This Time, It's Real: Affective Flexibility, Time Scales, Feedback Loops, and the Regulation of Emotion

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Abstract

Because both emotional arousal and regulation are continuous, ongoing processes, it is difficult, if not impossible, to separate them. Thus, affective dynamics can reveal the regulation of emotion as it occurs in real time. One way that this can be done is through the examination of intra- and inter-personal flexibility or the transitions into and out of affective states. The present paper reviews and then expands upon the Flex 3 model of real-time dynamic and reactive flexibility, specifying the ways in which individual differences in emotion regulation manifest as differences in flexibility. The differences in results at the real-time scale versus diurnal variability are also discussed within an emotion regulation framework.

Keywords: Flexibility; Affect; Emotion Regulation; Inertia; State Space Grids

Emotions arise through dynamic processes involving cognitive appraisals, physiological arousal, and expressive behavior (Hollenstein & Lanteigne, 2014; Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005). A common conceptualization of this process is as positive feedback where these components of the emotion system mutually amplify each other to create emotional states. However, emotions also dissipate through interactions involving these same mechanisms (Butler, Gross, & Barnard, 2014; Hollenstein & Lanteigne, 2014). Thus, the feedback loop is completed through the complementary dampening or maintenance of interactions among emotion system components through negative feedback. Moreover, positive and negative feedback processes do not stop and start but rather are continuous and ongoing, such that at no point during an emotional episode can one say that arousal or regulation is not occurring (Kappas, 2011; Thompson, 2011; Thompson, Lewis, & Calkins, 2008). Despite a broad theoretical acceptance of feedback loop explanations of emotions (e.g., Carver, this issue), empirical approaches largely consider regulatory processes as separate from emotion, as strategies or actions implemented to control emotional arousal in a hammer-and-nail fashion (e.g., Cole, Martin, & Dennis, 2004). This theory-research divide fails to integrate the feedback loop explanation into empirical methodology, neglecting that “emotion and regulation are one” (Kappas, 2011, p. 23). One implication of emotional dynamic feedback processes is that individual differences in emotionality – the occurrence, persistence, and dissipation of emotional states – can be observed as affective dynamics in naturalistic situations.

In the present paper, I argue that affective dynamics are one way to measure emotional processes as an integrated system of both positive and negative feedback components – emotion and regulation functioning as one system. Specifically, I will elaborate upon and extend the Flex 3 model of affective flexibility (Hollenstein, Lichtwarck-Aschoff, & Potworowski, 2013) to articulate how the dynamics of real-time affect correspond to competent emotion regulation and socioemotional functioning. Moreover, to situate this approach within the broader field of affective dynamics and this special issue, the distinction between time scales of measurement (i.e., real-time versus experience sampling) is emphasized. In the next section, I will first describe the dynamic systems conceptualizations upon which it is based. Then, I will review the salient aspects of the Flex3 model for the present purposes. Following that will be a discussion of the similarities and differences of real-time versus diurnal variability with respect to how these relate to emotion regulation. Finally, I will conclude with a summary and take-home messages to guide future research.

Affect Dynamics and Attractors in State Space

Approaching human behavior from a systems perspective is not new but has become more mainstream in the past decade or two (Hollenstein, 2011), particularly in affective science (e.g., Levenson, 1999; Lewis, 2005; Scherer, 2010). Conceptually, social groups (e.g., parent-child dyads), individuals, or processes within individuals (e.g., emotions) are considered complex, open systems with all the characteristics of any other complex, open systems found in nature. One of these characteristics is that although every system has myriad possible states available, only some of these states ever arise. States that recur frequently and persist for longer durations are called attractors – “absorbing” states that influence the trajectory of the system. The configuration of system attractors can be represented on a state space – the space of all possible states a system could be in at any given time.

Figure 1 is an illustration of the state space of the emotion systems of two individuals. This representation is in two dimensions for illustrative convenience although theoretically there may be other dimensions that are necessary for fully describing the emotion system (e.g., Carver, this issue; Fontaine, Scherer, Roesch, & Ellsworth, 2007). Further, consistent with dimensional approaches to emotion (e.g., Bradley, Codispoti, Cuthbert, & Lang, 2001; Russell, 2003), the dimensions shown here are valence and arousal. Although all combinations of valence and arousal are possible (i.e., the state space), not all of these ever manifest. Moreover, the states that recur most frequently and persist for longer durations are represented by the circles (i.e., attractors) in the state space. Often attractors on a state space are described as a topographical landscape with the attractors as valleys. The current state of the system is further conceptualized as a ball rolling through that landscape, which requires less energy to fall into, and more energy to emerge out of, attractor basins. The depth and diameter of different attractor regions represent the strength of influence or the "pull" of each on the system's trajectory. In Figure 1, these differences in attractor strength are represented by size and darkness.

