

**INTERPERSONAL EMOTION DYNAMICS IN MOTHER-DAUGHTER  
DYADS DURING ADOLESCENCE**

by

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A thesis submitted to the Department of Psychology

In conformity with the requirements for the degree of Doctor of Philosophy

Queen's University

Kingston, Ontario, Canada

May, 2016

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## Abstract

The overarching goal of the current dissertation was to examine emotion dynamics in mother-daughter interactions across different positive and negative contexts, and their associations with psychosocial adjustment—relationship quality and internalizing symptoms. This dissertation was informed by theoretical approaches that assert that humans are a fundamentally social species (Beckes & Coan, 2011), and that momentary features of interpersonal dynamics coalesce into broader psychosocial adjustment (e.g., Granic, 2005). Real-time mother-daughter emotion dynamics were examined in three studies. In Study 1, emotional load sharing (i.e., the distribution of the burden of emotional distress among relationship partners) during adolescent social stress was examined as it related to physical and relationship closeness. Dyads were randomly assigned to either have physical contact or no physical contact during the social stress elicitation. Evidence of load sharing was observed among dyads who were in physical contact, independent of relationship quality. However, without physical contact, load sharing was only evident among dyads with higher relationship quality. Thus, emotional load sharing occurred at higher levels of physical and/or relationship closeness in mother-daughter dyads. Study 2 was an examination of individual differences in dyadic socioemotional flexibility—the ability to adjust emotions according to situational demands—across positive and negative emotional contexts. Higher flexibility within emotional contexts, and moderate levels of flexibility across positive and negative emotional contexts, were associated with higher mother-daughter relationship quality and lower maternal internalizing symptoms (e.g., depression, anxiety, and social anxiety). In Study 3, mother-daughter arousal transmission—the extent to which mothers and daughters “pick up” on each others’ physiological arousal—was examined across positive and negative emotional contexts. Daughter-to-mother arousal transmission decreased between a positive context and a negative context but otherwise, daughter-to-mother and mother-to-daughter arousal transmission did not vary across contexts. Contrary to expectations, relationship quality was not associated with arousal transmission. The results, implications,

and future directions of the three studies were discussed in relation to three areas: (1) relationship quality in mother-daughter dyads, (2) mother-daughter arousal transmission, and (3) developmental processes.

## **Co-Authorship**

The three manuscripts of this dissertation were the collaborative effort of the doctoral candidate, Jessica Lougheed, and her supervisor, Dr. Tom Hollenstein. As the principal investigator, Ms. Lougheed was responsible for the conceptualization, design, data collection, analysis, and preparation of all of the manuscripts. Dr. Hollenstein supervised and assisted with all aspects of the research process and was thus included as a co-author on all three manuscripts. Dr. Peter Koval was consulted on the data analysis of the first study.

## Acknowledgements

Any long-term project requires the support of many hands to be successful. Numerous people supported me during the progress of this dissertation, and I would especially like to thank several people who were crucial to the preparation of this work. First and foremost, I am grateful to my supervisor, Dr. Tom Hollenstein. I have learned so much from you during my graduate training. One lesson I particularly value is that the most interesting pursuits are very often the most challenging, but also that nothing is hard—it just takes longer. Thank you for pushing me to persevere when things took unexpected turns and for helping me to grow as a scholar. I am excited to see what directions our future work together will take.

Second, I wish to thank my internal committee members, Dr. Wendy Craig and Dr. Tara MacDonald, for your insight and guidance at the various stages of this project. I am grateful for the time and support that you have provided. I am also grateful to my internal committee members, along with my external examiners, Dr. Nancy Salay and Dr. Jim Coan, for challenging me to think outside the box and for the fruitful discussions about this work.

Third, I am thankful for the support of my lab mates during my time at Queen's University—Jennifer Eastabrook, Dianna Lanteigne, Alexandra Irwin, Kalee De France, Tiffany Tsui, and Jessica Wilfong. I am grateful that we had the opportunity to work together as colleagues and grow together as friends. I could not have asked for a better lab family! I am also grateful to the many student research assistants and study participants who made the studies of this dissertation possible.

Finally, I wish to thank my family and friends for supporting me in pursuing my goals. My husband, Scott, deserves especial acknowledgement for metaphorically helping me to carry the weight of this dissertation.

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## **List of Abbreviations**

SBT	Social baseline theory
DS	Dynamic systems
TIES	Temporal interpersonal emotion systems
SNS	Sympathetic nervous system
GSR	Galvanic skin response
BDI-II	Beck depression inventory, second edition
BAI	Beck anxiety inventory
SAS-A	Social anxiety scale for adolescents, short form
LSAS	Liebowitz social anxiety scale
PANAS	Positive and negative affect schedule
SPAFF5	Specific affect code, 5-code version

# **Chapter 1: General Introduction**

## General Introduction

One of the defining characteristics of adolescence is unpredictability (Rosenblum & Lewis, 2003). Parents of adolescents anecdotally report the emotional ups and downs of interacting with their child, and describe the stark contrast of these interactions to the less intense and more predictable interactions of childhood (Steinberg, 2001). For example, an adolescent girl might be laughing with her mother over something comical at one moment, and at the next, be storming into her bedroom in anger. Parents may find these moment-to-moment shifts in adolescent emotions to be puzzling, but they are not surprising given that several developmental transitions typically co-occur during adolescence. First, adolescents experience puberty, which is associated with emotional intensity and lability (Buchanan, Eccles, & Becker, 1992; Quevedo, Benning, Gunnar, & Dahl, 2009). Second, adolescents begin spending greater amounts of time with extrafamilial relationship partners (e.g., peers, romantic partners), who influence adolescent activities, attitudes, and psychosocial adjustment (Brown & Larson, 2009; Collins & Laursen, 2004; Smetana, Campionne-Barr, & Metzger, 2006). Third, the parent-adolescent relationship becomes less hierarchical as adolescents gain autonomy from the family (Collins & Laursen, 2004; Smetana et al., 2006). Taken together, adolescents experience greater emotional intensity and lability at the same time as their social support networks are in flux. The increased emotional intensity and lability endemic to adolescence (Hollenstein & Loughheed, 2013; Rosenblum & Lewis, 2003) underlie the “emotional rollercoaster” that parents report experiencing in their interactions with their adolescents. On one hand, the increased emotional intensity of adolescence might lead to more emotionally intense and negative parent-adolescent interactions. On the other hand, greater emotional intensity might lead to greater closeness within the parent-adolescent relationship by providing opportunities for emotional closeness. This dissertation is based on the idea that the momentary dynamics of parent-adolescent interactions in different emotional contexts reflect how well parents and adolescents are adjusting to the “ride”.

For adolescents, there is a potential discrepancy between the support needed from close relationship partners in managing emotions and the availability of such partners (e.g., parents) to provide that support because of fluctuations in adolescent relationships. Although there are changes to parent-adolescent relationships, parental relationships provide a degree of continuity in adolescents' social lives (Smetana et al., 2006). The importance of this continuity is reflected in the associations between the interpersonal regulation of emotions in parent-adolescent relationships and psychosocial adjustment (Hollenstein & Lewis, 2006; Lichtwarck-Aschoff, Kunnen, & van Geert, 2009; Lougheed, Craig, et al., in press; Schwartz, Sheeber, Dudgeon, & Allen, 2012; van der Giessen, Branje, Frijns, & Meeus, 2013). Emotion regulation refers to the ability to modulate the intensity, form, and duration of emotions (Thompson, 1994). The ability to regulate emotions emerges from moment-to-moment interactions with primary caregivers (Fogel, 1993; Granic, 2005). From infancy, primary caregivers support their children in regulating emotions (Kopp, 1989; Stifter & Rovine, 2015). Children gradually internalize the ability to self-regulate emotions through repeated interactions with caregivers (Fogel, 1993; Kopp, 1989). Thus, emotion dynamics with primary caregivers, such as parents, form the foundation of emotion regulation and psychosocial adjustment across the lifespan (Fogel, 1993; Granic, 2005).

Taken together, the intensity of adolescent emotions is associated with emotion regulation difficulties, and emotion regulation difficulties tend to increase in typical development during adolescence (Hollenstein & Lougheed, 2013). Emotions are generated and regulated in the context of close relationships (Butler, 2011; Campos, Walle, Dahl, & Main, 2011; Fogel, 1993), and how parent-adolescent dyads manage the rollercoaster of emotional experiences as they unfold in real time continues to play an important role in adolescent psychosocial adjustment (Fussner, Luebbe, & Bell, 2014; Granic, Hollenstein, Dishion, & Patterson, 2003; Hollenstein & Lewis, 2006; Katz et al., 2014; Lougheed, Craig, et al., in press; Lougheed, Hollenstein, & Lewis, in press). The overarching goal of this dissertation was to examine the emotion dynamics of

parent-adolescent interactions across different positive and negative contexts, and their associations with psychosocial adjustment.

