, anxiety) and the flow state. Instead, these transitions tend to be sudden, occurring from one moment to the next, and mostly unconscious. In this sense, more research must be done to explain and model the sudden and nonlinear changes observed in the process of "finding flow" or getting into the "zone."

Rethinking the study of flow: From linear to nonlinear approaches

Applications of nonlinear dynamical systems models have demonstrated the link between nonlinear change (i.e., where changes in one variable can have a disproportionate impact on the state of other variables) and employee well-being at different levels of analysis (e.g., high levels of work motivation, see Arrieta et al., 2008; high levels of flow, see Ceja and Navarro, 2011; flourishing business teams, see Losada and Heaphy, 2004). Following the experience fluctuation model (EFM, Delle Fave et al., 2011), Ceja and Navarro (2011) found that the flow state is associated with nonlinear behavior (i.e., unstable dynamic patterns but with the presence of regularities), whereas the anxiety state is associated with linear behavior (i.e., regular and stable patterns across time) and the apathy state is associated with random behavior (i.e., a total absence of any pattern). Likewise, high levels of the antecedents of flow (i.e., balance of perceived challenges and skills) and the core components of flow (e.g., merging of action and awareness, etc.) are also associated with nonlinear behavior. The authors conclude that there may be such a thing as “healthy nonlinear variability” and that a decrease in such nonlinearity may indicate a decrease in employee well-being. Hence, employees experiencing high levels of well-being (i.e., high levels of flow) are likely to present nonlinear behavior as well as sudden changes in their optimal experiences at work.

Moreover, nonlinear change has another important meaning: at low levels of the independent variable, the dependent variable results in a single value. However, as the value of the independent variable increases and reaches a specific threshold, the stable state of the dependent variable suddenly splits into multiple stable states, converting the original stable state into an unstable state (May, 1974, 1976). The critical value of the independent variable at which the dependent variable presents two or more values is referred to as the bifurcation point (Guastello, 2002). In this sense, nonlinear behavior presents a cascade of bifurcation points, where there is a continuous transition from global stability (i.e., the dependent variable results in a single value) to unstable terrains, in which the behavior of the dependent variable is affected by two or more attractor basins, creating the appearance of more than one value for the dependent variable (May, 1976).

Following this line of thought, several authors (e.g., Houge-Mackenzie et al., 2011; Rea, 1993) have proposed the expansion and integration of the flow theory and the reversal theory (RT; Apter, 1982, 1989) constructs. These proposals expand the flow model by suggesting the existence of *bistability* in optimal experiences, more specifically, it is suggested that instead of being only one point of equilibrium in the flow process to which the person attempts to return, RT suggests that there may be two such points of equilibrium. Reversal theory’s central tenet is that psychological needs occur in pairs; for every psychological need there is an opposite need. In the RT model, psychologically healthy individuals are able to alternatively satisfy opposing needs via regular *reversals*. One of the results of such reversals may be a *sudden* or *discontinuous* change of hedonic tone in relation to the level of perceived challenge experienced at a specific moment (Apter, 1982). Given that the flow theory and the reversal theory are both non-homeostatic theories which define motivation as a harmonious process of dynamic disequilibrium, both theories provide a mutually enriching perspective on optimal experience (Rea, 1993).

According to Csikszentmihalyi (1993) the flow experience is an inherently unstable structure which promotes higher levels of complexity. More specifically, the author argues that the complexity of the self depends on the degree of its *differentiation* and *integration,* and flow experiences involve both of these dimensions of the self. To experience flow, we first need to recognize some opportunity for action a challenge. This involves the process of differentiation. As each person becomes involved with slightly different opportunities for action, he or she discovers more about the limits and the potentials of the self, and becomes more nearly unique. As one learns to master a challenge, the skills involved in the activity become part of one's repertoire of abilities; this involves a process of integration. This complex flow is a balanced alternation of the relaxing flow of mastery with the exciting flow of challenge. The reversal from relaxing flow to exciting flow is propelled by the need for new challenges (i.e., the state of differentiation). The reversal from exciting flow to relaxing flow is compelled by the need for mastery (i.e., the state of integration). The dynamic dance between the mastery of relaxing flow and the challenge of exciting flow is not a static balance but a dynamic balance that promotes the development of an enriching mental/emotional complexity (Csikszentmihalyi, 1990). According to this view, the experience of flow describes a nonequilibrium condition (Smith, 1994). An optimal experience of flow consists on positive reversals from the differentiation state to the integration state bypassing the more extreme negative reversals. More specifically, if an employee is not over-challenged he or she can bypass the over-excitement/anxiety reversal and immediate reverse to the calm mastery of the state of integration. If the employee is not given too much repetitive practice, he or she could bypass the apathy/boredom reversal and suddenly reverse to the exciting challenge of the differentiation state.

While there is evidence that work-related flow is highly dynamic and presents nonlinear changes, the main body of research on flow in the workplace has been based on traditional between-variance models (e.g., Bakker, 2005; Demerouti, 2006; Eisenberger et al., 2005; Salanova et al., 2006) and techniques based on the generalized linear model (GLM) (e.g., Fullagar and Kelloway, 2009; Mäkikangas et al., 2010). These models have made valuable contributions toward advancing flow theory and are a powerful tool if we have assumptions of linearity and stability of the phenomena under consideration. However, as we have stated before, flow appears to be characterized by nonlinear change and the existence of bistability, in other words more than one value in the dependent variable can emerge at specific values of the independent variable. In this sense, traditional linear models may be limited, as they can only detect linear change where changes in the independent variable result in single values for the dependent variable, excluding unstable states where more than one value for the dependent variable is possible. The limitations of using the GLM exclusively for studying flow are reflected in the limited variance explained by the conventional regression models encountered in the flow literature (e.g., from 13% to 18% in Eisenberg et al., 2005; or from 3% to 37% in Csikszentmihalyi and Moneta, 1996). The variance left unexplained in the former examples might be indicating the existence of sudden and nonlinear changes in the variables studied, and not only error variance.

For all of the above reasons, and, as previously stated, since flow is a process that involves sudden transitions as employees move from different states of consciousness to finally reach the "flow zone," it is reasonable to expect that when trying to model flow, nonlinear dynamical systems models will explain more variance than GLM models. This has been confirmed by a study on flow conducted by Guastello et al. (1999), which found that the average variance explained by a nonlinear dynamical systems model was 22%, compared to the 2% explained by its linear counterpart. This example highlights the advantages of using nonlinear methodologies to study the complex dynamics of flow.

In view of the above explanation, methodologies that are able to explain and model linear and nonlinear changes in an integrative manner have, in our view, a great deal to contribute to theory and empirical work on flow. A promising methodological approach can be the catastrophe theory. This theory provides an adequate conceptual framework for modeling both continuous and discontinuous or nonlinear changes in organizational behavior. According to Kauffman and Oliva (1994), models based on catastrophe theory present the following advantages over most commonly used linear models in organizational psychology. First, the catastrophe-theory approach focuses on process dynamics, and it is able to model discontinuous change. Second, the nonlinearity of the models enables them to present rich descriptions of the phenomenon under consideration. Third, outlier behavior is included in the model and not viewed as measurement error. In the following section, the basic tenets of catastrophe theory and its application to the study of flow in the workplace will be provided.