[Insert Figure 1 about here]

With these concepts in mind, it is possible to compare these two state spaces. Figure 1A is configured by several attractors, none of which are very large or deep. Figure 1B has only a few attractors, in particular one large, deep attractor. If we were to trace the trajectory, or sequence of system states, on these state spaces, Figure 1A would be characterized by more frequent changes and shorter durations in any particular state (i.e., it would take relatively less energy to move out of any particular state). Figure 1B, in contrast, would switch in and out of states less often and frequently remain stuck in the one large attractor state (i.e., it would take relatively more energy to move out of deep attractors). Given perturbations from the environment, the individual represented by Figure 1A could be described as more flexible – able to dynamically adapt to the emotionally-evocative vicissitudes of life – than the individual represented by Figure 1B[1]. Thus, aspects of flexibility, which can be captured through a sequence of affective states that change over time, reveal the result of the underlying positive and negative feedback process responsible for that state space configuration. The Flex 3 model, described next, was developed from this dynamic systems conceptualization of the emotion system as attractors on a state space. Here, I elaborate on regulatory aspects of the model not described or fully fleshed out in its original presentation (Hollenstein et al., 2013). Specifically, in this paper the connections between Flex3 and emotion regulation are explored based on the implications of the inseparability of emotion and regulation (Kappas, 2011) and differences between real-time dynamics and changes in diurnal affect observed from intermittent sampling methods.

The Flex 3 Model

The Flex 3 model (Hollenstein et al., 2013) depicted in Figure 2 differentiates between three ways to define and operationalize flexibility according to the time scale in which change occurs. For the current purposes, only the micro, real-time scale of dynamic flexibility and the meso, context-to-context scale of reactive flexibility will be discussed (the omitted third time scale is developmental, reflecting changes across months or years). Dynamic flexibility refers to the moment-to-moment changes in affect within a given context. For example, during an emotionally salient interaction (e.g., conflict) the shifts into and out of affective states reflect adaptive, competent regulation. Dynamic flexibility requires both the inhibition of the current state (negative feedback) and the activation of the subsequent state (positive feedback). That is, the interplay of positive and negative feedback processes within the emotion system produces dynamic flexibility of affect. Thus, a relatively greater propensity to transition into and out of states is considered flexible whereas a relatively lower tendency to make these shifts is considered rigidity. Moreover, the underlying attractor landscape can be inferred from observed affective dynamics as illustrated in Figure 1A as a flexible system and Figure 1B as a rigid one.

[Insert Figure 2 about here]

At a slightly longer time scale is reactive flexibility, responses to qualitative shifts in environmental demands. Flexibility at this scale can be seen in the ability to change both affective content (e.g., anger, joy) and patterns (e.g., dynamic flexibility) in response to changes in location, interaction partners, or other elicitors. For example, flexibility in the form of interpersonal repair can be seen in the ability to shift from negative to positive affective patterns after a conflict has been resolved (Granic et al., 2007). The relations between regulation and dynamic and reactive flexibility are described in more detail below.

Dynamic Flexibility

There are many ways to measure real-time variability, however, as Trull, Lane, Koval, & Ebner-Priemer (this issue) argue, variability by itself is insufficient without some means of indexing the temporal dependencies of moment-to-moment affect dynamics. There are two approaches in particular that demonstrate dynamic flexibility well. The first is real-time emotional inertia (Suls, Green, & Hillis, 1998), which has been extensively explored by Kuppens and colleagues (Koval, Kuppens, Allen & Sheeber, 2012; Koval, Pe, Meers, & Kuppens, 2013; Kuppens, Allen & Sheeber, 2010; Kuppens, Sheeber, Yap, Whittle, Simmons, & Allen, 2012). Emotional inertia is the tendency to persist in emotional states, particularly negative states, as indexed by the autocorrelation of affect. Thus, inertia is another term for rigidity. Using this approach, greater *real-time* inertia[2] has been positively correlated with regulatory difficulties and depression (Koval et al., 2012; Koval et al., 2013; Kuppens, et al., 2010; Kuppens et al., 2012). This line of research provides strong evidence that dynamic rigidity corresponds to dysregulation of affect. From a feedback loop perspective, the resistance to change of real-time inertia or rigidity reflects an emotion system in which the negative feedback processes are less able to counteract the arousal of positive feedback processes to bring the system into relative balance.