### **Theoretical Perspectives on Interpersonal Emotion Dynamics**

This dissertation is informed by the confluence of two theoretical perspectives: social baseline theory (Beckes & Coan, 2011), and the dynamic systems perspective (Butler, 2011; Hollenstein, Lichtwarck-Aschoff, & Potworowski, 2013; Lewis, 2000). Each perspective underscores the primacy of social relationships in emotional processes, and together they highlight the importance of interpersonal emotion dynamics in adolescent development. First, I will describe the significance of these two theoretical perspectives for understanding parent-adolescent emotion dynamics. Then, I will explain the contributions that each of the three studies of this dissertation makes to the research literature on parent-adolescent emotion dynamics.

**Social baseline theory.** SBT (Beckes & Coan, 2011; Coan & Sbarra, 2015) is a relatively new theory of social relationships that is based on the idea that humans are, fundamentally, a social species. According to SBT, humans evolved to be physically close to other humans, which is reflected in human biological, psychological, and social phenotypes (Beckes & Coan, 2011). Humans have evolved biopsychosocial mechanisms that enable energy conservation, and thus increase the likelihood of survival, through a process called load sharing (Beckes & Coan, 2011; Proffitt, 2006; Schnall, Harber, Stefanucci, & Proffitt, 2008). Load sharing refers to the distribution of physical (e.g., procuring food and other resources) and psychological (e.g., vigilance; emotion regulation) efforts among relationship partners, and it is positively associated with physical closeness and relationship quality with partners (Beckes & Coan, 2011; Coan, Schaefer, & Davidson, 2006). Load sharing distributes physical and psychological loads across individuals within social relationships and is postulated to result in energy savings, thereby increasing the likelihood of survival (Beckes & Coan, 2011). Individuals demonstrate optimal functioning when they are physically and psychologically close to relationship partners (Beckes & Coan, 2011; Coan et al., 2006). Conversely, individuals who are isolated from relationship

partners function at a relative deficit (Beckes & Coan, 2011). Thus, according to SBT, optimal functioning cannot be observed when individuals are removed from their social context (Beckes & Coan, 2011). The primacy of social relationships within SBT—that our baseline is social rather than individual—contrasts the vast majority of individual-level research within the discipline of psychology more broadly.

Empirical support for SBT shows that the demands of emotion regulation during stressful or otherwise negative emotional situations increase in accordance with the physical and relationship distance of partners (Coan, Beckes, & Allen, 2013; Coan et al., 2006; Conner et al., 2012). Conversely, individuals in closer proximity to relationship partners or with high quality relationships expend less effort on down-regulating negative emotions, as physical and relationship closeness reduce the generation of negative emotions such as stress and anxiety—the emotional load is shared (Coan, Kasle, Jackson, Schaefer, & Davidson, 2013; Coan et al., 2006; Conner et al., 2012). Physical closeness may remind individuals in negative situations that they need not carry their burdens alone, because a loved one is nearby to either literally or metaphorically lighten their load (Beckes & Coan, 2011). One attribute of high relationship quality is that partners feel that they can trust and depend on one another for load sharing, and previous research has shown that the greatest accentuation of stress responses was observed in the context of both low physical and relationship closeness (Coan et al., 2006).

Adolescents experience significant changes in their social lives (Collins & Laursen, 2004), and their own point of reference within their personal social baseline is likely to change accordingly. Adolescents become increasingly close to extrafamilial relationship partners such as peers and romantic partners as they gain autonomy from the family (Collins & Laursen, 2004; Smetana et al., 2006). The formation of new types of close relationship partners likely also means that new load-sharing partnerships form, and the forms of load sharing that parents provide for their adolescent likely vary in accordance with the developing parent-adolescent relationship. The parent-adolescent relationship provides continuity in adolescents' social lives, despite the

reorganization of close relationships in typical adolescent development (Smetana et al., 2006). Parent-child interactions continue to shape adolescent emotion regulation, as parental responses to adolescent emotions can either foster or hinder adolescents' ability to regulate emotions (Fussner et al., 2014; Katz et al., 2014; Lougheed, Craig, et al., in press; Lougheed, Hollenstein, et al., in press). Adolescents also continue to seek emotional support from their parents (Morris, Silk, Steinberg, Myers, & Robinson, 2007; Smetana et al., 2006). Therefore, parent-adolescent relationships continue to be the primary social baseline from which adolescents explore relationship dynamics and ultimately develop load-sharing skills, which sets the foundation for success in extrafamilial relationships.

There are several reasons why load sharing may play an important role in adolescent development. One is that load sharing partnerships reorganize in adolescence. Thus, adolescent social support changes at the same time as adolescents typically experience an increase in difficulties with emotion regulation and psychosocial adjustment (Hollenstein & Lougheed, 2013). Another is that adolescents have a relatively heavy emotional burden to bear, as they experience more negative life events as well as greater negative emotional responses to such events than in childhood, and are particularly sensitive to social stressors (Larson & Ham, 1993; Westenberg, Drewes, Goedhart, Siebelink, & Treffers, 2004). Taken together, the dynamics of parent-adolescent load sharing are expected to play an important role in adolescent psychosocial adjustment.

**The dynamic systems approach.** The DS approach to emotions and emotional development (Butler, 2011; Hollenstein et al., 2013; Lewis, 2000) is a metatheoretical perspective that specifies the relationships among elements in a system (Hollenstein, 2011). The DS approach, as a metatheory, does not define what constitutes a "system". In emotion research, systems have been conceptualized as the interactions among emotion indicators (e.g., physiological arousal, observed emotions, subjective feelings) within individuals, dyads, and families (Butler, 2011). As this dissertation is based on the SBT perspective, the system of



interest in this dissertation is interpersonal. Specifically, mother-daughter dyads are the systems examined in this dissertation (see page 21 for further information). Thus, the remaining description of the DS perspective will focus on dyad-level systems.

From the DS perspective, relationships are self-organizing temporal interpersonal emotion systems (TIES) that are comprised of individuals and the interactions between them (Butler, 2011, 2015; Randall & Butler, 2013). TIES emerge from the self-organization of attributes, such as relationship closeness, and states, such as emotions (Butler, 2011; Lichtwarck-Aschoff et al., 2009). Relationship states, such as dyad-level emotions, change over time as a function of previous dyadic states and interactions among system elements (i.e., individual physiological arousal, observed emotions, subjective feelings; Butler, 2011). Over repeated interactions within TIES, stable interpersonal emotion patterns arise and constrain future dyadic emotion dynamics (Butler, 2011; Fogel, 1993; Granic, 2005). Thus, emotion dynamics are co-constructed between relationship partners in the moment and, over time, these in-the-moment patterns stabilize into dyadic tendencies within TIES (Butler, 2011; Granic et al., 2003). In this manner, real-time emotion dynamics are the building blocks of dyadic attributes (e.g., relationship quality), which in turn constrain the emotion dynamics of TIES. Figure 1.1 is a representation of mother-daughter TIES. Real-time emotion dynamics (e.g., momentary changes in emotional expression, experiences, and physiological arousal) and psychosocial adjustment at the developmental time scale (e.g., relationship quality, internalizing symptoms) mutually influence each other both within person and between relationship partners.

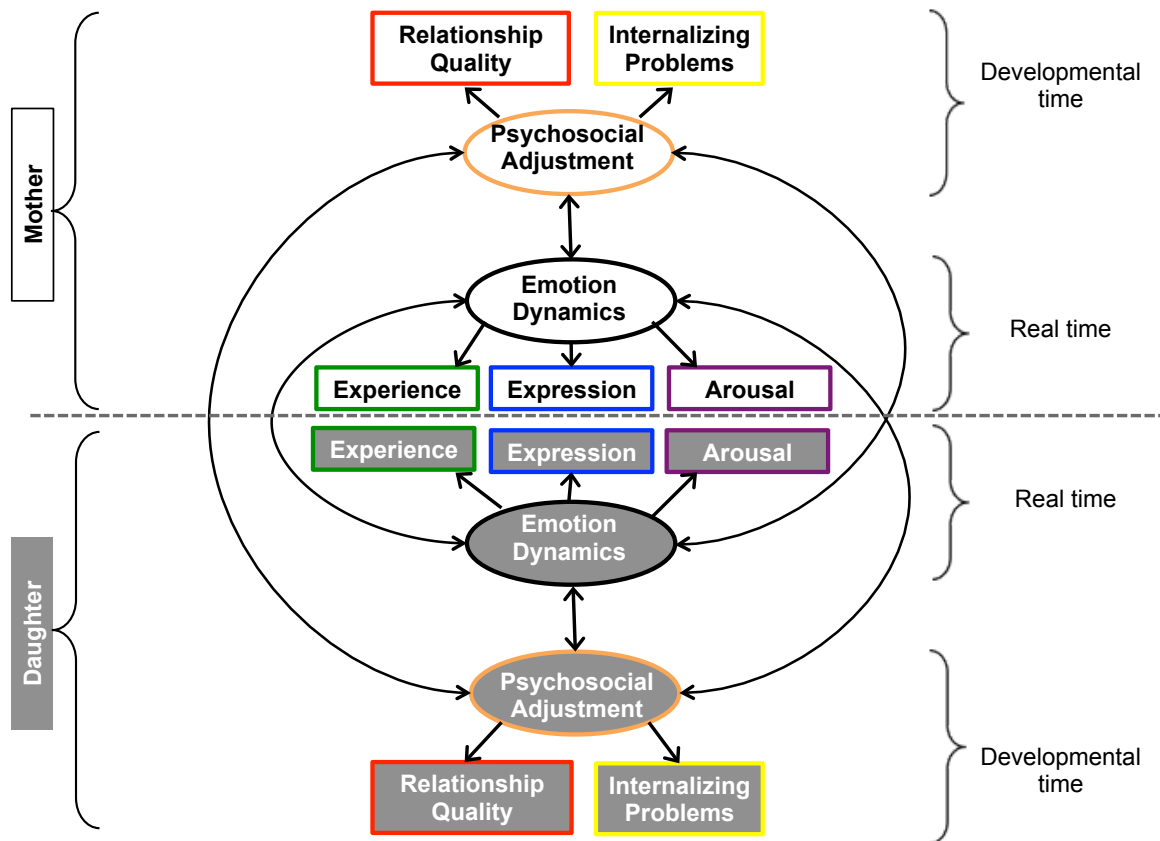


Figure 1.1. Representation of mother-daughter temporal interpersonal emotion systems (TIES).