Catastrophe theory: A brief introduction

Research based on nonlinear dynamical systems models has shown that sudden and smooth changes easily go hand in hand in organizational behavior when they are studied over time (Guastello, 2002; Karathanos et al., 1994). Catastrophe theory, developed by Rene Thom in 1975, concerns the study and description of discontinuous, abrupt changes in the dependent variables (i.e., order parameters) as a result of small and continuous changes in the independent variables (i.e., control parameters).

The fundamental catastrophe models of varying degrees of complexity can be classified into two groups: the cuspoids and the umbilics (Thom, 1975). The most widely used are the elementary cuspoids, which are referred to as the fold, cusp, swallowtail, and butterfly catastrophe models. Their names represent the geometric appearance of their structure. The cusp model, one of the simplest, has been used in many areas, such as work motivation (Guastello, 1987, 2002), decision making (Wright, 1983), adoption of technology (Lange et al., 2004), transitions in attitudes (van der Maas et al., 2003), and so on. Given the scope of the present study and space constraints, and taking into consideration the amount of work that has been developed on the topic, we will not describe catastrophe theory in more detail (readers interested in learning more about these basic concepts are advised to review the works by Cobb and Ragade, 1978; Cobb and Watson, 1980; or Stewart and Peregoy, 1983). We will now focus on the empirical application of a cusp catastrophe model to study flow in the workplace.

A cusp catastrophe model of flow in the workplace

A cusp catastrophe model describes the change between two stable states of behavior. It has one dependent variable or order parameter and two independent variables or control parameters. Control parameters fall into two categories: a) bifurcation parameters, which determine the change between the two stable states; and b) asymmetry parameters, which determine the strength and disparity between the two stable states. At certain bifurcation values, a small change in the asymmetry parameter could have a dramatic effect on the order parameter, resembling a fold-over or *S* shape. In other words, the impact of the asymmetry parameter on the order parameter becomes discontinuous. At other bifurcation values, even large changes in the asymmetry parameter can have no impact on the order parameter, and the effect of the asymmetry parameter on the order parameter becomes gradual and continuous. As a result, the bifurcation parameter indicates that there are specific situations where changes in the order parameter are drastic or discontinuous and other circumstances where these changes are more gradual and continuous. Hence, the bifurcation parameter indicates the number of discontinuities, whereas the asymmetry parameter relates to the proximity of the order parameter to a drastic change.

The cusp catastrophe model developed for the present study was motivated by the empirical evidence, which indicates that flow is a nonlinear dynamical process (Ceja and Navarro, 2009, 2011; Guastello et al., 1999) characterized by sudden experiences of rapture (Csikszentmihalyi, 1990), and therefore may be advantageously modeled by the cusp catastrophe model. As such, small changes in the control parameters (i.e., challenge and skill), when they occur at a specific time, can produce sudden and dramatic changes in the order parameters (i.e., enjoyment, absorption, and interest). Similarly, major changes in the same control parameters might not produce major changes in the order parameters if the system is not in a critical stage. In this sense, catastrophe theory offers promising possibilities in modeling the phase transitions as employees move into and out of flow from other, non-flow states of consciousness. Likewise, several authors have suggested the existence of *bistability or hysteresis* in flow experiences (e.g., Houge-Mackenzie et al., 2011; Rea, 1993; Smith, 1994) one of the important finger-prints or flags that signal the occurrence of catastrophes (Gilmore, 1993).

The model: Order parameter and control parameters

The hypothesized model is shown in Figure 1, which describes the change in the order parameter or dependent variable (i.e., enjoyment, interest, or absorption) as a result of the interaction between perceived challenge and skill. According to flow theory, gratified states of consciousness, such as enjoyment, interest, and absorption, are determined by the interaction between perceived challenge and skill (Ghani and Deshpande, 1994; Hektner et al., 2007; Moneta and Csikszentmihalyi, 1996). More specifically, when challenges and skills are high and well matched, feelings of enjoyment, interest, and absorption suddenly emerge and manifest themselves as effortless attention or flow (Bruya, 2010; Csikszentmihalyi, 1975, 1990). In view of the above, in our model, the dependent variables (Z) are the levels of enjoyment, interest, and absorption. The dependent variables are a function of the perceived challenge (Y) and skill (X). The dependent variable becomes bimodal for given X, Y pairs within the cusp region (area of overlap) shown in Figure 1. In other words, a given X, Y pair (challenge and skill) can give rise to two different Z values that represent the extent of the gratified state of consciousness (points C and D). In a nutshell, within the cusp region, an employee with a given X, Y pair can have very different subjective experiences (e.g., high levels of exciting flow), while that same person with the same values can also experience a sense of relaxing flow), giving rise to bimodal score distributions. The value of the dependent variable is measured by its position along the vertical axis. Outside the bifurcation set, things become more continuous, and a given pair of X, Y values usually generates only one response type (points A and B).

INSERT FIGURE 1 ABOUT HERE

The X-variable, which is shown as moving from left to right in Figure 1, is skill. In catastrophe models, the X-variable is characterized as the asymmetry variable because changes in this variable cause proportional changes in the dependent variable. In Figure 1, the variable represents left/right movement. The Y-variable represents the degree of perceived challenge that an employee is experiencing. In Figure 1 the variable is represented as back/front movement. In cusp catastrophe models, this is known as the bifurcation variable.

As values of Y increase (the origin is at the back of the figure), there comes a point where the surface splits into two states, represented in the bifurcation set. In catastrophe theory, this bimodal behavior is related to the phenomenon of hysteresis (Stewart and Peregoy, 1983).

Hysteresis

Hysteresis is a hallmark of nonlinear dynamical systems (Gilmore, 1993; Guastello, 2002). It refers to a sudden change or “jump” that will occur at different values of the asymmetry variable, depending on the direction of the change in this variable (Witkiewitz et al., 2007). The concept of hysteresis is illustrated in Figure 2: within a defined range of the underlying challenge parameter (X_1-X_2), the employee can be observed functioning on either two branches – a lower branch associated with the process of differentiation (Csikszentmihalyi, 1993), this is, recognizing some opportunity for action or challenge, or an upper branch associated with the integration process (Csikszentmihalyi, 1993), acquisition and assimilation of skills involved in the activity. An abrupt boundary separates the “flow state” from other nonflow states such as the boredom felt when challenges fall short of one’s skills and from the anxiety felt when the challenge significantly exceeds skills and competence. Interpreted in this way, flow corresponds to the bistable range of the challenge parameter in Figure 2.

