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Multilevel Modeling of Motivation

A Self-Determination Theory Analysis of Basic Psychological Needs

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Motivation is, by its very nature, a dynamic process. Human motives and desires fluctuate in direction and strength according to inner promptings and environmental contingencies that can facilitate or inhibit the satisfaction of needs, and desires also vary as individuals negotiate their day-to-day lives. This dynamic character of motivation has implications for research designs and analytic approaches used to investigate it. Because traditional one-occasion, experimental, and longitudinal approaches typically provide very limited opportunities to model the dynamic variability of motivation, researchers have begun to pair nontraditional methods such as experience sampling with analytic tools such as multilevel modeling to extend our understanding of motivation as it operates in day-to-day contexts. In this chapter, we discuss recent research using multilevel approaches to modeling the variable nature of motivation and its consequences. Specifically, we focus on recent efforts to understand the expression of three basic psychological needs specified by self-determination theory (SDT; Deci & Ryan, 2000; Ryan, 1995).

Self-Determination Theory and Basic Psychological Needs

Central to SDT is a view of the human organism as active and growth oriented, with a nature endowed with tendencies toward health and well-being (Ryan & Deci, 2000b). SDT proposes that inherent to the adaptive design of the organism is a propensity to exercise one's capacities, to seek connection with others, and to experience behavior as self-organized and congruent. It further suggests that these propensities are innate psychological needs—for competence (Deci, 1975; White, 1959), relatedness (Baumeister & Leary, 1995; Reis & Franks, 1994), and autonomy (deCharms, 1968; Ryan, 1993), respectively—whose fulfillment is essential to ongoing personal well-being, optimal behavioral functioning, and constructive social development (Ryan & Deci, 2000a).

Autonomy concerns volitional, self-endorsed action. When autonomous, individuals perceive that their behavior is willingly undertaken and concordant with the self. The opposite of

autonomy is *heteronomy*, or a perception of being controlled by forces felt to be alien to the self. Autonomy is not equivalent to independence or separateness, and in fact dependent acts and connecting behaviors are often highly volitional or autonomous. *Competence* pertains to the experience of mastery, or the effective performance of desired behaviors, which is experienced under conditions that support efficacy and provide optimal challenges. Finally, *relatedness* is the subjective experience of closeness and connection with others. It is maximized within relationships or groups that convey (usually through acts of empathy and caring) the sense that one belongs with and is significant to the other person or group.

Specifying autonomy, competence, and relatedness as basic psychological needs implies that individuals cannot psychologically thrive or function fully without satisfying them, just as they cannot physically thrive without the basic nutriments of food and water. Likewise, just as the physical environment can facilitate or hamper the satisfaction of physical needs, social environments can afford or hinder the fulfillment of autonomy, competence, or relatedness, with consequences for individual functioning and well-being. When a need is thwarted, invariably there is a deleterious impact on growth and wellness, whether or not that need represents one's values, goals, or desire. Thus a thrust of SDT is to examine variations in need fulfillment across time, contexts, and cultures, as these impact fluctuations in optimal functioning and well-being.

A large literature of empirical research has investigated the social psychology of psychological need support and hindrance (see Deci & Ryan, 2000; Ryan & Deci, 2000b, for reviews). Multilevel modeling approaches have enhanced the sophistication of SDT research by permitting a detailed examination of questions that reflect this person-by-situation character of need fulfillment, and the implications of this dialectic for psychological well-being. Primary questions addressed by this recent research include the following:

- How are basic psychological needs expressed and fulfilled in daily life and other, objective behavioral contexts?
- What consequences does need fulfillment, or lack thereof, have for personal (and collective) well-being across time and contexts?
- What psychological supports exist for need satisfaction?

In this chapter, we discuss research on the basic needs of autonomy, competence, and relatedness within an SDT framework, beginning first with a brief historical overview of research methodology in this area before turning to investigations using multilevel approaches to modeling the dynamic nature of need regulation and the outcomes of such regulation. We also discuss very recent research examining the role of mindfulness (Brown & Ryan, 2003) as a key internal support for healthy behavioral regulation. Finally, we offer suggestions for enhancing the sophistication of research using multilevel approaches as a means to both deepening our understanding of need fulfillment and providing a platform for applied research designed to enhance healthy regulation.

Traditional Approaches to the Study of Motivation: Cross-sectional, Longitudinal, and Experimental Designs

As in many areas of psychology, including positive psychology, a dominant form of measurement in the study of motivation has consisted of scales and questionnaires designed for single-occasion administration. Many such measures of motivation are retrospective in nature, asking individuals to reflect back upon their past psychological experience or behavior. As individual difference measures, they are designed to assess general dispositions or traits and are assumed to reflect stable individual characteristics that have important behavioral consequences. For example, dispositional measures like the General Causality Orientations Scale (Deci & Ryan, 1985), which assesses individual differences in autonomy, have demonstrated criterion validity, assessed both cross-sectionally and predictively over short- and longer-term time intervals.