The second approach to dynamic rigidity has been mostly inter- rather than intra-personal[3]. Using state space grid analysis (Hollenstein, 2013; Lewis, Lamey, & Douglas, 1999), several studies have explored the dynamic flexibility of *dyadic* affect. These studies have ranged from the face-to-face still face interactions between infant and mother (Sravish, Tronick, Hollenstein, & Beeghly, 2013) to parent-adolescent interactions (Hollenstein, & Lewis, 2006), and spousal interactions (Butler, Hollenstein, Shoham, & Rohrbaugh, 2013). Using parent-child interactions as an example, Figure 3 depicts two hypothetical state space grids. As with Figure 1, the state space grid on the left illustrates a dyadic system with greater variability and a more rigid dyadic system on the right. The dimensions of the state space are 5 possible levels of affect for each dyad member: High Negative, Low Negative, Neutral, Low Positive, and High Positive. Each cell on the grid represents a unique dyadic state (e.g., Mother Neutral with Child Positive). The size of the plot point indicates the duration of each affective event and the lines connect each temporally adjacent event with a line. From this graphical depiction it is possible to extract several indices. Comparing the two trajectories plotted on these state space grids, the one on the left covers more of the state space (dispersion), has more lines (transitions), and smaller plot points (smaller average durations). For dynamic flexibility, two of these indices in particular are of interest: transitions and average event durations. A dynamically flexible interaction would be characterized by higher transitions and lower average event durations (Figure 3a), rigidity by the opposite (Figure 3b). That is, the necessary inhibition of one emotional state in order to allow another to arise – the regulatory function of negative feedback – enables more changes in affect in real time.

[Insert Figure 3 about here]

There are several studies that demonstrate how dynamic flexibility, operationalized as transitions and average event durations, reflect individual differences in regulation. First, lower flexibility occurs in contexts with greater negative affect when regulatory challenges are more demanding (Hollenstein & Lewis, 2006). Second, children who persisted with clinical levels of externalizing problems even after an intensive treatment program have interactions with their parents that were more rigid than the dyads with children for whom treatment was successful (Granic, O'Hara, Pepler, & Lewis, 2007). Furthermore, in this same sample prior to treatment, children's neural processing during an emotional go/no-go task was assessed in terms of dorsal (regulation through strategic cognitive control) versus ventral (immediate, reactive regulation) processing of frustration due to loss of points in the task (Granic, Meusel, Lamm, Woltering, & Lewis, 2012). Greater parent-child flexibility predicted over 40% of the variance in the degree to which children used dorsal rather than ventral means of regulating their frustration during the task. This study provides more direct evidence of how individual differences in regulation can be observed as dynamic interpersonal flexibility.

Another approach to the variability of affect and attractors is based on Russell's concept of "core affect" (Russell, 2003). Kuppens and colleagues developed "DynAffect," a theoretical account of affect dynamics within a valence-arousal state space (Kuppens, Oravecz, & Tuerlinckx, 2010), that is similar to the conceptualization of dynamic flexibility presented here. The DynAffect model predicts that individuals have an "affective home base" that functions as an attractor. Individual differences in affect dynamics are then reflected in the temporal changes in arousal and valence that create a trajectory that moves in and out of the home base attractor. Greater variability of valence was associated with negative dispositions (e.g., neuroticism, negative affect) and the attractor strength on the arousal dimension was associated with better reappraisal. The similarities and differences between DynAffect and Flex3 are worth considering further. First, only one attractor was predicted to exist in the DynAffect model– each individual's "home base"of valence and arousal – which is not consistent with systems perspectives that emphasize the ubiquitous multistability (i.e., multiple attractors) in complex systems (Granic & Hollenstein, 2003; Lewis, 2005). Given that affective states are ipsative, if an individual is in a non-neutral (i.e., non-home-base) state then he or she is necessarily not in the home base state. Thus, the relative weakness of a home base attractor means that there are other attractors at more extreme values of valence and arousal. The Flex3 model does not suppose a single attractor for any individual or dyad, and the number, location, and strength of these other attractors influence a trajectory away from the "home base." For example, an individual who tends to get stuck in angry states (i.e., high real-time inertia of negative affect) would take longer to return to home base. Second, DynAffect, as presented to date, does not account for context. The presumption is that measurements taken across many days will likely catch some variability of context. This is probably true but not precise. The studies that have been used to show both real-time inertia (Koval et al., 2012; Koval et al., 2013; Kuppens, et al., 2010; Kuppens et al., 2012) and dynamic flexibility (e.g., Butler et al., 2013; Granic et al., 2007; Granic et al., 2012; Hollenstein, & Lewis, 2006; Sravish et al., 2013) have measured affect within emotionally charged contexts (e.g., interpersonal conflict) where non-neutral (non-home-base) affect is normative and functional. Moreover, Flex3 addresses context directly through the concept of reactively flexibility (adaptations to changes in context), described in detail in the next section. There is a third difference between the two models that may explain differences between the two models: time scale. Kuppens et al. (2010) test DynAffect through experience sampling methods – momentary assessments at random points throughout the day. Thus, DynAffect was not presented as a real-time model but a depiction of temporally non-adjacent affective states across longer time scales. This difference between real-time and longer time scales turns out to be quite crucial for affect dynamics. Thus, the Flex 3 model emphasizes that these scales must be considered separately, as discussed in detail later. Taken together, the DynAffect model and Flex3 are both attempts to understand variability and attractors as meaningful indices of emotional functioning, albeit with different evidence base and underlying assumptions.