INSERT FIGURE 2 ABOUT HERE

At point A_1 imagine an employee perceiving an engaging challenge or opportunity to act in his/her job; he/she is seeking novelty, being curious and experimental in relation to the specific task at hand. At point A_2 the employee is currently enjoying the exciting flow at that moment represented in the lower branch in Figure 2. As the employee increases its differentiation, it reaches a subjective region of higher challenge. At point A_3 the perceived challenge has increased to the point where the employee suddenly finds he/she can no longer sustain this differentiation, and abruptly reverses direction back towards the integration state. Figure 2 represents this reversal as a leap from A_3 on the lower branch of the system to point B_3 on the upper branch. Again integrating the skills involved in the activity and mastering the challenge, the employee then self-soothes and experiences a relaxing flow. The integration state allows the employee to move subjectively along the relaxing flow (point B_2) state shown on the upper branch until it has reached B_1 where the employee's sense of mastery gets to a point where she/he can no longer sustain this integration and needs new opportunities for action. Again there is a discontinuity, this time shown by the jump down to the lower branch at A_1, where the differentiation state begins again. At this point, the employee needs to find a new challenging activity or reconstruct the former activity in a way that represents new opportunities for action.

However, when perceived challenge is low (outside the range of the challenge parameter = X_1-X_2), the variables of enjoyment, interest, and absorption should show similar patterns when perceived skill is increasing; thus, hysteresis should not occur.

Hypotheses

The dynamic nature of flow and the capacity of the cusp catastrophe approach for modeling jointly continuous and sudden changes suggest that flow can be advantageously modeled from the catastrophe-theory perspective. More specifically, a cusp catastrophe model should be superior to the linear combination of variables for predicting the effect of perceived challenges and skills on the quality of employees' subjective experiences. In view of the above, two interdependent research hypotheses are associated with the present research study:

Hypothesis 1: The cusp catastrophe model of the effect of perceived challenges and skills on employee enjoyment, interest, and absorption will explain more variance than its comparable linear model

As we have stated before, flow is characterized as a sudden and enjoyable merging of action and awareness; likewise, there is empirical evidence that flow at work behaves in a nonlinear way across time and several authors have suggested the existence of *bistability and hysteresis* in optimal experiences. Therefore, it would be expected that a cusp catastrophe model will explain more variance than a linear model, because the linear model does not allow the researcher to distinguish between nonlinear change and random noise (i.e. it considers the nonlinear behavior as random, therefore the power to explain variance is lower). Similarly linear models tend to view bistable behavior as outlier behavior; hence this information is left out of the model.

Hypothesis 2: For the cases of high flow, the cusp catastrophe model will be especially successful in modeling the effect of perceived challenge and skill on enjoyment, interest, and absorption as compared to the linear model

The explicative power of the cusp catastrophe model will be especially powerful when flow reaches values within the bifurcation set (see Figure 1). The bifurcation set is defined by both middle and high levels of skill and challenge. In contrast, for low levels of perceived challenge and skill, the effect of skill and challenge on flow should become more gradual. In other words, considering that work-related flow represents a nonequilibrium condition that is located within the bifurcation set, where all bistable behaviour points are located, the strength of the cusp catastrophe model should become apparent in those cases of individuals experiencing optimal levels of work-related flow.

Method

Participants

Participants were 60 employees from different work backgrounds. The study sought a heterogeneous sample in terms of age, gender, and occupation, which enabled us to examine flow in the workplace within a broad range of employee profiles. There were, in total, 32 females and 28 males (mean age was 38 years, ranging from 26 to 64); 8% had high school diplomas, 57% had undergraduate degrees and 35% had postgraduate degrees. The participants had spent, on average, 8 years working in their companies (minimum 1 month and maximum 43 years) and 6 years in their current post (minimum 1 month and maximum 28 years); they dedicated an average of 8.3 hours per day to work (minimum 4 hours and maximum 14 hours) and 42 hours per week to work-related activities (minimum 16 hours and maximum 84 hours). Among the positions occupied by participants (that belonged to twenty-nine different occupations) were the following: IT manager, human resource advisor, researcher, chief executive officer, assembly-line worker, house cleaner, dog trainer, ballerina, scuba-diving instructor, etc. Participants did not receive any financial compensation for participating in the research study. It is important to emphasize that ESM samples are usually purposive and are not typically designed to be culturally or nationally representative (Hektner et al. 2007). Rather, our study was targeted at understanding the flow experiences of a heterogeneous sample of full-time and part-time employees occupying different job positions.

Design and procedure

Employees' perceptions of challenge and skill regarding work-related activities and their subjective experiences in terms of enjoyment, interest, and absorption were measured using the experience-sampling method (ESM; Delle Fave and Bassi, 2000; Hektner et al., 2007; Moneta and Csikszentmihalyi, 1996). A flow diary was created (see Instruments section). Each participant was given a handheld personal digital assistant (PDA), where the flow diary was contained, to carry for 21 consecutive working days, only during working hours, in order to obtain a wide sample of work-related activities performed by the employees. The PDA's were programmed to beep randomly six times per day, with intervals of at least 80 minutes between beeps.

Instruments

A flow diary was developed containing six questions covering various variables, which, as presented by flow theory (Csikszentmihalyi, 1975, 1990; Ghani and Deshpande, 1994; Hektner et al., 2007), are at the core of the flow experience. The selected variables and their corresponding items were: (1) activity—"What activity am I performing at this moment?", (2) perceived challenge—"How challenging do I find this activity?", (3) perceived skill—"What is my skill level for performing this activity?", (4) enjoyment—"How much do I enjoy doing this activity?", (5) interest—"How interesting is this activity?" and (6) absorption—"How quickly does time pass while I'm doing this activity?". Note that items 2 and 3 have been used successfully in previous flow research (e.g., Moneta and Csikszentmihalyi, 1999), and items 4, 5 and 6 have also been used previously by flow scholars (e.g., Ceja and Navarro, 2011).

The first question was aimed at focusing the employee's attention on a specific activity (the one the worker was engaged in when the PDA beeped); this way, participants answered the remaining questions with this activity in mind. The question was open-ended, and the employee had to describe the activity he/she was performing; the information obtained was in text form. Some examples of the activities sampled are: “I’m giving a creative dance lesson” and “I’m preparing a new choreography,” recorded by a professional ballerina. Likewise, a chief executive officer recorded the following activities: “I’m reviewing the financial records of the company” and “I’m in a board of directors meeting discussing the mission of the company.” For the remaining questions, a scale was computed that consisted of a continuous line blocked off at either end, which included the following markers: for questions 2, 3, and 4, “a little” and “a lot”; similarly, for question 5, “very interesting” and “slightly interesting.” Finally, for question 6, the labels on the scale indicated “time passes very fast” and “time passes very slowly.” For questions 2 through 6, participants were required to put a mark directly on the line (scale) that appeared on the screen; the PDA automatically changed the mark into a value within a 0–100 scale.

Analysis

The data obtained through the ESM are in the form of time series. Therefore, in order to test our hypotheses, the data were fitted individually. The independent variables were skill and challenge, and the dependent variables were enjoyment, interest, and absorption. Similarly, we created a total flow score variable named *flow* by computing the average of enjoyment, interest, and absorption. Significant and positive correlations were found between enjoyment, interest, and absorption at the between-person level of analysis: r(enjoyment/interest) = .85**, r(enjoyment/absorption) = .76**, r(interest/absorption)= .65** (** $p < .01$, $N = 60$); and at the within-person level of analysis: r(enjoyment/interest) = .88**, r(enjoyment/absorption) = .68**, r(interest/absorption)= .62** (** $p < .001$, $N = 6{,}981$). In addition to this, we conducted correlation analyses of all variables at the within- and between-persons level of analysis following the WABA procedure (Dansereau et al.,1984). These results can be seen in Table 1.