Parent-child dyads are typically the first TIES to emerge in development (Fogel, 1993). Parent-child relationships have several characteristics that differentiate them from other parent-child TIES at other points in development. First, increased autonomy from the family coincides with adolescents becoming more adept at regulating emotions (Morris et al., 2007), and adolescents therefore are likely to become more adept at sharing the emotional burdens of their close relationship partners. Second, compared to parent-child relationships, parent-adolescent relationships are characterized by greater conflict and negative emotion, and less warmth (Larson & Ham, 1993; Laursen, Coy, & Collins, 1998; Steinberg, 1990). Thus, parent-adolescent TIES are characterized by greater emotionality than in childhood (Granic et al., 2003; Hollenstein & Lewis, 2006; Lichtwarck-Aschoff et al., 2009), which challenges adolescents' developing emotion regulation abilities (Somerville & Casey, 2010; Steinberg, 2010). Taken together, parent-

adolescent TIES are simultaneously regulating relationship closeness at the same time as real-time emotion dynamics intensify.

As components of TIES, parents' and adolescents' emotions mutually influence each other via several different forms of emotion dynamics (Butler, 2011). First, physical distance from others during a stressful situation can accentuate physiological arousal associated with stress (Coan et al., 2006). Second, socioemotional flexibility is the regulatory process by which emotion states change in response to situational demands (Bonanno, Papa, Lalande, Westphal, & Coifman, 2004; Hollenstein et al., 2013). As adolescence is rife with interpersonal challenges and changing contexts, and given adolescents' emotional developments and new social experiences (e.g., school and relationship transitions; Eccles et al., 1993; Smetana et al., 2006), flexibility in parent-adolescent interactions is one proximal factor in adolescents' psychosocial adjustment (Lichtwarck-Aschoff et al., 2009; van der Giessen, Branje, Frijns, & Meeus, 2013). Third, the transmission of physiological arousal between partners in TIES is one process by which partners "pick up" on each others' emotion states (Butler, 2011; Field, 2012; Timmons, Margolin, & Saxbe, 2015). The extent to which any of these dynamics are adaptive or maladaptive depends on the quality of the relationship and the specific emotions being regulated within TIES such as adult romantic partners (Butler, 2011; Timmons et al., 2015; Walle & Campos, 2012), but whether the same is true in parent-adolescent TIES is unknown.

Taken together, parent-adolescent dyads encounter new situations and emotion experiences related to the adolescent transition (Granic et al., 2003; Lichtwarck-Aschoff et al., 2009; Smetana et al., 2006). The continued development of adolescent emotion regulation is supported by dynamic adjustments of the parent-adolescent TIES according to situational demands (Hollenstein & Lewis, 2006; Lichtwarck-Aschoff et al., 2009; Lougheed, Craig, et al., in press; Lougheed, Hollenstein, et al., in press). Interpersonal emotion dynamics—that is, the presence of relationship partners during stress, dyadic flexibility, and arousal transmission—

contribute to relationship quality and adolescent psychosocial adjustment (Beckes & Coan, 2011; Coan et al., 2006; Hollenstein et al., 2013; van der Giessen et al., 2013).

### **The Current Dissertation**

Together, the DS (Butler, 2011; Hollenstein et al., 2013; Lewis, 2000) and SBT (Beckes & Coan, 2011) perspectives offer developmental and evolutionary explanations of the significance of emotion dynamics in parent-child TIES. The manner in which emotions are socialized in parent-child TIES lay the biopsychosocial foundations for load sharing and thus have evolutionary significance. Relationship quality is a defining feature of parent-child TIES, as it emerges from real-time emotion dynamics within the system and in turn has implications for systemic emotion dynamics (e.g., load sharing; the extent to which the system is able to respond according to situational demands).

Both the SBT (Beckes & Coan, 2011) and DS (Butler, 2011; Hollenstein et al., 2013; Lewis, 2000) perspectives emphasize the importance of parent-child emotion dynamics in psychosocial adjustment. However, there are several gaps in research to date on parent-child emotion dynamics. First, the vast majority of research on parent-child emotion dynamics has focused on infancy and early childhood, and relatively little is known about these dynamics in adolescence (Morris et al., 2007). Adolescents, especially adolescent girls, are at particular risk for psychosocial adjustment difficulties (e.g., depression and anxiety) related to difficulties with emotion regulation (Graber, 2004). Because parent-child emotion dynamics form the basis of emotion regulation across the life span (Fogel, 1993; Granic, 2005; Kopp, 1989), it is important to understand the associations between parent-adolescent emotion dynamics and adolescent girls' psychosocial adjustment. Second, most research on parent-child interactions has employed static measures of emotion regulation (e.g., self-report measures, global ratings of observations) that preclude the analysis of temporal dynamics (Hamaker, Ceulemans, Grasman, & Tuerlinckx, 2015; Lunkenheimer & Leerkes, 2015), despite the importance of real-time processes in emotion regulation development (Fogel, 1993; Granic, 2005). Third, most studies on parent-child

interactions have examined social contexts that elicit a broad range of negative emotions, such as conflict discussions (e.g., Flannery, Montemayor, Eberly, & Torquati, 1993; Hollenstein & Lewis, 2006; Papini, Datan, & McCuskey-Fawcett, 1988; van der Giessen et al., 2014). However, the full range of positive and negative emotions are regulated in parent-child interactions, and different emotions of the same valence (e.g., social stress, anger, and sadness are all negatively valenced emotions) have different functional significance and meaning in close relationships (Walle & Campos, 2012).

This dissertation takes steps towards addressing these gaps in the research literature by examining real-time mother-daughter emotion dynamics across a range of positive and negative emotion contexts in adolescence. Mother-daughter dyads were the focus of the current dissertation because, compared to other parent-adolescent dyads (e.g., mother-son, father-daughter), females tend to be more emotionally expressive than males (Brebner, 2003), adolescent girls tend to disclose more to their parents than adolescent males (Collins & Russell, 1991), and mothers tend to be the primary parental source of emotional support (Klimes-Dougan et al., 2007). Mother-daughter dyads are also arguably one of the most emotionally intense TIES across development, as mother-daughter dyads show the greatest amount of parent-child conflicts during adolescence (Collins, 1990; Hill, 1988). In line with the SBT and DS perspectives, this dissertation examined mother-daughter emotion dynamics in specific emotional contexts: (1) the context of mothers' physical closeness to their daughters during adolescent social stress (Study 1), and (2) shifting between specific positive and negative emotions (Studies 2 and 3).

**Description of the three studies.** Study 1 was an examination of load sharing in mother-daughter dyads during adolescent social stress. Previous research from the SBT perspective has examined load sharing in terms of increases in neural responding to threatening situations at greater physical and relationship distances from partners (Coan, Beckes, et al., 2013; Coan, Kastle, et al., 2013; Coan et al., 2006). However, according to the DS perspective, interpersonal processes such as load sharing emerge from real-time emotion dynamics (Butler, 2011; Granic,

2005; Lewis, 2000). In line with both the SBT and DS perspectives, the broad objective of Study 1 was to examine load sharing as a dynamic process. Daughters participated in a spontaneous speech task during a laboratory session (Lanteigne, Flynn, Eastabrook, & Hollenstein, 2014; Westenberg et al., 2004), while their mothers were randomly assigned to either place their hand atop their daughter's during the task, or to not touch their daughters during the task. Load sharing was examined in terms of the associations between physical and relationship closeness on the overall levels of arousal elicited during social stress, as well as two emotion dynamics: (1) *arousal transmission*, the extent to which partners' emotional arousal are associated with each other over time (Butler, 2011), and (2) *arousal attenuation*, the extent to which arousal decreased over time during social stress. Examining emotion dynamics as they varied by physical and relationship closeness during adolescent social stress provided insight into how emotional loads are shared in real time in mother-daughter dyads.