Despite this, one-occasion assessment relies upon an assumption of temporal stability, regardless of whether the behavior or characteristic measured is theoretically understood to be stable or variable. Yet individuals do not behave according to their trait descriptions in every situation or even across broad classes of situations. Intraindividual variability of this kind has been shown both in research that has tested the situational specificity of motivation and in studies that have repeatedly sampled behavior over time. For example, La Guardia, Ryan, Couchman, and Deci (2000) found significant variations in psychological need fulfillment

across different interpersonal relationships. In turn, these within-person differences in need fulfillment from social partner to social partner predicted variability in security of attachment. Although it is often assumed that security of attachment is a stable individual difference variable, contextual variations in support for psychological needs appear to create within-person variations in this presumably stable trait. Other research (e.g., Reis, Sheldon, Gable, Roscoe, & Ryan, 2000) has revealed a marked degree of intraindividual variability in need fulfillment across days of the week. Fluctuations in day-to-day need fulfillment, controlling for individual differences and prior day effects, predicted changes in daily psychological wellness. Such studies showing both contextual and temporal fluctuations thus belie the assumption of stability upon which one-occasion measures are founded.

A reliance upon single-occasion individual difference measures has had a practical basis, as motivational dynamics have, until relatively recently, been difficult to measure and model systematically. Yet the frequent consequence of this dominant approach is that variability in motivation processes has been treated as error, and the assumption of stasis, over situations and over both short and long periods of time, is tacitly relied upon in such research endeavors (Brown & Moskowitz, 1998). A second assumption upon which the reliance on one-occasion, retrospective measures rests is that responses to them will be reasonably accurate. The validity of this assumption can also be questioned, given the inherent limitations to human memory in accurately describing past experience and the variety of sources of error that enter into retrospective reporting, including past event salience, idiosyncratic anchor events, current psychological states, and social desirability.

The incorporation of time into research designs enables the study of whether and how a characteristic will demonstrate stability and change—over time, as in traditional longitudinal designs, or in response to situational factors, as in experimental studies. Both approaches have contributed significantly to our understanding of a variety of motivational issues. Yet the relatively simple way in which these designs are typically employed has imposed limitations on the depth of understanding to be gained about motivational phenomena. Traditional longitudinal designs, which use relatively long inter-measurement intervals, limit investigations to

static or slowly changing phenomena. Researchers using such designs implicitly or explicitly expect that if change occurs, it will be permanent or unidirectional, rather than ongoing or repeated. Change of the latter sort may be embedded in apparently slowly changing or progressive phenomena and the picture provided by measures collected at widely spaced intervals may mask the nonlinear and short-term linear dynamics inherent in behavior. The use of experimental designs reflects a recognition that motivation can vary quickly in response to social and other situational forces, but such designs have typically been used to examine simple pre-post change. In all three traditional research designs discussed here, the lived and often nonlinear nature of motivational processes can easily be missed.

Multilevel Modeling and the Process Approach to Motivation

An important advance in the study of motivational processes came with the introduction of expanded longitudinal studies that measure behavior intensively over time. Following a process approach to research design (Brown & Moskowitz, 1998; Larsen, 1989), this research minimizes the difficulties associated with one-occasion, retrospective measures by collecting data as it occurs in laboratory or natural situations. Also, by expanding the traditional longitudinal design to include many reports or samples of behavior, stability and change can be examined more closely and precisely. Finally, the process approach still permits the study of manipulated effects on behavior but opens the door to examining more complex (but often realistic) responses to experimental inputs as they unfold over time. The process approach provides a frame-by-frame motion picture of behavior (Turk, 1994), rather than snapshots at a single time or at widely spaced time points. A major benefit of this approach is not just that it provides a more detailed and, therefore, accurate look at behavioral processes, but also in uncovering new motivational and other behavioral phenomena, because the focus of research broadens to include both the structure and the dynamics of behavior over time, including behavior that is traditionally viewed as dispositional in nature (Diener, 1996).