To analyze the fit of the cusp catastrophe model to the flow data and compare the fit to a linear model, the R cusp package (Grasman et al., 2009) was used. This method implements and extends Cobb's maximum likelihood approach (Cobb and Watson, 1980; Cobb et al., 1983) and makes it easy to fit the cusp model to real data and compare it to linear and logistic regression models (including main effects and interaction between challenge and skills). It is important to note that the cusp package allows comparison of the fit of the cusp model to its logistic counterpart; therefore, we took advantage of this opportunity and included both the linear and logistic models in our analysis. Likewise, considering the nested structure of our data, we compared the fit of each model (i.e., cusp catastrophe, linear and logistic) individually for each participant.

Several model-fit statistics are calculated in order to assess the fit of the cusp model and the linear and logistic regression models. First, the conventional R^2 for the linear and logistic models and the pseudo-R^2 statistic for the cusp model are calculated. It is important to emphasize that the pseudo-R^2 is not in all cases a trustworthy guide in selecting the model, especially in nonsymmetrical distributions (Grasman et al., 2009). For this reason, a second comparison criterion based on the AICc (Akaike's information criterion corrected) and BIC (Bayes's information criterion) indexes was used. These indexes can help compare the cusp model to competitor models like the linear and logistic regression models; the model that shows the lower AICc and BIC indexes emerges as fitting the data best (Grasman et al., 2009). Finally, the likelihood ratio chi-square test was utilized to compare the fit of the cusp model and the linear regression model (contrasting the AICc and BIC indexes).

To our knowledge, the flow theory has not yet examined whether skill and challenge are good asymmetry and bifurcation parameters, with the exception of the work presented by

Rea (1993), which points out theoretically that perceived challenge should be a good bifurcation parameter, as at specific values of perceived challenge the experience of flow presents a bistable behavior or two points of equilibrium. From a methodological perspective Grasman et al. (2009), suggest a series of steps for identifying good asymmetry and bifurcation parameters. Hence, following Grasman et al's (2009) procedure, in order to decide whether skill and challenge are good asymmetry and bifurcation parameters, histograms of enjoyment, interest, and absorption for different values of skill and challenge were developed. More specifically, for challenge to be a good bifurcation parameter, enjoyment, interest, and absorption should change from unimodal to multimodal distribution for different challenge values. Likewise, if skill is a good asymmetry factor, then enjoyment, interest, and absorption should change from left-skewed to right-skewed with increasing values of skill. In other words, skill and the dependent variable should correlate strongly.

Finally, in order to test the second hypothesis, we first calculated the cutoff value for identifying the high-flow cases. To this aim, following Hektner et al's (2007) procedure we standardized the total flow variable of the 6,981 registers across the 60 participants. The cutoff value for high-flow cases was Z-scored flow variable above 0.5 (M_{high} = 79.60) and -0.5 (M_{low} = 56.00) for low-flow cases. The Mann-Whitney U test showed that these groups were statistically different ($p < 0.001$). Second, we selected the participants experiencing high levels of flow; this is, those that presented a mean flow score higher of 79.60 (nine participants). We then compared the fit of each model (i.e., cusp catastrophe, linear and logistic) individually for each of the high-flow participants.

Results

We begin with descriptive statistics of the data; next, we present the catastrophe analyses that provide evidence that work-related flow is a discontinuous process that suffers abrupt changes; and finally, we provide further results from the catastrophe analyses, which reveal that the cusp model is especially advantageous for analyzing those cases of high levels of flow.

The correlations, means, and standard deviations for all study variables at the within-person level of analysis for the whole sample (N = 6,981) are presented in Table 1. A detailed examination of Table 1 yields interesting insights regarding the dynamics and relationships among the variables examined in the present study. First, we find that the lowest mean score value recorded was for perceived challenge ($M_{challenge}$ = 44.08) as compared to the rest of the study variables. Second, perceived skill and perceived challenge were uncorrelated (at both levels of analysis). Third, as we have stated before, the variables of enjoyment, interest, and absorption are correlated, supporting the view of operationalizing flow as the average of the three variables (i.e., enjoyment, interest, and absorption). Fourth, the flow variable is also correlated with all study variables, confirming the principal tenets of the flow theory (Csikszentmihalyi, 1990).

INSERT TABLE 1 ABOUT HERE

Three models (linear, logistic, and cusp models) were tested for each participant. Perceived challenge and skill were entered as predictors of flow, enjoyment, interest, and absorption for the three models. In Table 2, the goodness-of-fit statistics of the linear, logistic, and cusp models are presented. Lower values of AICc and BIC indicate a better-fitting model; as shown in Table 2, the cusp model provided a better fit to the data than the linear and logistic models for all the variables. According to the R^2, the cusp model generally provided a better fit to the data, and in some cases the goodness of fit was similar to that of the logistic model (see the case of enjoyment in Table 2). However, considering the AIC and BIC in all cases the cusp model provided a better fit. These results clearly support Hypothesis 1.

INSERT TABLE 2 ABOUT HERE

Moreover, for the nine employees presenting the highest levels of flow, the cusp model presents higher R^2 for all cases, as compared to the linear and logistic models. More specifically, the R^2 for the cusp model presents a median value of 0.53, whereas the R^2 for the linear model is 0.31 ($p < 0.001$). Likewise the R^2 for the logistic model is 0.37. This indicates that the cusp catastrophe model generally provides a better fit to the data than the linear and logistic models for participants experiencing high levels of flow. It is important to emphasize that in the cases of high levels of flow the R^2 of the cusp catastrophe model clearly explains more variance than when we examine that of the entire sample. The full results for these nine employees are presented in Table 3 and they support Hypothesis 2.

INSERT TABLE 3 ABOUT HERE

Examples of a good fit of the flow data to the cusp model are demonstrated in Figure 3, which shows line graphs, and the three- and two-dimensional displays of the fit of the cusp model for two specific cases (9 and 58). Only two cases are presented in order to facilitate the understanding and reading of these results. Both cases are drawn from among the nine employees experiencing the highest levels of flow. These diagrams are used to confirm the sudden changes occurring in the process of flow. That is, if the data are located in the bifurcation set (the area between the bifurcation lines), the behavior presents sudden and discontinuous changes. As we can see from Figure 3, for both cases, a good majority of the observations fall within the cusp or bifurcation set, indicating an appropriate fit of the data to the cusp model.