Study 2 was an examination of socioemotional flexibility in mother-daughter dyads across specific positive and negative emotion contexts. Socioemotional flexibility is the ability to adjust emotions in accordance with changing emotional contexts (Hollenstein et al., 2013). Flexibility involves dyadic shifts in and out of emotion states over time and the range of emotional states expressed during interpersonal interactions (Hollenstein, 2015; Hollenstein et al., 2013). The ability to adjust emotion dynamics in accordance with situational demands is an indicator of adaptive psychosocial adjustment (Granic, O'Hara, Pepler, & Lewis, 2007). From the DS perspective, flexibility in real time begets the ability to adjust to changing circumstances more broadly, and is thus negatively associated with psychosocial adjustment difficulties (Granic, 2005; Granic et al., 2007). Socioemotional flexibility has not been explicitly defined within the SBT perspective, but its qualities as a form of interpersonal emotion regulation are in line with the central tenet of SBT that one function of close relationship partners is to reduce the energy costs of emotion regulation. Socioemotional flexibility is an efficient form of dyadic emotion regulation and is thus expected to be associated with higher levels of relationship quality. Mother-

daughter dyads participated in a new emotion elicitation task developed for this dissertation, the Emotional Rollercoaster task, during an observational session in the laboratory. The Emotional Rollercoaster task elicits multiple reversals between specific positive and negative interpersonal interactions in an A-B-A-B-A design, and consists of five emotion discussions in a fixed order with the following topics: (1) Happy/Excited, (2) Worried/Sad, (3) Proud, (4) Frustrated/Annoyed, and (5) Grateful. Individual differences in dyadic flexibility were examined within and across positive and negative emotional contexts, as well as their associations with mothers' and daughters' psychosocial adjustment (relationship quality, internalizing symptoms). The use of the Emotional Rollercoaster task enabled a nuanced understanding of the associations between flexibility and psychosocial adjustment.

Study 3 built on the foundations laid by Studies 1 and 2 and was an examination of mother-daughter arousal transmission across positive and negative emotional contexts. Arousal transmission can be associated with adaptive dyadic emotion dynamics, such as when each partner's arousal decreases together in response to a threatening or challenging situation, but it can also be associated with negative dyadic dynamics such as the escalation of negative emotions during conflicts (Butler, 2011; Levenson & Gottman, 1983; Timmons et al., 2015). According to the DS perspective, arousal transmission is one emotion dynamic that shapes the characteristics of TIES through self-organization (Butler, 2011, 2015). The transmission of arousal within TIES is related to the quality of the relationship (Timmons et al., 2015). In TIES with high relationship quality, arousal transmission in some emotion contexts can indicate empathic dynamics (Chatel-Goldman, Congedo, Jutten, & Schwartz, 2014). In line with SBT, arousal transmission may therefore be an important dynamic underlying the ability to share the load of close relationship partner's emotional experiences. The same sample as Study 2 was used in Study 3 so that mother-to-daughter and daughter-to-mother arousal transmission across a range of positive and negative contexts could be examined. Examining variations in arousal transmission by relationship quality

and emotional context highlights the functions of arousal transmission in mother-daughter interactions.

**Summary of objectives.** This dissertation was designed to make novel contributions to the research literature on parent-adolescent relationships by focusing on real-time dynamics during specific interpersonal contexts of both positive and negative emotional valence. The objectives of the three studies of this dissertation were to: (1) explore load sharing as a dynamic process in mother-daughter dyads; (2) examine individual differences in socioemotional flexibility across specific positive and negative contexts; and (3) compare the transmission of arousal across positive and negative contexts.



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**Chapter 2: Sharing the Burden: The Interpersonal Regulation of  
Emotional Arousal in Mother-Daughter Dyads**

## Abstract

According to Social Baseline Theory (Beckes & Coan, 2011), load sharing is a feature of close relationships whereby the burden of emotional distress is distributed across relationship partners. Load sharing varies by physical closeness and relationship quality. We investigated the effect of load sharing on emotional arousal via galvanic skin response, an indicator of sympathetic nervous system arousal, during a social stressor. Social stress was elicited in 66 adolescent girls ( $M_{\text{age}} = 15$  years) using a spontaneous public-speaking task. Mother-daughter dyads reported their relationship quality and physical closeness was manipulated by having mothers either touch their daughter's hand or not touch during the performance. We found evidence of load sharing among dyads who held hands, independent of relationship quality. However, without physical contact, load sharing was only evident among dyads with higher relationship quality. Thus, high relationship quality buffers against threat in a similar way to the physical comfort of a loved one.

*Keywords:* mother-daughter interactions, adolescence, interpersonal emotion regulation, social stress

## Sharing the Burden: The Interpersonal Regulation of Emotional Arousal in Mother-Daughter Dyads

Decades of research indicate that social relationships are crucial for mental and physical health (Holt-Lunstad, Smith, & Layton, 2010). Not only do positive (i.e., stable, supportive, and satisfying) social relationships have indirect salutary effects on health, they have also been causally linked to a lower likelihood of mortality (Holt-Lunstad et al., 2010; House, Landis, & Umberson, 1988). However, according to Social Baseline Theory (SBT; Beckes & Coan, 2011), positive relationships may not confer psychological and physical benefits. Rather, a lack of or distance from significant others leads to negative mental and physical health outcomes (Beckes & Coan, 2011). Thus, positive social relationships are the norm, and deviations from that baseline (e.g., a lack of sufficient relationships, or the presence of negative relationships) drive the associations between relationships and psychosocial outcomes (Beckes & Coan, 2011).

The main tenet of SBT is that humans evolved to be in close proximity to other humans (Beckes & Coan, 2011). Group living is an evolutionary adaptation that leads to survival through efficient energy management and the conservation of resources, as living in close proximity to others distributes the burden of tasks that lead to survival (e.g., vigilance for predators, self-regulation) among members of the group (Roberts, 1996). There is evidence that social relationships have been central to the evolution of resource conservation mechanisms (Beckes & Coan, 2011). For example, individuals are more likely to succeed if challenges are perceived as less threatening, and physical closeness to another person, especially a trusted relationship partner, decreases perceived threat in challenging situations (Schnall, Harber, Stefanucci, & Proffitt, 2008).

One mechanism through which social relationships lead to energy conservation is the process of *load sharing* (Beckes & Coan, 2011). Load sharing involves distribution of the burden associated with challenging situations (e.g., emotional distress) across relationship partners (Ehrenberg, Gearing-Small, Hunter, & Small, 2001). Load sharing can be instrumental or

psychological (Beckes & Coan, 2011). An example of instrumental load sharing is when family members share the burden of household chores. An example of emotional load sharing—the focus of the current study—is when a mother helps her daughter to manage her stress by offering some form of comfort. In this example of emotional load sharing, the comfort offered by the mother reduces the amount of energy expended by the daughter in managing her own stress, and thus regulation would be more efficient. Load sharing implies that close relationship partners are extensions of each other and that individuals' interactions with the world are embedded within social systems (Beckes & Coan, 2011). Isolated individuals therefore experience greater demands on their own psychological resources, such as when self-regulating emotion and behavior (Schnall et al., 2008).

### **Interpersonal Emotion Regulation**

Under threatening circumstances, it is necessary for individuals to regulate emotions to overcome challenges (Thompson, 1994). Emotion regulation refers to processes that increase, decrease, or otherwise change the occurrence, intensity, or temporal profile of emotions (Thompson, 1994). Interpersonal emotion regulation, specifically, refers to both the up- and down-regulation of emotions through social interactions, in which individuals' emotions are connected to and affected by the emotions of their interaction partner (Butler, 2011; Thompson, 1994). Emotions are inherently social signals to others that, among many things, communicate needs and potential threats (Campos, Walle, Dahl, & Main, 2011). Load sharing allows emotional strain to be distributed across relationship partners, which prevents ego depletion (i.e., a reduction in self-control observed among individuals following effortful self-regulation; Baumeister, Bratslavsky, Muraven, & Tice, 1998) and thereby conserves resources required for effective emotion regulation (Beckes & Coan, 2011; Fitzsimons & Finkel, 2011). Thus, load sharing can be considered a form of interpersonal emotion regulation. Distance from relationship partners places a greater demand on emotion regulation resources compared to when close relationship partners

are present to influence and regulate each others' emotions (Butler, 2011; Fitzsimons & Finkel, 2011; Hughes, Crowell, Uyeji, & Coan, 2012).

The ability to regulate emotions develops in an interpersonal context (Fogel, 1993; Kopp, 1989). Close relationship partners (e.g., primary caregivers) support children of all ages in threatening, stressful situations, and provide emotional scaffolding that helps children internalize their own abilities to manage emotions under stress (Kopp, 1989; Morris, Silk, Steinberg, Myers, & Robinson, 2007). The role of the parent-child relationship in shaping children's emotion regulation goes beyond parental socialization via modeling and scaffolding. Parent-child dyads are a temporal interpersonal emotion system (TIES), in which the subcomponents of both parents' and children's emotion systems (e.g., physiological arousal) are directly linked in time to each others' (Butler, 2011; Crowell et al., 2014). That is, parent-child dyads are a dynamic system in which emotions are co-constructed and regulated interpersonally (Granic, 2005). The parent-child TIES emerges through repeated interpersonal interactions, in which emotions are mutually regulated in real time, and developmentally, long-standing interpersonal patterns emerge (Fogel, 1993). Two examples of interpersonal emotion regulation in TIES are emotion transmission (one partner's arousal predicts their partner's arousal at a subsequent point in time), and attenuation (the influence of one partner on their partner's decrease in arousal over time; Butler, 2011).