Reactive Flexibility

In the original formulation of the Flex 3 model, reactions to significant qualitative shifts in context and/or goals constituted a manifestation of flexibility that is different from real-time dynamics (Hollenstein et al., 2013). This ability to adaptively shift attention, affect, or patterns of behavior as a new situation requires is actually the more common way that flexibility has been conceptualized (Schultz & Searleman, 2002). From a regulatory feedback standpoint, flexibility at this scale requires the inhibition of the previous affective states to allow for different states to occur. There are myriad examples from everyday life, for instance: finding out a manuscript was rejected just before starting a lecture on positive affect or having an emotionally difficult conversation with a spouse and then an upset child comes into the room needing positive soothing. Thus, the ability to change affective behavior and appraisals to accommodate the vicissitudes of context-to-context change is flexible and adaptive and associated with resiliency and positive outcomes (Bonanno, Papa, Lalande, Westphal, & Coifman, 2004; Cheng, 2001).

Reactive flexibility has been demonstrated clearly in A-B-A interpersonal interaction designs in several studies wherein parent-child dyads proceeded through a positive-negative-positive discussion topic sequence (e.g., plan a party, solve an interpersonal conflict, spend lottery winnings). Hollenstein & Lewis (2006) demonstrated that parent-adolescent negative affect was greatest during the conflict discussion, as would be expected, but also that dynamic flexibility (i.e., real-time transitions between dyadic affective states) was lower compared to the two positive discussions. Both of these result patterns indicated flexible responses to the positive and negative contextual demands. Granic and colleagues (Granic et al., 2007) went further by showing that reactive rigidity characterized parent-child dyads with poorly regulated externalizing children. Specifically, dyads with children who did not show improvement from an intensive behavioral intervention could not stop expressing negative affect during the third (positive) discussion, whereas those who did improve from treatment did. These less regulated dyads found it difficult to shift out of conflict to be able to playfully imagine what they could do with millions of dollars.

It is important to note that although the Flex 3 model distinguishes between dynamic and reactive flexibility, both are effectively real-time scaled. The difference lies in the width of the time windows within which affect is observed. The context-to-context shifts are between temporally adjacent contexts, not separated by windows of unobserved behavior as with experience sampling methods (e.g., Trull, Lane, Koval, & Ebner-Priemer, this issue). Hence, for both dynamic and reactive flexibility, transitions are the core feature. Furthermore, this real-time focus reflects the continuous nature of emotion regulation - feedback processes occurring at every moment affecting change in each of those moments. In contrast, any observations of affective dynamics that are based on temporally non-adjacent sampling intervals (e.g., experience sampling) cannot capture actual transitions but infer whether a transition has occurred simply because reports obtained hours apart did or did not differ. Thus, non-real-time observations are not just expanding the time window of observation but are necessarily proxy measures of the underlying real-time affect dynamics that give rise to these sampled states. In the original formulation of the Flex 3 model, affective dynamics at longer time scales, typically measured through experience sampling or momentary assessment techniques, were acknowledged in terms of variability but not integrated into the conceptualization of flexibility. In the final section, I will explore the connection between affective dynamics at longer time scales, dynamic and reactive flexibility, and regulatory processes.