The introduction of multilevel modeling (MLM; e.g., Bryk & Raudenbush, 1992; Kreft & deLeeuw,

1998) represents a second important contribution to investigations in motivation, in part because it capitalizes on the process approach to research design. As Maxwell and Tiberio discuss (chapter 30, this volume), it permits the study of inter- and intraindividual variability across situations and across time with a more careful parsing of between- and within-persons variance. It also permits the study of interactions across levels of analysis—between groups and persons, or between persons and occasions—and it allows for the incorporation of time-series variables into analyses, as is discussed below. As this discussion suggests, multilevel modeling capitalizes on the strengths of each of the traditional methodological approaches to motivation discussed above, in its ability to incorporate individual difference effects, experimental group effects, and the study of behavioral variability and change through repeated measurement across situations and time.

Exemplary MLM Research in Motivation

Need Satisfaction and Day-to-Day Personal Well-Being

Several studies have examined two of the primary questions noted earlier, namely, “How are needs expressed and satisfied in daily life and other, objective behavioral contexts?” and “What consequences does need fulfillment, or lack thereof, have for personal well-being?” Sheldon, Ryan, and Reis (1996) examined the role that two of the three basic psychological needs specified by SDT—autonomy and competence—have in creating “good days.” In a sample of 60 undergraduates, they collected reports of need satisfaction at both trait and state levels, where the latter was assessed once per day for 14 days. At the close of each day, individuals were asked to rate the degree of autonomy and competence experienced in the three activities in which they had spent the most time. Also measured daily were levels of hedonic well-being (pleasant and unpleasant affect), eudaemonic well-being (subjective vitality), and physical health (common symptoms of illness) experienced over the course of the day.

Using a weighted least squares approach to MLM, with persons treated as a random effect, Sheldon et al. (1996) entered both trait (Level 2) and state (Level 1) autonomy (AUTO) and competence (COMP) need satisfaction terms

into multilevel models predicting each type of daily (Level 1) well-being (WB), as well as a well-being composite. Focusing first on Level 2 effects, the following basic model was tested:

$$WB_{ij} = \beta_{B-P}AUTO_i + \beta_{B-P}COMP_i + \beta_{B-P}SEX_i + \alpha_i + \varepsilon_{ij} \quad (1)$$

where $i = 1, 2, 3, \dots, I$ and $j = 1, 2, 3, \dots, n_i$.

AUTO and COMP are measured once for each of the I individuals (Level 2), whereas WB is measured n_i times for the i th individual (Level 1). The β_{B-P} terms refer to between-person effects, α_i is the intercept for each person (i.e., each person’s well-being on an average day), and ε_{ij} refers to the within-person residuals. Sheldon et al. (1996) found that individuals higher in trait autonomy and competence had better days, on average, than those scoring lower in these dispositions. This result is consistent with a personological approach, which assumes that well-being is determined by stable, enduring qualities of the person. Sheldon et al. (1996) also tested a model including effects of Level 2 traits, gender, and their interaction, and a number of Level 1 predictors, as follows:

$$WB_{ij} = \beta_{B-P}AUTO_i + \beta_{B-P}COMP_i + \beta_{B-P}SEX_i + \beta_{Int}(AUTO_i \times SEX_i) + \beta_{Int}(COMP_i \times SEX_i) + \beta_{W-P,i}WBLAG_{ij} + \beta_{W-P,i}IMPORT_{ij} + \beta_{W-P,i}WE_{ij} + \beta_{W-P,i}TIME_{ij} + \beta_{W-P,i}AUTO_{ij} + \beta_{W-P,i}COMP_{ij} + \alpha_i + \varepsilon_{ij} \quad (2)$$

In this model, $\beta_{W-P,i}$ terms refer to within-person effects in which, for example, people report higher well-being at a time when their need for autonomy is more satisfied. Sheldon et al. (1996) found that after factoring in the Level 2 effects of traits and gender, and the effects of several Level 1 variables, including lagged (prior day) well-being (WBLAG), daily activity importance (IMPORT), day of the week (and specifically, a dummy-coded weekend effect, WE), and time of day (TIME), the days on which individuals experienced more autonomy and competence relative to their own baseline were also better days.

In an effort to extend the Sheldon et al. (1996) findings, Reis et al. (2000) employed the same methodological and analytic approach to examine the trait and state effects of all three basic needs—autonomy, competence, and relatedness—upon

day-to-day hedonic, eudaemonic, and physical well-being. Insofar as all three represent basic needs, the authors reasoned that each should evidence a unique effect on well-being at both between- and within-person levels of analysis. The Level 2 results of the multilevel analyses showed that trait autonomy and relatedness predicted higher day-to-day positive affect, while autonomy alone predicted higher vitality. Persons higher in dispositional competence showed lower daily negative affect and symptoms. At Level 1, daily autonomy and competence were associated with higher day-to-day levels of all types of well-being examined, while relatedness was most strongly related to higher positive affect and vitality.