**Interpersonal regulation of sympathetic nervous system activity.** One component of emotional responding is sympathetic nervous system (SNS) activity, which is triggered during threatening situations and is associated with stress and anxiety (Crowell et al., 2005; Kreibig, 2010). SNS arousal plays a role in sensitivity to interpersonal challenges, and interpersonal emotional reactivity and regulation (Diamond & Cribbet, 2013). SNS arousal increases during socially-stressful situations, such as giving a speech in front of a stranger (Eastabrook, Lanteigne, & Hollenstein, 2013), and both SNS arousal and recovery are positively associated with affiliation (e.g., behavioral warmth) in mother-adolescent interactions (Diamond & Cribbet, 2013; Willeman, Schuengel, & Koot, 2009). SNS arousal is regulated in part through social interactions,

and individuals who experience loneliness (i.e., a lack of sufficient social relationships) have difficulties with regulation, as indicated by chronically elevated SNS arousal (Cacioppo, Hawkley, & Bernston, 2003). In addition, it is common for individuals to seek social interactions when SNS arousal is high as a means of decreasing SNS arousal (Taylor, 2006). Load sharing may therefore be one mechanism in the social regulation of SNS arousal because SNS arousal is most often reactivity to threat, and the regulation of threat is thought to be the evolutionary origin of load sharing (Beckes & Coan, 2011; Coan & Sbarra, 2015). Although there is an emerging body of research on dyadic psychophysiological processes (e.g., Connell, Hughes-Scalise, Klostermann, & Azem, 2011; Crowell et al., 2014; Ferrer & Helm, 2013; Reed, Randall, Post, & Butler, 2013), the hypothesis that load sharing would be reflected in interpersonal SNS response patterns has not yet been tested.

**Interpersonal emotion regulation in adolescence.** During adolescence, individuals are particularly sensitive to social stress (Westenberg, Drewes, Goedhart, Siebelink, & Treffers, 2004), as adolescence involves the formation of novel social bonds with peers and the transformation of family relationships (Smetana, Campione-Barr, & Metzger, 2006). More generally, adolescence is a period of intense psychological, biological, and social changes, accompanied by more intense emotions (Hollenstein & Loughheed, 2013). This places adolescents at an increased risk for psychosocial adjustment difficulties, and emotion regulation is an important contributor to adolescent well-being (McLaughlin, Hatzenbuehler, Mennin, & Nolen-Hoeksema, 2011).

Interpersonal emotion regulation via load sharing in caregiver-adolescent TIES (Butler, 2011; Crowell et al., 2014) may be essential to typically-developing adolescents' responses to social threats because of the role played by caregivers in the socialization of emotion regulation from childhood through adolescence (Morris et al., 2007). Load sharing can occur through either physical closeness or relationship closeness (i.e., relationship quality) to significant others (Beckes & Coan, 2011; Schnall et al., 2008). For example, either distance from a close

relationship partner or lower subjective relationship quality may lead to increased arousal under stress (Coan, Schaefer, & Davidson, 2006; Coan, Kastle, Jackson, Schaefer, & Davidson, 2013; Schnall et al., 2006). Indeed, physical closeness and relationship quality may interact, with emotional load sharing being most effective when high levels of relationship quality and physical closeness combine (Coan et al., 2006). Although load sharing is an interpersonal process, much of the research to date has examined it in terms of attenuated threat responses within the individual who is experiencing stress (e.g., Coan et al., 2006, Coan et al., 2013). It is unknown how individuals respond when they are sharing load of another's distress, which is an important aspect when examining interpersonal processes in TIES (Butler, 2011). Thus, in the current study, we examined both physical closeness and relationship quality with respect to mothers' sharing of their adolescent daughters' emotional load through decreases in daughters' arousal and associations between daughters' and mothers' arousal during adolescent social stress.

### **The Current Study**

We examined emotional load sharing during an adolescent-targeted social stressor, by examining physiological arousal of the SNS via galvanic skin response (Boucsein, 2012). The galvanic skin response is a measure of electrodermal changes due to SNS activity, and is associated with anxiety and stress responses in adolescents and adults (Boucsein, 2012; Crowell et al., 2005; Kreibig, 2010). The social stressor was a spontaneous speech task in which daughters were instructed to give a speech on a topic of their choice in front of an experimenter. We manipulated physical closeness during the speech task by randomly assigning mother-daughter dyads to either (a) touch hands during the speech task (mothers kept their hand atop their daughter's hand; *Touch* condition), or (b) not to touch each other during the speech task (*No Touch* condition). Mother-daughter dyads were the focus as adolescent females share more with their parents and are more emotionally expressive than males (Collins & Russell, 1991; Perry-Parrish & Zeman, 2011).

The objective was to examine load sharing—the shared burden of emotion regulation as a function of both physical closeness and relationship quality—in terms interpersonal emotion processes. Evidence of maternal load sharing of adolescent stress can be observed in different ways: lower average levels of adolescent arousal, interpersonal influences on arousal dampening, and greater decreases in adolescent arousal over time at higher mother-daughter physical closeness and relationship quality. First, we examined maternal load sharing of adolescent arousal in terms of overall levels of arousal, with lower adolescent arousal at higher physical closeness and relationship quality providing evidence of load sharing (Coan et al., 2006). Second, we examined load sharing in terms of *arousal transmission*, the extent to which one’s emotional arousal influences the arousal of another person over time (Butler, 2011). Arousal transmission occurs in situations that elicit empathy, such as seeing a family member in a stressful situation (Goubert, Vervoort, Sullivan, Verhoeven, & Crombez, 2008; Reed et al., 2013). Arousal transmission refers to positive covariation between interaction partners’ emotions (Butler & Randall, 2013). Arousal transmission can occur in two directions, one being the transmission of arousal amplification (e.g., a mother’s and daughter’s stress levels mutually amplify each others’) and the other being the transmission of arousal dampening (e.g., a daughter’s stress level decreases through interacting with her mother who feels a lower level of stress, resulting in mutual dampening of arousal over time). Load sharing can be observed in the transmission of arousal dampening. The transmission of arousal dampening reflects the synchronized emotional responses indicative of load sharing because the social regulation of emotion decreases the perception of threat among relationship partners (Beckes & Coan, 2011). Third, we examined load sharing in terms of the influence of the mother on adolescents’ *arousal attenuation*, the extent to which arousal decreased over time during the socially stressful task as a function of touch and relationship quality.

We hypothesized that greater physical closeness and relationship quality would be associated with lower average levels of adolescent arousal, the mother-to-daughter transmission



of arousal dampening, and more efficient adolescent arousal attenuation (i.e., a steeper decrease in arousal over time during the stressful task). We also hypothesized that physical closeness and relationship quality would interact, such that load sharing (lower arousal, the interpersonal transmission of arousal dampening, and more efficient arousal attenuation) would be greatest when both physical proximity and relationship quality were combined (among dyads with higher relationship quality in the Touch condition). Finally, as the current study is the first study to date that examines the physiological responding of the individual sharing the load of the individual under stress, we also examined mothers' physiological responses as they shared the load of their daughters' stress. As SBT posits that psychological load sharing functions to decrease the *perception* of threat (Beckes & Coan, 2011), we expected to find that greater physical closeness and relationship quality would not be associated with differences between conditions on mothers' average levels of arousal, daughter-to-mother arousal transmission, and mother arousal attenuation.

## **Method**

### **Participants**

Participants were a community sample of 66 typically-developing adolescent females aged 14.03 to 16.88 years ( $M = 15.15$ ,  $SD = .79$ ) and their mothers. Mothers' ages ranged from 32.98 to 54.98 years ( $M = 45.88$ ,  $SD = 4.34$ ). Participants were recruited via telephone from the participant database maintained by the Developmental area of the Department of Psychology at a university in Southern Ontario, and through posters in community and online locations such as malls, libraries, and Facebook. Approximately 59% of families had a gross family income greater than \$100,000 per year, 15% had an income between \$75,000 and \$100,000 per year, 14% had an income between \$40,000 and \$75,000 per year, 6% had an income between \$25,000 and \$40,000 per year, and 5% had an income less than \$25,000 per year. Mothers reported their marital status as married (82%), divorced (8%), living with a domestic partner (6%), single (3%), and separated (1%). Mothers identified their own ethnicities as European Canadian (83%), Other (11%),

Central/South American (3%), and First Nations (3%). Mothers identified their daughters' ethnicities as European Canadian (82%), Other (15%), and First Nations (3%). Mother and daughter participants received \$15 each for participating.

### **Procedure**

Mothers and daughters attended a laboratory session where they first received a letter of information and provided informed consent. Participants were seated in comfortable chairs beside each other in an observation room equipped with obscured video cameras and physiological recording equipment that were monitored from an adjacent room. A female experimenter familiarized participants with the general procedures of the study and the physiological recording equipment before participants filled out a series of questionnaires online. Questionnaires pertained to demographics and relationship quality.