Flexibility, Diurnal Variability, and Emotion Regulation

An interesting conundrum emerges from a first-glance contrast of real-time affective dynamics and affect variability across days and weeks. Studies using experience sampling (intermittent sampling several times a day) have shown a *positive* association between greater variability and a range of individual difference factors related to poor regulation including depression, anxiety, neuroticism, and borderline personality disorder (Ebner-Priemer et al., 2007; Eid & Deiner, 1999; Trull et al., 2008; Wichers et al., 2010). Emotional inertia derived from these sampling methods also has a positive association with well-being (Koval & Kuppens, 2012; Koval et al., 2012; Koval et al., 2013; Kuppens et al., 2010). Similarly, the DynAffect studies introduced earlier showed similar associations between variability and (low) self-esteem, and greater "home base" attractor strength associated with less rumination and more reappraisal. (Kuppens et al., 2010). How can this pattern of results be rectified with what seems to be an opposite pattern with dynamic and reactive flexibility (i.e., rigidity is associated with poor regulation)? There are several possible answers: differences between observation and self-report, time scale, and the functions of emotion regulation.

The simplest contrast between the two sets of results is that the evidence for dynamic and reactive flexibility has come from the observational coding of affect (Granic et al., 2007; Hollenstein & Lewis, 2006; Kuppens et al., 2010) whereas evidence for the positive associations of lower variability has come from self-reports (Eid & Deiner, 1999; Koval & Kuppens, 2012; Koval et al., 2012; Koval et al., 2013; Kuppens et al., 2010; Wichers et al., 2010). Depressed, anxious, neurotic, or low self-esteem individuals may be more likely to acknowledge and report a greater diversity of affective states (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003; Watson & Clark, 1984). This would result in a greater range of affect and a weaker “home base” attractor across days or weeks. To address the observation/self-report differences, future studies should examine either real-time self-reports of affect or observations of affect over long periods of time.

The second explanation is the issue of time scale. If individuals were observed continuously for several days and also prompted periodically to report their affective state, how well would these measurements at different time scales correspond? Taking previously reported results together, poorly regulated (e.g., depressed, anxious) individuals would be expected to be more rigid with fewer real-time transitions, higher inertia, and difficulty shifting affect from context to context compared to well-adjusted controls. At the same time, intermittently sampled self-reports would indicate greater variability of affect and weaker home base attractors. Fewer real-time transitions and higher inertia means that affective states persist for longer, though not forever. Eventually these states do change, just at a slower rate than controls. Longer durations of states makes them more memorable and salient and therefore more accessible for self-report. For example, imagine a conflict negotiation between spouses that ultimately gets resolved. One scenario would be that the frustration about not being heard persists for most of the conversation; another scenario would be that the frustration is fleeting. If the ecological momentary assessment occurred at the conclusion of the conflict, after a mutual resolution was achieved, an individual in the first scenario may be more likely to report a non-neutral affect but in the second scenario the frustration may pale in comparison to the current, contented state, which is what gets reported. Moreover, greater reactive rigidity – the decreased ability to shift out of negative affect when new contexts arise (e.g., emotional context insensitivity; Rottenberg, Gross, & Gotlieb, 2005) – would also increase the probability that any sampling moment would capture a non-neutral affect, even if the reporter was in a putatively positive context. Thus, greater rigidity in real time would increase the probability of a greater variability at the daily/weekly time scale due to a greater probability of non-neutral states.

Finally, emotion regulation may be a possible explanation of the differing results across time scales. In Gross' model of emotion regulation (Gross, 1998), there are several stages in the regulatory process: situation selection, situation modification, attentional deployment, cognitive change, and response modulation. All of these occur in real time and are part of both the up-regulatory positive feedback and down-regulatory negative feedback loops of the emotion system. Each of the components of regulation could be rigid or flexible. Again using the example of an individual considered dysregulated by dint of problems with depression or anxiety, consider each in turn. Rigid situation selection would manifest as avoidance or resistance to a wider range of situations, thus increasing the probability of negative affect across the course of a day or over several days. Consequently, situation modification would be limited by rigid negative affect, perhaps by eliciting negative reactions from others, thus fulfilling the negative prophecy of rigid situation selection. Attentional deployment is the first regulatory action to emerge in development and may be the most basic engine of regulatory flexibility. Negative affective states, most notably fear and anxiety, restrict attentional focus through vigilance to threat. Similarly, cognitive reappraisals of the significance of emotionally-relevant events represent a flexibility of appraisal. Finally, rigid response modulation, most often identified as expressive suppression, has the ironic effect of making negative states persist (Butler, Egloff, Wilhelm, Smith, Erickson, & Gross, 2003). Thus, poorly regulated individuals may be rigidly regulated individuals, which can explain the tendency to exhibit fewer transitions and greater inertia within emotional context as well as a resistance to change affective patterns when contexts change. Again, this increased probability of non-neutral affect in real time would increase the overall range of affect detected at the longer time scales of intermittent experience sampling.