As a further extension to Sheldon et al. (1996), Reis et al. (2000) also tested for interaction effects between trait autonomy, competence, and relatedness and their corresponding state expressions in the prediction of daily well-being. Theoretically, this investigation was rooted in the recognition that while the three needs are universal (Deci & Ryan, 2000), some individuals may be more responsive to daily variations in activities or situations that afford or hinder need satisfaction. Reis et al. (2000) tested two competing models that would each indicate that the day-to-day relation between need satisfaction and well-being varied as a function of traits. A deprivation model posited that higher levels of daily need satisfaction would enhance well-being to the extent that individual trait levels were low. That is, when one or more needs was chronically or dispositionally unsatisfied, the opportunity to satisfy those needs would provide a greater well-being benefit than to those higher in dispositional need satisfaction. In contrast, a sensitization model proposed that higher trait need satisfaction reflected a higher value placed on it, and a greater likelihood that such persons would show well-being benefits. This model was tested:

$$\begin{aligned}
 WB_{ij} = & \beta_{B-P}AUTO_i + \beta_{B-P}COMP_i \\
 & + \beta_{B-P}RELAT_i + \beta_{W-P,i}WBLAG_{ij} \\
 & + \beta_{W-P,i}AUTO_{ij} + \beta_{W-P,i}COMP_{ij} \\
 & + \beta_{W-P,i}RELAT_{ij} \\
 & + \beta_{Int}(AUTO_i \times AUTO_{ij}) \\
 & + \beta_{Int}(COMP_i \times COMP_{ij}) \\
 & + \beta_{Int}(RELAT_i \times RELAT_{ij}) \\
 & + \alpha_i + \varepsilon_{ij}
 \end{aligned} \tag{3}$$

The β_{Int} coefficients in this equation estimate the extent to which the day-to-day effects of each type of need satisfaction on well-being (Level 1) vary by trait levels of need satisfaction (Level 2). Each $\beta_{W-P,i}$ main effect term now represents the effect of day-to-day need satisfaction on well-being for the i th person if trait levels of need satisfaction equaled zero. Together, the $\beta_{W-P,i}$ assess the individual differences in the effects of day-to-day need satisfaction that cannot be accounted for by trait need satisfaction (cf. Schwartz & Stone, 1998).

The MLM results offered some support for the sensitization model, in that persons higher in each trait variable showed higher daily well-being when daily activities supported the satisfaction of each need. Reis et al. (2000) suggested that higher dispositional need satisfaction might reflect a heightened sensitivity to those needs and therefore a greater responsiveness to environmental events relevant to them. Conversely, lower trait scorers may be comparatively insensitive to such events, which then have less impact on psychological well-being. This person \times situation dynamic surrounding the manifestation and consequences of need satisfaction is consistent with both Bem and Funder's (1978) template matching model and Coté and Moskowitz's (1998) behavioral concordance model, which also recognize that responsiveness to situations, and the outcomes of that responsiveness, are guided by dispositional features. However, it is notable that in none of the interactions tested by Reis et al. (2000) was there a negative slope for those low in trait need satisfaction; therefore, while those more highly "traited" in need satisfaction showed higher well-being when their needs were satisfied on a day-to-day basis, those dispositionally low in need satisfaction also generally benefited, but simply not as much, when they had experiences of autonomy, competence, and relatedness. In sum, sensitization effects accounted for some added variance in well-being, atop the main effects expected by a model of basic psychological needs.¹

Both of the studies reviewed in this section also shed light on the weekly cyclicity of well-being, or the noteworthy tendency for persons to exhibit higher positive affect and lower negative affect on weekends. The two studies' results suggested that weekends were characterized by relative increases in fulfillment of basic psychological needs, and the enhanced satisfaction of these needs explained a significant proportion of this "weekend effect."

A third study examining need satisfaction and its relation to ongoing well-being focused on young athletes in the high-pressure world of competitive sport (Gagné, Ryan, & Bargmann, 2003). While recognizing that psychological and physical benefits can derive from participation in organized athletics, researchers have also documented mood disturbances and damaged self-esteem in children and teenagers experiencing high performance pressure (e.g., Davis, 1997). Of long-standing interest to motivation researchers, as well as parents, teachers, coaches, and other motivators, is how healthy motivation, and, by implication, well-being can be facilitated. Gagné et al. applied multilevel modeling to examine whether need satisfaction derived from athletic involvement was related to well-being outcomes in young female gymnasts. They also examined whether external motivational influences—that is, the motivational climate surrounding athletic participation—affected need satisfaction, motivation, well-being, and the relations between them. Specifically, Gagné et al. conducted a 4-week diary study with 33 female gymnasts aged 7 to 18 years to investigate the predictive relations of perceived parent and coach motivational supports to the athletes' enduring and daily motivation and need satisfaction. They also examined how daily motivation and need satisfaction during practice affected the athletes' well-being.