INSERT FIGURE 3 ABOUT HERE

Discussion

With flow theory as the backdrop, the focus of the present study was to model well-being fluctuations in the daily lives of employees. Specifically, the current study contributes to flow theory by empirically showing that work-related flow stands as a *peak experience* where abrupt and continuous changes occur jointly over time. In other words, the present study has been able to model, for the first time, the sudden merging of action and awareness described in qualitative narratives found in the flow literature. Likewise, it is shown that those cases presenting high levels of flow stand frequently within the bifurcation set (e.g., see Figure 3, middle and right figures) characterized by discontinuous and abrupt changes. In addition to this, the study demonstrates that the discontinuities and nonlinear changes observed in the process of flow can be advantageously modeled using a cusp catastrophe approach.

The use of catastrophe theory to model flow in the workplace

The results of the present study give further support to the evidence that perceived skill and challenge are powerful predictors of work-related flow. Likewise, our study confirms that enjoyment, interest, and absorption may present both linear and nonlinear changes at different values of challenge and skill. More specifically, it is shown that not all changes in employee well-being are smooth and continuous; indeed, employee happiness can also present discontinuous or sudden changes over time.

Although our findings largely confirm the flow model, they also point out some deviations from the ideal simplicity of the theoretical model. These deviations concern the drastic and discontinuous changes shown by the cusp catastrophe model. More specifically, the statistical significance and better fit of the cusp catastrophe model to the flow data introduce nonlinearity to flow theory and corroborate the empirical work on the nonlinear behavior of flow across time (e.g., Ceja and Navarro, 2009, 2011; Guastello et al., 1999). The increasing evidence of the existence of nonlinear relationships in the process of flow calls for the development and application of nonlinear approaches to the study of this phenomenon. In our view, the use of both approaches (linear and nonlinear dynamical systems models) should provide further understanding of the sudden and discontinuous transitions (e.g., when a worker shifts from a flow state to non-flow states of consciousness) often observed in the life of a happy worker. More specifically, linear approaches may be useful for modeling nonflow states at work (e.g., where perceived challenge is low), whereas nonlinear methodologies (e.g. catastrophe models) can advantageously be used to model optimal states of consciousness (e.g., when perceived challenge is medium-high) in the workplace. Hence, both approaches can complement each other, providing scholars with a broader understanding of employee well-being.

Interpretation of the cusp catastrophe model of flow at work

The cusp catastrophe model presented in this study describes the pattern of behavior of enjoyment, interest, and absorption, driven by the interaction of two fundamental determinants of flow: perceived challenge and skill. More specifically, according to our model, perceived challenge indicates that there are specific situations (i.e., when perceived challenge is medium-high) where changes in the subjective experiences of employees are drastic and discontinuous and others (i.e., when perceived challenge is low) where these changes are more gradual and continuous. Hence, perceived challenge indicates the number of discontinuities in employees' quality of life, whereas perceived skill gives us information about the proximity to a drastic change in employee well-being.

Likewise, the bifurcation set described by our model indicates that the variables involved in the flow process have a threshold, beyond which two diverging behaviors are possible (i.e., flow or non-flow states). Employees with values corresponding to the bifurcation set can be attracted either to a flow state of consciousness (i.e., high levels of enjoyment, interest, and absorption) or to non-flow states of consciousness. This bimodal behavior may lead to sudden changes in the quality of employees' experiences. In this sense, workers can settle into different states of consciousness. For instance, employees who perceive their job as not giving them opportunities for action could get caught in non-flow states of consciousness, such as boredom. However, when they are faced with new tasks and their perception of challenge changes and rises above a specific threshold, they can drastically move into the flow zone. When their perception of challenge falls below a different threshold, they can shift equally drastically into a non-flow state, such as anxiety. However, when their perception of challenge is between the two thresholds mentioned above, their subjective experiences will change in a more gradual and continuous way. The bimodal behavior encountered at specific values of perceived challenge is a hallmark of nonlinear behavior.

The findings of the present study give support to the theoretical suggestions of other authors (e.g., Houge-Mackenzie et al., 2011; Rea, 1993) that propose the integration of concepts from the reversal theory (RT; Apter, 1982) and the flow theory. In other words, the present study demonstrates the existence of *bistability* or *hysteresis* in work-related flow.

Accordingly, the experience of flow at work describes a nonequilibrium condition where within a defined range of perceived challenge (i.e., the bifurcation set) there is more than one point of equilibrium to which the employee is attracted. Within this defined range of perceived challenge, the employee can be observed functioning on either the differentiation process (i.e., recognizing some opportunity for action or challenge) or the integration process (i.e., acquisition and assimilation of skills involved in the activity). An abrupt boundary separates the flow state from other non-flow states such as boredom, relaxation or anxiety. In this sense, work-related flow corresponds to a bistable range of challenge where reversals or discontinuous changes in work-related flow occur over time. All of these findings extend the current conceptualization of work-related flow by integrating concepts of reversal theory, catastrophe theory and the flow theory. The integration of these theories provides the ground for capturing the qualitative narrative where work-related flow is described by discontinuous or abrupt changes in a quantitative testable framework. In our view, this integration represents an important advancement for gaining a deeper understanding of the process of work-related flow.

Modeling high levels of flow

Our results also show that high levels of flow, especially, are best modeled by the cusp catastrophe model. Better performance for the high flow cases is not surprising for catastrophe-theory models. Previous research has found a link between nonlinear behavior and employee well-being at various levels of analysis (e.g., high levels of work motivation, see Arrieta et al., 2008; high levels of flow, see Ceja and Navarro, 2011; flourishing business teams, see Losada and Heaphy, 2004). Hence, employees experiencing high levels of well-being (e.g., high levels of flow) are likely to present discontinuities in their optimal experiences at work, a hallmark of nonlinear behavior. Due to the strong nonlinearity encountered in high levels of employee well-being, and being unconstrained by assumptions of linearity, cusp catastrophe models appear to be especially powerful in cases of high work-related flow.

Allowing for complexity and nonlinearity, the cusp catastrophe model indicates that the relationship among the variables examined in the present study may be more complex than traditional linear approaches can manage. In this sense, the linear approaches are likely to be reductionist. Following Guion’s (1999) argument that work and organizational psychology is too linked to linear techniques of data analysis, we believe that research on employee well-being can benefit from an expansion of the methodological approaches currently used for modeling optimal states of consciousness, such as flow. Our results invite the development and testing of nonlinear dynamical systems models within employee well-being research, which will likely produce significant insights about employee flourishing and form the basis of new research questions (e.g., to examine whether the specific values of perceived challenge at which the bifurcation set is created are distinct for each employee or whether similarities in this threshold can be found between different workers).

Practical implications

The existence of linear and nonlinear relationships and gradual as well as discontinuous changes observed in flow has important practical implications, as these insights may be transformed into job redesign and other intervention strategies aimed at fostering employee happiness. First, if managers wish to take an active role in facilitating employees’ optimal experiences, they must fully understand the regular and discontinuous changes that can occur, according to our findings, in the quality of employees’ experiences. Moreover, they should strive to better understand two of the key determinants of flow (i.e., perceived challenge and skill) and how these antecedents interact and affect the daily life of a happy worker. As a mental model catastrophe theory can help managers to identify values of perceived challenge and skill at which the experience of flow becomes discontinuous or bimodal. As shown by our model, perceived challenge acts as the bifurcation parameter. In other words, it indicates the number of discontinuities found in employees' optimal experiences. Hence, managers should be aware that the extent to which workers perceive opportunities for action in their work-related activities will determine the emergence of drastic changes in the subjective experience of their workforce. In other words, perceived challenge plays a key role in the process of *suddenly* entering the "flow zone."