Conclusion

Measuring specific emotion regulation processes as they occur naturally in real time is difficult, to say the least. However, the temporal dynamics of affect can reveal individual differences in these emotional processes related to adaptive socioemotional well-being. The support for this claim was argued in several ways. First, the dynamic, feedback-loop account of emotion processes is a means to integrate two major perspectives, emotion theories and models of emotion regulation, that have developed somewhat independently of one another. Taking this integrated approach seriously, the idea that regulation is separate from emotion and functions as a somewhat external force that implements control over emotions is not tenable (Campos, Frankel, & Camras, 2004; Kappas, 2011; Thompson et al., 2008). Second, the implication of such a conceptualization is that transitions into and out of affective states occur as a result of the combination of positive and negative feedback forces in the emotion system. Finally, given these first two premises, system flexibility operationalized as the flexibility of either intra- or inter-individual emotion systems can be interpreted as the adaptive functionality underlying individual differences in socioemotional functioning.

There are at least a few imminent future research directions that can flesh out how flexibility and other affective dynamic indices can provide deeper insight into individual differences in socioemotional functioning. As mentioned earlier, one of these would be to examine affective dynamics at several time scales within the same participants (Trull et al., this issue). An example of such a design would be to have a combination of a lab observation, in which several emotion elicitation tasks occurred one after the other alternating by valence or emotion type, as well as a concomitant experience sampling of affect several times a day for a week or more. With such a design, dynamic and reactive flexibility in the lab could be compared directly to diurnal variability of affect in the real world. A second set of unexplored questions involves the comparison of intra- versus inter-individual dynamics of affect. While the Flex 3 model would not predict opposite results among these two systems (i.e., rigidity would be problematic both within and between individuals), there may be differential associations with other indices of socioemotional functioning. For example, it is possible that intra-individual rigidity would show stronger associations with internalizing processes but inter-individual rigidity would show stronger associations with externalizing behavior. Finally, so far flexibility indices derived from state space grids have not been compared directly with other indices like inertia. With these and other ideas for future research, we can begin to explore how flexibility of affect may be a window to emotion regulation.

In conclusion, the burgeoning field of affect dynamics has exposed the importance of the structure of affect, above and beyond affective content. Three critical aspects of affective dynamics need to be incorporated into research and theory on socioemotional functioning. The first is that affective dynamics reflect the complete feedback loop of the emotion system, the positive feedback of emotional arousal and the negative feedback of emotion regulation. The second is that dynamics of temporally adjacent states (i.e., the realm of emotion) should be considered separately from the dynamics observed with gaps of hours or days between measurements (i.e., the realm of mood), as these have so far yielded contrary results. Finally, from an integrated emotion systems perspective, real-time affective dynamics reflect individual differences in emotional/regulatory processes.

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Figure Captions

1. Two Hypothetical Affective State Spaces with Attractors: (A) several small (lighter colored) attractors indicate a flexible affective system; (B) the dominant single strong (darker colored) attractor indicates a rigid affective system.
2. Two Levels of the Flex 3 Model. At the real-time scale, changes in affect reflect the dynamic flexibility of the system. Reactive flexibility is the adaptive adjustment to new, temporally-adjacent contexts (adapted from Hollenstein, Lichtwarck-Aschoff, & Potworowski, 2013).
3. Two State Space Grids Depicting Mother-Child Interactions. Trajectory A shows more flexibility than trajectory B because it has more transitions (lines) among affective states and shorter average durations (smaller plot points).

Footnotes

[1] The possibility that this deep attractor could exist in a putatively positive state does not negate that the affective dynamic would still be rigid. At an extreme, a very strong positive attractor could occur during a manic episode. At more mundane day-to-day levels, this could reflect a person who is rigidly resisting negative states, even though negative emotions are functional and frequent enough to be typical.

[2] As will be discussed later, the distinction of real-time process and measures versus those that occur or are measured at non-real-time scales is an essential distinction.

[3] The Flex3 model does not make that distinction though most empirical evidence upon which the model is based comes from studies of interpersonal interactions. A recent study examined both dyadic flexibility and the individual flexibility of each dyad member and found that both approaches were related to the outcome (depression) but dyadic flexibility accounted for more of the variance (van der Giessen, et al., in press). Thus, slight differences intra- versus intra-individual flexibility may exist but are not necessary to distinguish for the current purposes.