At the beginning of the study, the athletes completed a measure of self-regulation for gymnastics, which assessed the relative autonomy of their involvement in the sport. They also completed measures of perceived parental and coach autonomy support. At the beginning of each of 15 practices, the gymnasts rated reasons, which varied in degree of autonomy, for attending the practice. At the start and close of each practice, they completed a measure of positive and negative affect, self-esteem, and subjective vitality. A report on need satisfaction during practice was also completed at the end of each practice.

Gagné et al. (2003) first established, using aggregated diary data, that the more autonomy-supportive parents and coaches were perceived to be, the more autonomously motivated was the athletes' sport involvement over time. Perceived autonomy support from coaches also predicted higher levels of need satisfaction over the course of the 15 practice sessions. Gymnasts whose sport involvement was more autonomously regulated showed better well-being over time.

MLM using maximum likelihood estimation found that the relative autonomy of day level (Level 1) incoming, or prepractice, motivation was related to incoming well-being, particularly lower negative affect and both higher vitality and self-esteem. The strongest predictor of Level 1 change in well-being from pre- to postpractice (in which prepractice well-being was included in the equation to control for initial level) was whether each of the needs for autonomy, competence, and relatedness were satisfied during practice. Perceived enduring autonomy support from parents and coaches assessed at the beginning of the study (Level 2) did not moderate these results.

The results of the multilevel investigations reviewed thus far suggest three primary conclusions: First, need satisfaction varies on a day-to-day basis above and below personal baseline levels, and second, these fluctuations have significant consequences for day-to-day well-being. Indeed, Sheldon et al. (1996) and Reis et al. (2000) specifically showed that such variations had influence above and beyond what traits could explain. Finally, the significance of the effects of autonomy, competence, and relatedness at both between- and within-subjects levels of analysis is consistent with SDT's position that each of these three psychological needs has a unique and important impact on well-being, whether examined as a trait characteristic, as intraindividual variation across time, or as interindividual differences in intraindividual experience.

Value Orientation and Collective Well-Being

The interest in active, growth-oriented processes that characterizes SDT has been applied not only to personal well-being but also to social and collective well-being. Sheldon and colleagues have explored the role of individual intrinsic and extrinsic value orientations in the preservation of a natural resource (Sheldon & McGregor, 2000) and in prosocial behavior (Sheldon, Sheldon, & Osbaldiston, 2000). Intrinsic values are theorized to reflect basic psychological needs and include the desire for personal development, affiliation with others, and community involvement (Ryan, Sheldon, Kasser, & Deci, 1996). Extrinsic values include the desire for wealth, attractiveness, and fame, and endorsement of such values is believed to reflect a disconnection from, and lack of fulfillment of, basic

psychological needs. Past research has demonstrated that a greater weight given to extrinsic relative to intrinsic values is associated with poorer psychological adjustment, lower subjective well-being, and health risk behavior (e.g., Kasser, 2002; Kasser & Ryan, 1993, 1996).

Sheldon and McGregor (2000) investigated whether these value orientations would have consequences for collective (ecological) well-being as well. Groups of four participants with similar value orientations (all extrinsic and all intrinsic), and groups with mixed orientations (half intrinsic, half extrinsic) were first formed. Each type of group then engaged in a resource dilemma task involving timber harvest in a national forest. This task represented a "tragedy of the commons" paradigm, wherein the procurement of resources in the short term could have long-term effects. It was expected that those with relative intrinsic value orientations would show greater care in preserving the resource, given their stronger sense of community and identification with prosocial norms. Those more extrinsically oriented were expected to deplete the resource more quickly, given their focus on personal material acquisition.

The dependent variable in this study was the total amount of timber that groups, and participants within groups, would harvest over the course of the dilemma task. Each group member submitted a harvest bid each year for 25 years, or until the resource was depleted. MLM using a weighted least squares approach was used to test the hypotheses. Because groups were formed using a median split on individuals' value orientation scale scores, the use of MLM was crucial to separate and thereby "deconfound" the two levels of effect. The following equation was constructed:

$$\text{HARVEST}_{ij} = \beta_{B-P} \text{VO}_i + \beta_{W-P,i} \text{VO}_{ij} + \beta_{\text{Int}} (\text{VO}_i \times \text{VO}_{ij}) + \alpha_i + \varepsilon_{ij} \quad (4)$$