Second, given that perceived challenge appears to play a key role in the dynamics of flow, managers should make sure that their employees are able to perceive their work objectives as real opportunities for action. But how can managers succeed at knowing what work goals will be perceived as opportunities for action by their employees? Lazarus's theory of cognitive appraisal (Lazarus and Folkman, 1984) can help managers to develop challenging work environments. More specifically, the theory of cognitive appraisal states that demanding situations can be cognitively appraised as either challenging (i.e., the employee evaluates the situation as an opportunity for self-growth and identifies the skills available to manage the demands) or threatening (i.e., the employee evaluates the situation as a source of failure and he/she is unable to find the necessary skills to manage the demands; Lazarus and Folkman, 1984). It has been found that appraisal processes can be influenced through simple oral instructions, and therefore it may be possible to increase employee well-being by creating a more challenging work environment (Drach-Zahavy and Erez, 2002). In this sense, managers can frame employees' goals in positive terms, highlighting positive outcomes and success and attributing success to their own effort, consistency, and focus on the task. This way, employees will be more likely to evaluate their work environment as meaningfully challenging, and they will have the capacity to engage proactively in the process of continuously updating their skills and engaging in challenging goals, achieving flow. It is important to note that according to our results and as Lazarus (1991) also emphasizes, coping with work events unfolds dynamically, over time, so the same work activity may be a source of challenge or distress at different times. Flow activities must constantly be re-created. This is the fact that makes the process of flow a dynamical and developmental phenomenon. In this sense, organizations should be aware of the “rocky road” to employees’ flow.

Limitations and opportunities for future research

Several limitations should help guide future research. One consideration relates to the need for using a larger sample size in order to examine whether the results obtained in the present investigation can be replicated. Likewise, another consideration relates to the analysis technique used for comparing the accuracy of the cusp catastrophe model and the linear and logistic regression models (i.e., the R cusp package; Grasman et al., 2009). The data of the individual participants formed time series, and time series tend to be autocorrelated. The cusp model and the linear and logistic regression models as applied in the current study assume that each of the data points is independently distributed from other data points (and therefore uncorrelated). Nonetheless, the three models (linear, logistic, and cusp) are affected in a similar way, and so the comparison used in our study will still lead to appropriate conclusions. It should be noted that, to our knowledge, no techniques for fitting time series data to cusp catastrophe models are available. We therefore call for the examination and improvement of the different fitting techniques for the cusp catastrophe models used in the social sciences (e.g., maximum likelihood technique, see Cobb and Watson, 1980; polynomial regression technique, see Guastello, 1982, 1987; and multivariate GEMCAT, see Oliva et al., 1987; Lange et al., 2000).

Similarly, it is important to examine possible limitations derived from our conceptualization of perceived challenge as independent from perceived skill. Perceived challenge and skill have been traditionally conceived as independent measures in the flow literature (e.g., Csikszentmihalyi, 1990; Csikszentmihalyi and Rathunde, 1993; Hektner et al., 2007; Moneta and Csikszentmihalyi, 1996). Moreover, we found no significant correlation between both variables at the within- and between-individuals level of analysis. We must note, however, that theoretical and empirical work on cognitive appraisal theory (e.g., Lazarus and Folkman, 1984) suggests that when faced with a demanding situation, an individual primarily appraises the situation as threatening or challenging and secondarily appraises the situation in terms of whether he/she has the skills to respond to the situation effectively. Following this reasoning, challenge and skill may not be independent, and their relationship may be more complex than traditional measures of flow are able to explain. Therefore, further refining the measures of perceived challenge and skill by integrating cognitive appraisal theory (Lazarus and Folkman, 1984) with flow theory could broaden our understanding of the complex interplay between perceived challenge and skill that produces flow. For instance, while the combination of perceived challenge and perceived skill has been shown to lead to flow, past research has not made distinctions between perceptions of challenge versus threat. It may be worthwhile for future research to examine how the appraisal of a difficult activity as a challenge or a threat interacts with perceived skill to affect optimal experience.

Likewise, a fruitful area for future research may be to study situation-related (e.g., specific work-related activities and work environments) and person-related (e.g., different personality traits, such as autotelic employees or achievement-oriented individuals) predictors of the discontinuous and abrupt changes observed in work-related flow.

Finally, although the ESM offers many benefits for studying work-related flow over time, especially when compared to traditional cross-sectional survey designs, it is important to consider some of its limitations (e.g., Bolger et al., 2003; Scollon et al., 2003). A practical concern is that in order to obtain reliable and valid data, ESM studies must achieve a level of dedication and participant commitment not commonly required in other types of research studies (e.g., survey based cross-sectional studies). Often the alarms used can disrupt employees' activities and can also disrupt employees' flow experiences (in the case of the present study). Therefore, the degree of motivation plays a significant role in determining whether an employee will successfully complete an ESM study. In the present research study, employees were asked to fill in a flow diary six times per day for a period of 21 days. Given these demands, our sample was composed mainly of motivated and happy employees, as shown by the mean value of enjoyment (68,83), interest (63,69) and absorption (70,36), resulting in certain self-selection bias. Therefore, it may be interesting to study larger samples of workers presenting low levels of flow, with the objective of validating the findings presented here. Researchers willing to study less motivated employees would be advised to signal participants less frequently, for instance, once or twice per day. Likewise, in order to increase employee's motivation and commitment towards the study, it is important to gain participant trust by making them understand the importance of the study. In the current research study, participants saw the value of the study through personal feedback given by the researchers halfway and at the end of the study.

It is important to emphasize that at this point, ESM, while far from perfect, is probably the best method for studying work-related flow in its natural, spontaneous context, providing information which is complementary to other traditional designs (Hektner et al., 2007). The ESM notably reduces the likelihood of retrospection, as it minimizes the amount of time elapsed between the flow experience and the account of the experience, making it a very powerful method for capturing the temporal and dynamic aspects of work-related flow.

Conclusions

Recently there has been an increased interest in the study of within-individual fluctuations in employee well-being (e.g., Sonnentag and Ilies, 2011; Xanthopoulou et al., 2009). Flow is a construct that is central to employee well-being research, and it provides organizational scholars with a valuable conceptual framework with which to unwind the psychological mechanisms that explain fluctuations in employee happiness. Various studies have confirmed that flow is highly unstable across time and tends to behave in a nonlinear way (Ceja and Navarro, 2009, 2011; Guastello et al., 1999). Although it has been said that flow presents continuous fluctuations over time, there is still a need to model these fluctuating and nonlinear dynamics. The present study represents the first attempt to model flow at work using a cusp catastrophe approach. It shows the advantage of using catastrophe models (i.e., cusp catastrophe model) for modeling flow experiences at work over traditional linear techniques of data analysis, such as linear regression. Overall, our study demonstrates that work-related flow presents linear and nonlinear relationships and gradual as well as discontinuous or abrupt changes across time. In this sense, nonlinear approaches to employee well-being can complement traditional linear approximations by enriching our capacity to understand, characterize, and integrate different patterns of change (e.g., gradual, continuous, sudden, nonlinear) found in flow and other instances of employee well-being. We hope that the findings from the present study will encourage other organizational scholars to consider using catastrophe theory, as well as other nonlinear approaches (e.g., artificial neural networks; fractal techniques, etc), to continue providing insights into the dynamic and fluctuating aspects of employee happiness.