Figure 1.

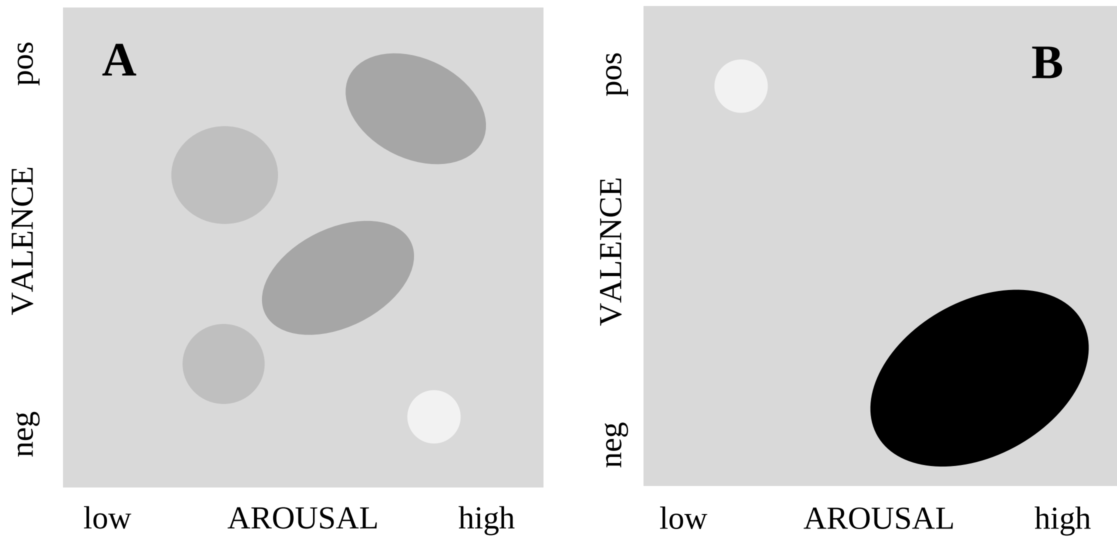
A
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Figure 2.