Interestingly, Sheldon and McGregor (2000) hypothesized, and found, contrasting effects of value orientation at the group level (Level 2, represented by $\beta_{B-P} \text{VO}_i$) and at the individual, within-group level (Level 1, represented by $\beta_{W-P,i} \text{VO}_{ij}$). At Level 1, the study showed that, compared to more intrinsic persons, those more extrinsically oriented made more total profit, because they harvested more timber than their group mates. In contrast, however, Level 2 re-

sults showed that extrinsic groups harvested the least over time, followed by mixed-value groups, and then intrinsic groups, who harvested the most over time because their forest resource was not as quickly depleted by high profit taking. These multilevel results demonstrated that individual self-restraint, rooted in intrinsic values, can benefit a social group, while self-interest can help to maximize personal gain but at the expense of collective well-being.

In a second study, Sheldon et al. (2000) permitted participants to assort themselves into groups, who then participated in an iterated prisoner's dilemma (PD) game, in which they could choose to cooperate or to get ahead over five rounds of play. Results showed, first, that individuals tended to assort themselves into groups of similar value orientation—that is, extrinsics with extrinsics, and likewise for intrinsics. The primary multilevel model was structured identically to Equation 4. The analysis revealed, paralleling the results of the previous study, that individuals scoring higher in extrinsic value orientation made more defection choices during the PD game and thus scored more points than those less extrinsic or those intrinsic in orientation. However, Level 2 results showed that groups with high mean levels of intrinsic values scored more points overall than did groups with lower average levels of intrinsic values. In neither this study nor the Sheldon and McGregor (2000) study did the relation between individual values and outcome vary as a function of the mean level of group value orientation (i.e., there were no Level 1 \times Level 2 interaction effects). Thus, the effects of individual-level values and group-level values were independent of each other. These results showed, as before, that selfish gain often came at the expense of collective loss, while altruists accrued both personal and collective benefits, at least when making choices in the company of other prosocial actors.

Theoretically, the multilevel approach taken to these data support hierarchical conceptions of adaptive fitness, in which individuals' fitness level is determined by their behavior within social groups, as well as by the behavior of the aggregate to which those individuals belong (see Sheldon & McGregor, 2000, for review). The results of these studies also support the use of the multilevel approach to explore the long-term social consequences and viability of individual traits, and the behavior that follows from them (Sheldon & McGregor, 2000).

The Role of Mindfulness in Supporting Healthy Motivation

As already noted, there has been long-standing research interest in how social and other contextual supports for autonomy, competence, and relatedness can facilitate self-motivation and well-being (e.g., Gagné et al., 2003). Recent research using MLM has begun to explore the third primary question of interest to SDT researchers noted earlier, namely, "What psychological supports exist for the self-regulation of need satisfaction?" This question is important because even when environments provide an optimal motivational climate, healthy regulation requires a reflective consideration of one's behavior and its fit with personal values, needs, and interests (Ryan & Deci, 2004). Several influential organismic and cybernetic theories of behavioral regulation place central emphasis upon attention and awareness, the capacity to bring consciousness to bear on present events and experience (e.g., Carver & Scheier, 1998; Deci & Ryan, 1985; Varela, Thompson, & Rosch, 1991). Recent research in our laboratory has focused on the concept of *mindfulness*, a quality of consciousness that pertains to an open or receptive attention to and awareness of what is taking place in the present (e.g., Brown & Ryan, 2003).

Several studies have shown that mindfulness conduces to autonomous behavior (see Brown & Ryan, 2004a, for review). For example, Brown and Ryan (2003) asked samples of students and working adults to complete a self-report dispositional measure of mindfulness developed by the authors, called the *Mindful Attention Awareness Scale* (MAAS). Individuals then recorded the relative autonomy of their behavior at the receipt of a pager signal three times a day over a 2-week (students) or 3-week (adults) period. MLM of unconditional means (see Singer, 1998) first established that there was significant between- and within-subjects variation in day-to-day autonomy. Next, the effects of four important time-series variables, namely, time of day (TIME), day of study (DAY), weekly cyclicity (WKCYCLE), and serial autocorrelation (AUTOCORR), were factored in to produce the following equation:

$$\begin{aligned} \text{AUTO}_{ij} = & \beta_{B-p}\text{MAAS}_i + \beta_{W-p,i}\text{TIME}_{ij} \\ & + \beta_{W-p,i}\text{DAY}_{ij} + \beta_{W-p,i}\text{WKCYCLE}_{ij} \\ & + \beta_{W-p,i}\text{AUTOCORR}_{ij} \\ & + \alpha_i + \varepsilon_{ij} \end{aligned} \quad (5)$$