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Notes

[1] In our view, some of these eight core dimensions can be considered as antecedents of flow (e.g., clarity of goals and positive feedback about the progress being made). Hence, the distinction between core dimensions, antecedents and outcomes of work-related flow needs to be further refined. There are some authors like Quinn (2005) who have started the process of clarifying this issue.

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Lucia Ceja is a Researcher in the Family-Owned Business Chair at IESE Business School, University of Navarra. She obtained her PhD in Work and Organizational Psychology from the University of Barcelona. She has received several international research awards such as the *Gallup Strength Scholar award* and the *Barcelona Chamber of Commerce research Award*

(Cambra de Comerç de Barcelona). Her current research interests involve the application of the nonlinear dynamical systems theory to the study of employee well-being and the fields of coaching psychology and family business. Her work is published in journals including *Journal of Organizational Behavior, Human Relations, Journal of Happiness Studies*. [Email: LCeja@iese.edu]

Jose Navarro is an Associate Professor of Organizational Psychology and Organizational Behavior at the University of Barcelona. He is currently the head of the Social Psychology department. His research interests centre on issues of work motivation and team behavior. In the field of work motivation he is interested in knowing how high motivation evolves non-linearly over time showing chaotic patterns. In the area of teamwork his interests lie in knowing how the fit between uncertainty of the tasks-group and the complexity of the social structure developed in the group is a main determinant of team effectiveness. His work has been published in journals such as *Journal of Organizational Behavior, European Journal of Work and Organizational Psychology, Small Group Research, Journal of Happiness Studies, Nonlinear Dynamics Psychology and Life Sciences, Spanish Journal of Psychology, Psicothema, Revista de Psicología del Trabajo y de las Organizaciones, Revista de Psicología Social*. [Email: j.navarro@ub.edu]

Table 1 Means, standard deviations, and correlations of study variables at the within- and between-persons level of analysis

	M	SD	1	2	3	4	5	6
1. Challenge	44.08	23.74	----	-0.005	0.407**	0.500*	0.240	0.416**
2. Skill	78.37	15.48	-0.084	----	0.397**	0.184	0.494**	0.391**
3. Enjoyment	68.83	22.59	0.064	0.254**	----	0.853**	0.766**	0.949**
4. Interest	63.69	23.15	0.257**	0.203*	0.886**	----	0.658**	0.913**
5. Absorption	70.36	20.7	0.086	0.275**	0.682**	0.620**	----	0.885**
6. Flow	67.63	19.61	0.155*	0.274**	0.914**	0.894**	0.856**	----

Note: Within-person correlation values based on 6,981 registers across 60 individuals (below the main diagonal). Between-persons correlation values based on 60 individuals (above the main diagonal). **p < .01, *p < .05.
Within-person correlations should be viewed with caution due to their sensitiveness to the variables included in the analysis and their variances (see Nezlek, 2008).

Table 2 Fit statistics for linear, logistic, and cusp models

		Linear	Logistic	Cusp
Flow	AICc	978.95**	503.47	265.46**
	BIC	989.71**	516.79	281.16**
	R^2	.23	.44	.39
Enjoyment	AICc	1031.31**	363.70	361.07**
	BIC	1031.79**	376.94	332.72**
	R^2	.19	.47	.45
Interest	AICc	1018.69**	981.03	267.05**
	BIC	1026.02**	1001.33	282.64**
	R^2	.24	.38	.42
Absorption	AICc	994.54**	785.73	245.95**
	BIC	1005.09**	799.05	261.51**
	R^2	.20	.35	.49

Note: The AIC, BIC and R^2 were calculated as the average of all cases. The trimmed mean was used in order to eliminate outliers or extreme observations, discarding 5% of the values at the high and low ends.
AICc = Aikaike information criterion corrected; BIC = Bayesian information criterion.
N = 6,981 logs across 60 participants.
The chi-square likelihood ratio test was calculated for the AICc and BIC indexes.
** p < .0001

Table 3 Fit statistics (R^2) for the nine employees with high levels of flow

	Linear	Logistic	Cusp
Case 2	0,31	0,33	0,53
Case 24	0,19	0,23	0,75
Case 3	0,34	0,4	0,39
Case 22	0,16	1,00	0,16
Case 59	0,41	0,42	0,44
Case 34	0,41	0,82	0,00
Case 9	0,22	0,32	0,75
Case 58	0,49	0,00	0,61
Case 36	0,01	0,13	0,72
Median of nine cases	0,31	0,37	0,53

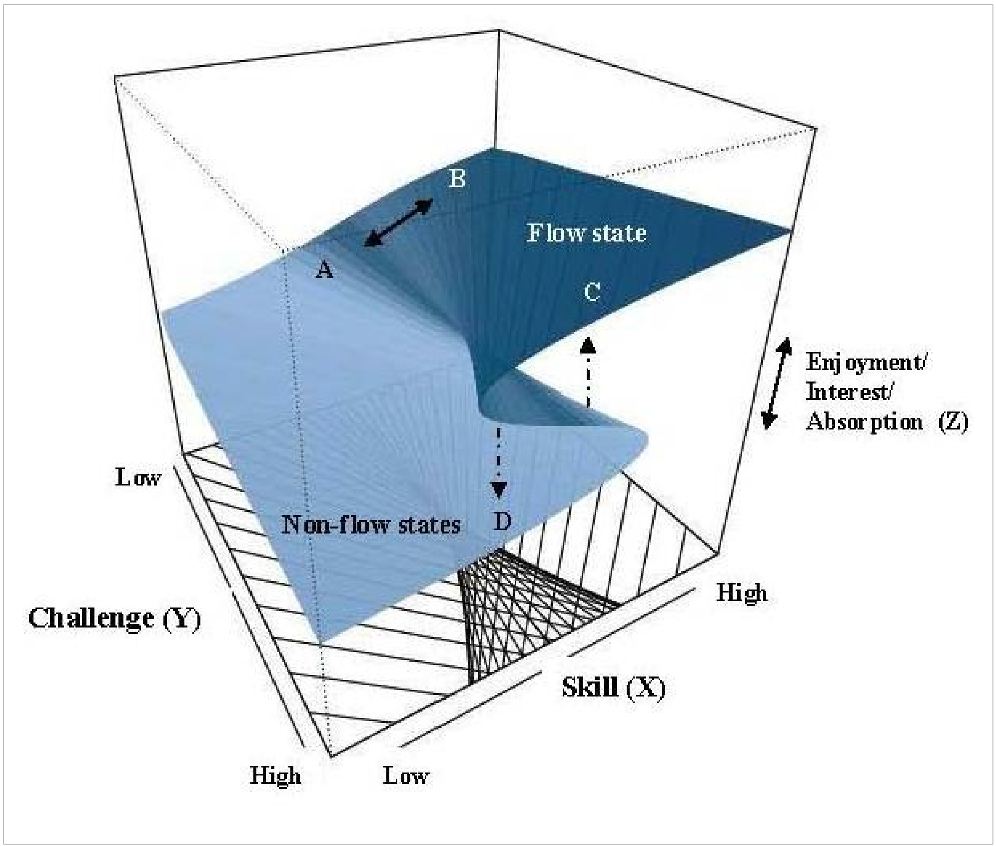

Figure 1 Cusp catastrophe model of flow experiences at work.