Next, physiological sensors were applied to participants by female experimenters. To measure sympathetic physiological arousal via galvanic skin response (GSR), an SS3 electrodermal response transducer (BioPac Systems Inc., 2007) was attached to the tips of the middle and ring fingers on one hand of each participant. GSR was recorded continuously from an MP150 amplifier (BioPac Systems Inc., 2007) at 200 Hz and was calculated as level of conductance in micromhos. Heart rate and respiration were also measured but were not analyzed as part of the current study as they are not direct indicators of SNS activity.

Once physiological sensors were recording, participants were instructed to either touch hands by having the mother place her hand on her daughter's (Touch condition;  $n = 34$ ), or to ensure they were not touching during the remainder of the session (No Touch condition;  $n = 32$ ). Next, to obtain a baseline arousal measure, participants sat quietly while watching a neutral nature film clip for approximately 2.5 minutes in order to measure participants' normal resting physiological states. Following the baseline phase, social stress was elicited using a speech task, in which adolescents were instructed to make a 3-minute speech on any topic as if in front of

classmates at school. Mothers in both conditions were instructed to be silent during the speech task. At the end of the lab session, all participants were debriefed.

## **Measures**

**Questionnaires.** In addition to responding to a questionnaire regarding demographics, mothers and daughters completed a questionnaire regarding relationship quality.

**Relationship quality.** We assessed relationship quality using a measure developed by Beazer (1998) based on three separate scales assessing relationship quality (Cicirelli, 1980; Esposito, 1995; Risman & Park, 1988). Mothers and daughters each responded to eight items (e.g., “How much do you feel that you can turn to your mother/daughter when you are in need of help or guidance?”, “In general, how close to you feel to your mother/daughter?”) on a 7-point scale (1 = *not at all*, 7 = *very, very much* or *very, very close*). Internal consistency of the mean across all items was good for mothers ( $\alpha = .88$ ) and daughters ( $\alpha = .92$ ). Mothers’ and daughters’ relationship quality scores were moderately, positively correlated ( $r = .35$ ,  $p = .01$ ). We formed a dyadic measure of relationship quality by calculating the mean of mothers’ and daughters’ scores in order to examine load sharing with respect to the overall level of relationship quality, rather than with respect to individuals’ perceptions of the relationship separately for mothers and daughters.

**Laboratory measures.** Laboratory measures were physiological recordings that occurred during baseline and speech tasks.

**Baseline arousal.** GSR was recorded continuously during the baseline task. GSR data were smoothed at a sampling rate of 1000 Hz to yield a continuous measure with the AcqKnowledge 4.2 software package (AcqKnowledge, 2011). Average GSR values were calculated separately for mothers and daughters.

**Arousal during speech.** To examine load sharing of physiological arousal, mothers’ and daughters’ fluctuations in GSR were measured continuously during the speech task. To prepare physiological arousal data for analysis, the AcqKnowledge 4.2 software package (AcqKnowledge,

2011) was used to process GSR time series data. Smoothed GSR data were exported into 5-second epochs, as latencies for electrodermal responses can range up to 5 seconds (Boucsein, 2012). Each of the 35 epoch values was the mean GSR value for those 5 seconds. Finally, to control for individual differences in baseline GSR and to facilitate interpretation across participants, we calculated the percent change from baseline for all epochs (Boucsein, 2012; Eastabrook et al., 2013; Swan et al., 2007). Specifically, each individual's baseline GSR mean was subtracted from their GSR mean for each 5-second epoch of the speech task, and the result was divided by their baseline GSR mean. Thus, a value of zero on GSR-percent-change indicated a speech response equal to an individual's own baseline, whereas negative values indicated decreases in GSR and positive values increases in GSR from a person's baseline GSR mean.

## **Results**

### **Preliminary Analyses**

Data from three dyads were excluded from analyses due to technical problems that resulted in missing or unusable physiological data. All variables were inspected for normality of distributions, univariate outliers, and missing values. Relationship Quality was negatively skewed so a square-root transformation was applied prior to conducting preliminary analyses. Dyads (with at least one member) with extreme values greater than 3.5 standard deviations from the sample mean on variables were excluded from analyses in order to prevent outliers from exerting undue influence on the results ( $n = 2$ ). Thus, analyses reported below are based on 61 dyads (Touch  $n = 31$ ; No Touch  $n = 30$ ). For comparison, results of analyses using the full sample are reported in footnotes, below, where the results differed.

Table 2.1 shows the means and standard deviations for Relationship Quality, Baseline Mother Arousal, and Baseline Daughter Arousal. Independent samples  $t$ -tests comparing dyads in the Touch and No Touch conditions on mean Relationship Quality, and Baseline GSR among adolescents revealed no significant differences between conditions,  $ts < 1.13$ ,  $ps > .27$ . A

significant difference was found for baseline GSR level among mothers,  $t(59) = -2.09, p = .041$ .<sup>1</sup> The main analyses (see below) were run on percent change from baseline scores in order to account for individual differences in baseline GSR arousal levels and therefore also to overcome issues associated with mean level differences between conditions on mothers' baseline GSR arousal levels. On average, daughters showed significantly higher GSR percent change from baseline during the speech task than mothers,  $t(59) = -10.36, p < .01$ , which indicates that the speech task was successful as an adolescent-focused stressor.

Table 2.1  
*Means and Standard Deviations of Relationship Quality, and Baseline Mother and Daughter Arousal*

Variable	No Touch	Touch	Total
Relationship Quality	5.98 (0.63)	5.93 (0.57)	5.95 (0.59)
Baseline Mother Arousal	2.34 (1.71)	3.28 (1.79)	2.82 (1.80)
Baseline Daughter Arousal	4.90 (1.19)	5.39 (2.12)	5.15 (1.73)

*Note.* Standard deviations in parentheses. Raw values reported.

### **Physical Closeness, Relationship Quality, and Arousal Levels and Transmission**

**Model 1 description.** We used multilevel modeling to examine the effects of physical closeness and relationship quality on arousal levels and interpersonal transmission of emotional arousal. Specifically, we used two-level models for distinguishable dyads, in which measures (5-second epochs) at Level-1 were nested within dyads at Level-2 (Bolger & Laurenceau, 2013). This approach simultaneously estimates separate parameters for each member of the dyad and allows modeling of within-dyad processes, such as arousal transmission. An unstructured covariance matrix was used in model estimation. In Model 1, we examined the extent to which dyadic partners' arousal levels (i.e., GSR) predicted each other over time. In this model, an individual's arousal level at time  $t$  (i.e., the current 5-second epoch) was modeled as a function of

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<sup>1</sup> This difference was marginally significant when the outliers were included in the analysis,  $t(61) = -1.96, p = .06$ .

her partner's arousal level at time  $t-1$  (i.e., the previous 5-second epoch) using a cross-lagged regression approach. Following Bolger and Laurenceau (2013), we estimated separate intercepts and slopes for mothers (denoted by the subscript  $M$ ) and daughters (denoted by the subscript  $D$ ), as shown below:

Level-1:

$$\text{Arousal}_{ti} = \pi_{0Mi} + \pi_{0Di} + \pi_{1Mi} (\text{Daughter's Arousal}_{t-1i}) + \pi_{1Di} (\text{Mother's Arousal}_{t-1i}) + e_{ti}$$

Level-2:

$$\pi_{0Mi} = \beta_{00M} + \beta_{01M} (\text{Condition}_i) + \beta_{02M} (\text{Relationship Quality}_i) + \beta_{03M} (\text{Condition} * \text{Relationship Quality}_i) + r_{0Mi}$$

$$\pi_{0Di} = \beta_{00D} + \beta_{01D} (\text{Condition}_i) + \beta_{02D} (\text{Relationship Quality}_i) + \beta_{03D} (\text{Condition} * \text{Relationship Quality}_i) + r_{0Di}$$

$$\pi_{1Mi} = \beta_{10M} + \beta_{11M} (\text{Condition}_i) + \beta_{12M} (\text{Relationship Quality}_i) + \beta_{13M} (\text{Condition} * \text{Relationship Quality}_i) + r_{1Mi}$$

$$\pi_{1Di} = \beta_{10D} + \beta_{11D} (\text{Condition}_i) + \beta_{12D} (\text{Relationship Quality}_i) + \beta_{13D} (\text{Condition} * \text{Relationship Quality}_i) + r_{1Di}$$

At Level-1, the outcome ( $\text{Arousal}_{ti}$ ) was a 'stacked' variable reflecting each person in dyad  $i$ 's arousal level at time  $t$  (the variable is stacked because mothers' and daughters' values are in a single data column on top of each other; see Bolger & Laurenceau, 2013). The outcome was modeled as a function of two random intercepts ( $\pi_{0Mi}$  and  $\pi_{0Di}$ ) and two random slopes ( $\pi_{1Mi}$  and  $\pi_{1Di}$ ). The Level-1 slopes reflect the cross-lagged association between each person's arousal level at time  $t$  and their partner's arousal level at time  $t-1$ , and therefore represent the transmission of physiological arousal. Specifically, the Level-1 slope ( $\pi_{1Mi}$ ) reflects the association between a mother's current arousal level and her daughter's arousal level 5 seconds earlier, for dyad  $i$ . Similarly, the Level-1 slope ( $\pi_{1Di}$ ) reflects the association between a daughter's current arousal level and her mother's arousal level during the previous 5-second interval, for dyad  $i$ . The cross-lagged predictors ( $\text{Daughter's/Mother's Arousal}_{t-5i}$ ) were person-mean centered, such that they

reflect deviations from each individual's mean level (note that centering was done at the person-level rather than the dyad-level; see Bolger & Laurenceau, 2013). Due to centering of the cross-lagged predictors, the Level-1 intercepts ( $\pi_{0Mi}$  and  $\pi_{0Di}$ ) reflect the average levels of arousal for mothers and daughters in each dyad  $i$ , respectively.