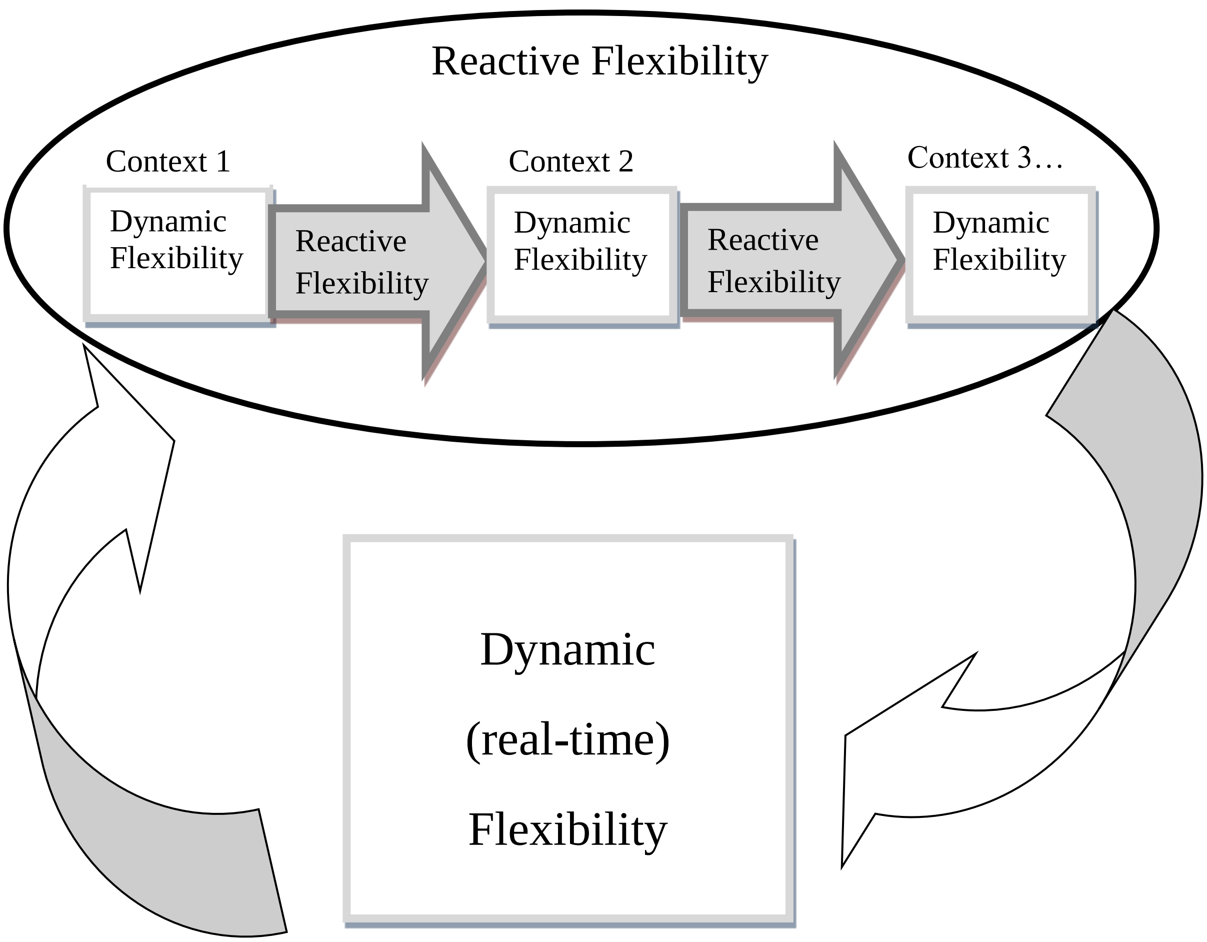
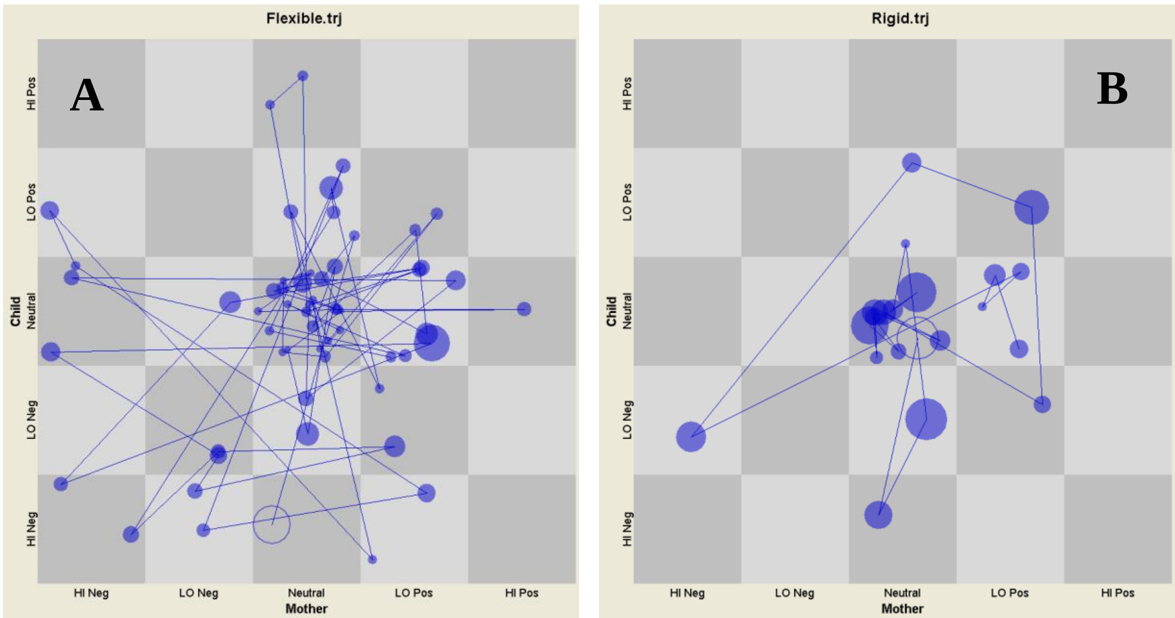

Reactive Flexibility
Context 1
Dynamic Flexibility
Reactive Flexibility
Context 2
Dynamic Flexibility
Reactive Flexibility
Context 3…
Dynamic Flexibility
Dynamic (real-time) Flexibility

Figure 3.



Flexible.trj
A
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Neutral
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Child
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Neutral
LO Pos
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Mother
Rigid.trj
B
HI Pos
LO Pos
Neutral
LO Neg
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Child
HI Neg
LO Neg
Neutral
LO Pos
HI Pos
Mother