The $\beta_{W-p,i}\text{WKCYCLE}_{ij}$ coefficient is represented by a cosine function, which is an alternative way to assess the day-of-week effect to the dummy variable approach used by Sheldon et al. (1996) and Reis et al. (2000). Because Brown and Ryan (2003) were not interested in specific day-of-week (e.g., weekend) effects, the trigonometric approach was used, which allows for fewer terms in model equations. Also in Equation 5, the inclusion of $\beta_{W-p,i}\text{AUTOCORR}_{ij}$ permitted an assessment of first-order lagged effects of within-person autonomy, and is an alternative to the dependent variable lag coefficient used by Sheldon et al. (1996) and Reis et al. (2000; see Equations 2 and 3).² In the present study, MLM using restricted maximum likelihood estimation found that more mindful individuals in both samples showed higher levels of autonomous behavior on a day-to-day basis.

This study also included a state measure of mindfulness, such that individuals rated how attentive they were to what was occurring during the activities that they also rated their relative autonomy. Two additional terms were added to Equation 5 to examine the role of state mindfulness on day-to-day autonomy: $\beta_{W-p,i}\text{MAAS}_{ij}$ represented the main effect, and $\beta_{\text{Int}}(\text{MAAS}_i \times \text{MAAS}_{ij})$ represented the trait \times state mindfulness interaction. MLM showed that momentary variation in mindfulness was related to fluctuations in autonomy. Specifically, those who were more mindfully attentive to their activities also experienced more autonomous motivation to engage in those activities. The effects of trait (Level 2) and state (Level 1) mindfulness on autonomy were independent in this study, indicating that the regulatory benefits of mindfulness were not limited to those with a mindful disposition. Other research (Brown & Ryan, 2004b) examining day-to-day competence and relatedness has found similar results, providing evidence that trait and state mindfulness offer an important, ongoing internal support for psychological need satisfaction. Moreover, those activities that were associated with greater mindfulness not only fostered autonomy; they also were related to within-person enhancements in well-being.

Future Directions in the Modeling of Motivational Processes

MLM techniques present a number of opportunities and challenges for future research in motivation, several of which we briefly discuss here.

More Intensive Sampling of Day-to-Day Behavior

As is apparent from this review, much of the research modeling motivational processes from within an SDT framework has used diary methods of various kinds. Optimally, these methods have the advantage of capturing psychological and behavioral events and experiences close to the time of their occurrence, and the use of multiple records of experience greatly enhances measurement reliability and statistical power. However, most of the diary research in motivation reviewed here has not taken full advantage of opportunities to model the dynamics of internal experience and behavior, and increasing the sophistication of diary studies would serve important methodological and conceptual purposes. More intensive sampling—multiple times per day rather than just once per day and over longer time intervals than a week or two—would permit the study of diurnal (daily) and septurnal (weekly) dynamic (e.g., cyclic) patterns. For example, there is some evidence for regular daily (Brown & Ryan, 2003) and weekly (Brown & Ryan, 2003; Reis et al., 2000) cyclicity in autonomy and relatedness. Lagged or autocorrelated effects can also be studied in more detail with the collection of measures on a greater than once-per-day basis. Some multilevel modeling software (e.g., SAS PROC MIXED; SAS Institute, 1992, 1997) is well-suited to the incorporation of time series variables like time of day, day of week, day of study, and serial autocorrelation, all characteristics that frequently appear in time-series data and explain meaningful variance in day-to-day outcomes (West & Hepworth, 1991). Even when interest is not specifically in such variation, time-series variables should be included in multilevel models of day-to-day behavior for control purposes.

More intensive sampling would also permit the study of social and other situational influences on day-to-day motivational processes and behavior. For example, the role of supports for need satisfaction has been understudied in day-to-day contexts. Given evidence that needs are often dependent on social contexts for their expression and fulfillment, and need fulfillment conduces to well-being, it is important to understand how specific kinds of social and other daily activities, and the reasons for engaging in those activities, contribute to dynamic person \times situation models of motivation, motivational supports, and the positive well-being consequences that follow from them (Reis et al., 2000).

Effects of Interventions to Enhance Self-Motivation

The majority of research using diary methods in the study of motivation, and a variety of other domains of behavior, has been interested in obtaining detailed pictures of naturally occurring behavior. For reasons already noted, there has been good reason for this. Yet the combination of diary methods and multilevel modeling presents a rich opportunity to examine the real-world effects of clinical, educational, organizational, and other interventions on motivational processes (cf. Deci, Connell, & Ryan, 1989; Williams, Gagné, Ryan, & Deci, 2002). In interrupted time-series designs, for example, a target behavior is recorded repeatedly before (baseline), sometimes during, and following an intervention. Multilevel analysis can then test whether (a) the parameters of the behavior (Level 1) change in response to the Level 2 intervention, as compared to control or other intervention conditions, and (b) whether the effects of the intervention are conditioned by subject and contextual factors. Smyth, Soefer, Hurewitz, and Stone (1999) provided an example of a multilevel analysis of interrupted time-series data in the health domain.