At Level-2, the Level-1 intercepts and slopes were allowed to vary randomly across dyads and were modeled as a function of Condition (0 = No Touch; 1 = Touch) and Relationship Quality (standardized across dyads). Thus, for mothers,  $\beta_{00M}$  is the estimated mean level of arousal in the No Touch condition at an average level of Relationship Quality,  $\beta_{01M}$  represents the effect of Touch condition (i.e., the difference between Touch and No Touch conditions) on the mean level of arousal,  $\beta_{02M}$  reflects the association between Relationship Quality and the mean level of arousal in the No Touch condition, and  $\beta_{03M}$  is the interaction between Condition and Relationship Quality on the mean level of arousal (i.e., the difference between Touch and No Touch conditions in terms of the association between Relationship Quality and mean arousal). The Level-2 parameters  $\beta_{00D}$ ,  $\beta_{01D}$ ,  $\beta_{02D}$ , and  $\beta_{03D}$  are the corresponding estimates for daughters.

Furthermore, at Level-2,  $\beta_{10M}$  represents the average arousal transmission slope for mothers (i.e., the association between a mother's current arousal level and her daughter's arousal 5 seconds earlier, or daughter-to-mother arousal transmission) in the No Touch condition at the average level of Relationship Quality.  $\beta_{11M}$  represents the difference between conditions in daughter-to-mother arousal transmission at the mean level of Relationship Quality.

$\beta_{12M}$  represents the association between Relationship Quality and daughter-to-mother arousal transmission in the No Touch condition. Finally,  $\beta_{13M}$  represents the interaction between Condition and Relationship Quality on the daughter-to-mother arousal transmission slope. The Level-2 parameters  $\beta_{10D}$ ,  $\beta_{11D}$ ,  $\beta_{12D}$ , and  $\beta_{13D}$  are the corresponding estimates for daughters.

**Model 1 results.** Model 1 examined mean-level differences and cross-lagged correlations of mother and daughter arousal (arousal transmission).

**Mothers' mean level of arousal.** Parameter estimates for mean-level differences in mothers' arousal are shown in Table 2.2. As expected, the non-significant parameter estimates for  $\beta_{01M}$ ,  $\beta_{02M}$ , and  $\beta_{03M}$  indicate that, for mothers, the mean level of arousal did not vary by Condition, Relationship Quality, or their interaction.

**Daughters' mean level of arousal.** Parameter estimates for mean-level differences in daughters' arousal are shown in Table 2.2. The positive, significant parameter estimate for  $\beta_{03D}$  indicated that the effect of Condition on mean level of arousal varied by Relationship Quality<sup>2</sup> (see Figure 2.1a). This significant interaction was followed up with a simple slopes analysis. Contrary to expectations, the slope for the Touch condition was not significant, indicating that, in the Touch condition, daughters' mean level of arousal did not vary by Relationship Quality. However, the slope for the No Touch condition was significant ( $\beta = -.14$ ,  $SE = .06$ ,  $p = .03$ , 95% CI [-.26, -.02]), indicating that, in the No Touch condition, Relationship Quality was significantly negatively related to mean level of arousal.

**Daughter-to-mother arousal transmission.** Parameter estimates for the cross-lagged influence of daughter arousal on mother arousal are shown in Table 2.2. There was evidence for significant daughter-to-mother arousal transmission, on average (see  $\beta_{10M}$ ). However, the non-significant parameter estimates for  $\beta_{11M}$ ,  $\beta_{12M}$ , and  $\beta_{13M}$  indicated that daughter-to-mother arousal transmission did not vary by Condition, Relationship Quality, or their interaction.

**Mother-to-daughter arousal transmission.** Parameter estimates for the influence of Mother Arousal on Daughter Arousal are shown in Table 2.2. There was a marginally significant ( $p = .06$ ) interaction between Condition and Relationship Quality<sup>3</sup> ( $\beta_{13D}$ ). Due to the exploratory nature of this study, this marginally-significant interaction was followed up with a simple slopes analysis to facilitate interpretation. Figure 2.1b plots the association between Relationship Quality

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<sup>2</sup> This effect was in the same direction, but no longer statistically significant when outliers were included in the analysis,  $\beta_{03D} = .22$ ,  $SE = .14$ ,  $p = .12$ , 95% CI (-.05, .49).

<sup>3</sup> This interaction was statistically significant when outliers were included in analyses,  $\beta_{13D} = -.36$ ,  $SE = .17$ ,  $p = .04$ , 95% CI (-.69, -.03)



and mother-to-daughter arousal transmission separately for each Condition. Contrary to expectations, the simple slope for Touch condition was not significant, indicating that among dyads who made physical contact during the stressor, mother-to-daughter arousal transmission (the extent to which mothers' arousal predicted daughters' arousal) did not vary by Relationship Quality. In contrast, mother-to-daughter arousal transmission was significantly associated with Relationship Quality in the No Touch condition, with higher Relationship Quality being associated with greater mother-to-daughter arousal transmission ( $\beta = .44$ ,  $SE = .14$ ,  $p < .01$ , 95% CI [.17, .71]).<sup>4</sup> Thus, in the No Touch condition, mothers' arousal more strongly predicted daughters' arousal at higher levels of Relationship Quality. Regarding effect sizes, Condition and Relationship Quality accounted for 10% of the between-dyad variance in cross-lagged slopes, and adding the interaction increased the variance accounted for to 13%.

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<sup>4</sup> When outliers were included in the analyses, simple slopes were significant for both Touch ( $\beta = .14$ ,  $SE = .07$ ,  $p = .04$ , 95% CI [.00, .28]) and No Touch ( $\beta = .50$ ,  $SE = .16$ ,  $p < .01$ , 95% CI [.19, .81]) conditions.

Table 2.2

*Fixed Effect Estimates from the Multilevel Model 1 Examining Mean-Level Differences and Cross-Lagged Correlations of Mother and Daughter Arousal (Arousal Transmission)*

Outcome	Parameter	Mean Level			Cross-Lagged Correlation (Arousal Transmission)			
		Estimate (SE)	<i>p</i>	95% CI	Parameter	Estimate (SE)	<i>p</i>	95% CI
Mother	Intercept, $\beta_{00M}$	.72 (.17)	< .001	[.39, 1.05]	Intercept, $\beta_{10M}$	.54 (.25)	.04	[.05, 1.03]
Arousal	Condition, $\beta_{01M}$	-.29 (.21)	.16	[-.70, .12]	Condition, $\beta_{11M}$	.27 (.60)	.65	[-.91, 1.45]
	RQ, $\beta_{02M}$	-.06 (.10)	.53	[-.26, .14]	RQ, $\beta_{12M}$	-.06 (.20)	.75	[-.45, .33]
	Condition x RQ, $\beta_{03M}$	-.06 (.12)	.62	[-.30, .18]	Condition x RQ, $\beta_{13M}$	.35 (.35)	.32	[-.34, 1.04]
Daughter	Intercept, $\beta_{00D}$	.64 (.07)	< .001	[.50, .78]	Intercept, $\beta_{10D}$	.58 (.18)	< .01	[.23, .93]
Arousal	Condition, $\beta_{01D}$	-.25 (.12)	.04	[-.49, -.01]	Condition, $\beta_{11D}$	-.02 (.21)	.92	[-.43, .39]
	RQ, $\beta_{02D}$	-.14 (.06)	.03	[-.26, -.02]	RQ, $\beta_{12D}$	.44 (.14)	< .01	[.17, .71]
	Condition x RQ, $\beta_{03D}$	.17 (.08)	.05	[.01, .33]	Condition x RQ, $\beta_{13D}$	-.34 (.18)	.06	[-.69, .01]

*Note.* RQ = Relationship Quality, CI = confidence interval. No Touch = 0, Touch = 1. Approximate *df* = 57.