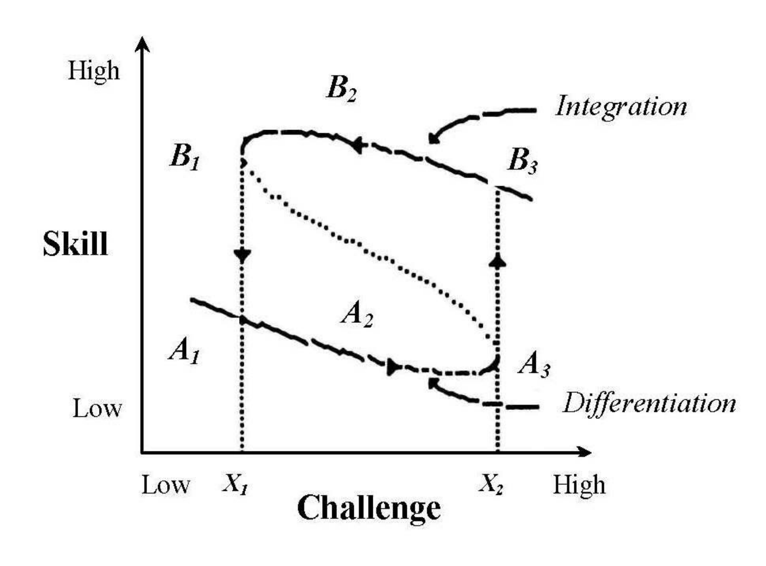

Figure 2 The process of hysteresis in work-related flow.

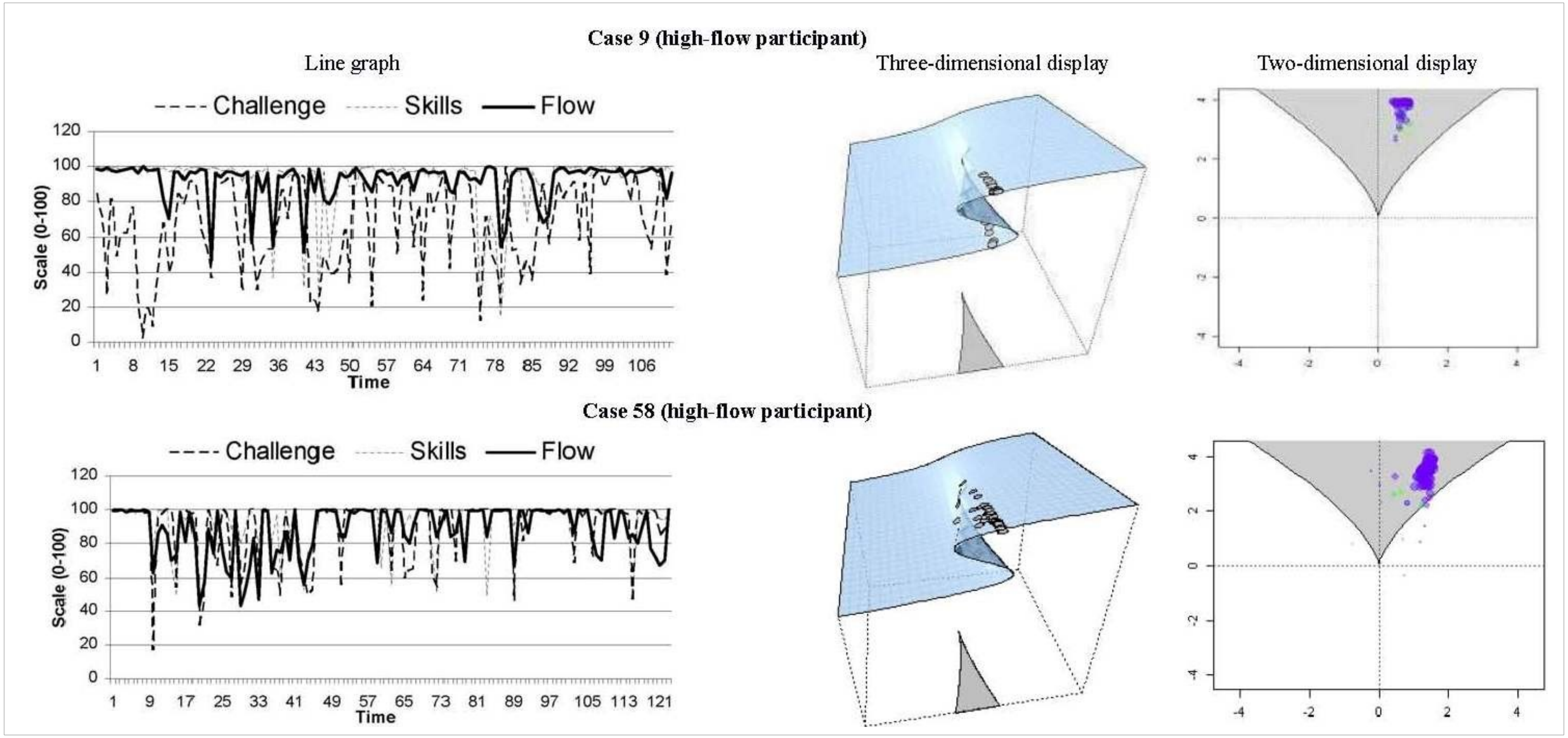

Figure 3 Line graphs (left) of cases 9 and 58; three- and two-dimensional displays (middle and right respectively) of the fit of the cusp model for cases 9 and 58. Both cases represent high flow participants. As explained in the text (see page 13), the fold in the image on the middle and the dark gray area in

the image on the right represent the bifurcation set. The colored points in the middle and right figures represent each of the observations recorded for cases 9 and 58.

Corresponding author

Lucia Ceja

IESE Business School

Family-Owned Business Chair

Av. Pearson 21

08034 Barcelona

Spain

LCeja@iese.edu

Secondary affiliation

Social Psychology Department

University of Barcelona

Paseo Valle de Hebron, nº 171

08035 Barcelona

Spain

luciaceja@gmail.com

Other author:

Jose Navarro

Social Psychology Department

University of Barcelona

Paseo Valle de Hebron, nº 171

08035 Barcelona

Spain

j.navarro@ub.edu