Laboratory-Based Investigations of Motivational Processes

Research in SDT has long been interested in the study of motivation under controlled laboratory conditions (e.g., Deci & Ryan, 1985). Yet little attention has been paid to motivational processes unfolding in real-time laboratory contexts. Sheldon and McGregor's (2000) multilevel analysis of iterated behavioral choices in a resource dilemma task represents an important touchstone for such work, as it models how behavior can change over time in response to both personality and social influences. As alluded to in our discussion of future intervention research, examination of the effects of experimental manipulations on motivational dynamics is well suited to multilevel analysis.

Maximizing the Use of Multilevel Analyses

Beyond the research design possibilities that MLM affords are opportunities to make more complete use of multilevel analyses and statistics. For example, aside from using model parameter

estimates, motivation researchers are encouraged to use effect variance estimates, which reflect the estimated variance accounted for by modeled effects within the population. Covariance estimates indicate how much the model intercepts and slopes vary across subjects (or schools, organizations, etc.). Significant covariance in a slope parameter, for example, can point to meaningful individual differences in the covariation between a predictor and outcome (see Singer, 1998). Beyond testing for main effects at each level of a multilevel model, as well as interactions within and across levels, researchers can also use multilevel models to test for mediational effects, using the strategies that are used in ordinary least squares regression (e.g., Baron & Kenny, 1986; MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002), with modifications made to accommodate multilevel testing. Of interest, for example, would be tests of whether need satisfaction mediates the relation between internal or external motivational supports and a variety of motivational outcomes examined over time, including academic or work performance, creative output, social behavior, and well-being.

Conclusion

Because motivation is a dynamic phenomenon that is sensitive to both person and situational changes, it is particularly well suited to multilevel modeling research. In this chapter, we have attempted to show that there is a natural pairing between expanded longitudinal designs, including daily experience and lab-based methods, and multilevel modeling approaches to the study of motivational processes. While this body of work is still small, important findings have been uncovered: The fulfillment of basic psychological needs fluctuates on a day-to-day basis, and subjective well-being is robustly affected by these fluctuations. Other research, discussed only briefly here, indicates that well-being and optimal functioning show intraindividual fluctuations from relationship to relationship and life role to life role. SDT research has shown that this fluctuation in functioning corresponds to changes in supports for psychological needs across these relationships and roles (e.g., La Guardia et al., 2000; Ryan, La Guardia, Solky-Butzel, & Kim, 2005).

Although considerable research has been devoted to the main effects of traits and types of daily events and situations on wellness, multilevel

research reviewed herein suggests that day-to-day well-being is contingent on finding personal value or meaning in everyday activities (Reis et al., 2000; see also Sheldon & Kasser, 1995, 1998). Research also suggests that collective or group well-being depends on personal values tied to basic psychological needs. Finally, more recent research indicates that the quality of consciousness known as mindfulness can serve as a dispositional and situational support for basic need fulfillment.

There is still considerable potential to be tapped in the exploration of substantive and analytic questions on motivational processes, and we have outlined several possibilities for future research in multilevel modeling. While beyond the scope of this chapter, it is also worth noting that there are rich research opportunities in joining major analytic forces, such as multilevel modeling with latent variable modeling (e.g., Chou, Bentler, & Pentz, 2000). A defining feature of the recent progress in motivation research, and in the field of psychology as a whole, has been a rapid increase in the sophistication of its research methods and analytic tools. Researchers willing to take a close look at motivational processes through the lens of multilevel and other cutting-edge approaches will do much to expand our basic and applied understanding of this central feature of human behavior.

Notes

1. Reis et al. (2000) also tested gender main effects and interactions with both Level 2 and Level 1 need satisfaction. None of the results qualified the results reported here.

2. First-order autocorrelation is one of the simplest autoregressive error structures and is commonly termed AR(1). When observations on some variable are equally spaced in time, this structure assumes that the residuals for adjacent observations will be most highly correlated, the residuals for observations two intervals apart will be less highly correlated, and so on. There are also continuous-time versions of the usual AR(1) error structure that are capable of assessing first-order autocorrelation when observations are unequally spaced in time (see Schwartz & Stone, 1998).

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