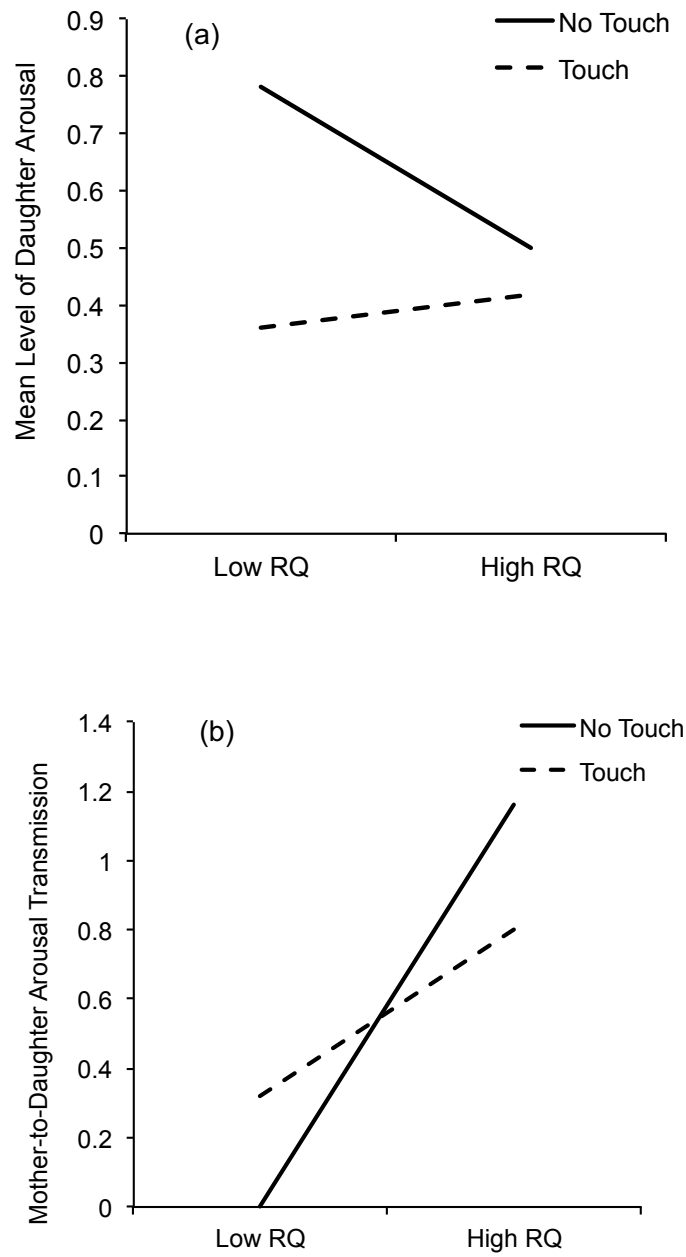


Figure 2.1. Interaction of (a) Condition and Relationship Quality on the mean level of Daughter Arousal, and (b) Condition and Relationship Quality on mother-to-daughter arousal transmission. RQ = Relationship Quality.

## Physical Closeness, Relationship Quality, and Arousal Attenuation

**Model 2 description.** A second multilevel model was used to examine the effects of physical closeness and relationship quality on the attenuation of physiological arousal over the course of the speech task. Specifically, we estimated change over time in mothers' and daughters' arousal using a linear growth model at Level-1. Model 2 was otherwise equivalent to Model 1 reported above. The equation for Level 1 was:

$$\text{Arousal}_{it} = \pi_{0Mi} + \pi_{0Di} + \pi_{1Mi}(\text{Time}_{it}) + \pi_{1Di}(\text{Time}_{it}) + e_{it}$$

At Level-1, the outcome (Arousal<sub>it</sub>) represents person *i*'s Arousal at time *t* as a function of two random intercepts ( $\pi_{0Mi}$  and  $\pi_{0Di}$ ) and two random slopes ( $\pi_{1Mi}$  and  $\pi_{1Di}$ ) reflecting the linear effect of time for mothers and daughters respectively. The time variable ranged from 0 (start of the speech-task) to 1 (end of the speech-task) with equally spaced intervals for intervening observations. Thus, the Level-1 intercepts ( $\pi_{0Mi}$  and  $\pi_{0Di}$ ) reflect the level of arousal at the beginning of the speech task for mothers and daughters, respectively. The Level-1 slopes are the linear effects of time for mothers' arousal and daughters' arousal and therefore represent change in arousal over time, with negative slopes indicating arousal attenuation. The Level-1 slope ( $\pi_{1Mi}$ ) represents the change in mothers' arousal over time, for dyad *i*. Similarly, the Level-1 slope ( $\pi_{1Di}$ ) represents the change in daughters' arousal over time, for dyad *i*. At Level-2, the Level-1 intercepts and slopes were allowed to vary randomly across dyads and were modeled as a function of Condition (0 = No Touch; 1 = Touch) and Relationship Quality (standardized across dyads). Thus, for mothers,  $\beta_{00M}$  is the estimated level of arousal at the beginning of the speech task in the No Touch condition at the average level of Relationship quality,  $\beta_{01M}$  represents the effect of the Touch condition (i.e., the difference between the Touch vs. No Touch conditions),  $\beta_{02M}$  reflects the association between Relationship Quality and the level of arousal at the beginning of the speech task in the No Touch condition, and  $\beta_{03M}$  is the interaction between Condition and Relationship Quality on the level of arousal (i.e., the difference between Touch and No Touch conditions in terms of the association between Relationship Quality and level of

arousal) at the beginning of the speech task. The Level-2 parameters  $\beta_{00D}$ ,  $\beta_{01D}$ ,  $\beta_{02D}$ , and  $\beta_{03D}$  are the corresponding estimates for daughters.

At Level-2,  $\beta_{10M}$  represents mothers' change in arousal over time among dyads in the No Touch condition at the average level of Relationship Quality (Level-1 slope  $\pi_{1Mi}$ ).  $\beta_{11M}$  represents the effect of the Touch condition (i.e., the difference between the Touch and No Touch conditions) on mothers' change in arousal over time at the average level of Relationship Quality.  $\beta_{12M}$  is the effect of Relationship Quality on mothers' change in arousal over time for the No Touch condition. Finally,  $\beta_{13M}$  is the difference between conditions in terms of the association between Relationship Quality and mothers' change in arousal over time. The Level-2 parameters  $\beta_{10D}$ ,  $\beta_{11D}$ ,  $\beta_{12D}$ , and  $\beta_{13D}$  are the corresponding estimates for daughters.

**Model 2 results.** Model 2 examined arousal change over time (linear time slope) of mother and daughter arousal during the speech task.

***Mother arousal attenuation.*** Parameter estimates for the linear time trend of mother arousal are shown in Table 2.3. Mother arousal at the start of the speech task did not vary by Condition, Relationship Quality, or their interaction. Regarding arousal attenuation, in line with expectations, the non-significant parameter estimate for  $\beta_{10M}$  indicated that in the No Touch condition, mothers' arousal did not change significantly over the course of the speech task. Also in line with expectations, the non-significant parameter estimate for  $\beta_{11M}$  indicated that the Touch condition did not differ from the No Touch condition in terms of mothers' change in arousal over time. Similarly, the non-significant parameter estimates for  $\beta_{12M}$  and  $\beta_{13M}$  indicated that mothers' change in arousal over time did not vary by Relationship Quality or the interaction between Condition and Relationship Quality, respectively.

***Daughter arousal attenuation.*** Parameter estimates for the linear time trend of daughters' arousal are shown in Table 2.3. In line with expectations, the significant parameter estimate for  $\beta_{01D}$  indicated that daughters' arousal was lower at the beginning of the speech task in the Touch condition than the No Touch condition. Regarding arousal attenuation, the interaction

between Condition and Relationship Quality ( $\beta_{13D}$ ) was significant. We followed this up with a simple slopes analysis, which revealed that among dyads in the Touch condition, daughters' change in arousal over time did not vary significantly by Relationship Quality ( $\beta = .02$ ,  $SE = .03$ ,  $p = .47$ , 95% CI [-.04, .08]). In contrast, among dyads in the No Touch condition, daughters' arousal was significantly related to relationship quality, such that arousal decreased more steeply over time at higher levels of Relationship Quality ( $\beta = -.12$ ,  $SE = .05$ ,  $p = .03$ , 95% CI [-.22, -.02]). Figure 2.2 displays linear time slopes reflecting daughters' arousal attenuation separately for each condition and for high (+ 1 *SD*) versus low (- 1 *SD*) levels of relationship quality. Regarding effect sizes, Condition and Relationship Quality accounted for 1% of the between-dyad variance in the linear time slopes, and adding the interaction increased the variance accounted for to 7%.

Table 2.3

*Fixed Effect Estimates from the Multilevel Model 2 Examining Arousal Change over Time (Linear Time Slope) of Mother and Daughter Arousal During the Speech-Task*

Outcome	Arousal at Start of Speech Task				Arousal Attenuation (Linear Time Slope)			
	Parameter	Estimate (SE)	<i>p</i>	95% CI	Parameter	Estimate (SE)	<i>p</i>	95% CI
Mother	Intercept, $\beta_{00M}$	.73 (.16)	<.001	[.42, 1.04]	Intercept, $\beta_{10M}$	-.02 (.08)	.79	[-.18, .14]
	Condition, $\beta_{01M}$	-.20 (.23)	.38	[-.65, .25]	Condition, $\beta_{11M}$	-.17 (.12)	.16	[-.41, .07]
	RQ, $\beta_{02M}$	-.05 (.10)	.62	[-.25, .15]	RQ, $\beta_{12M}$	-.03 (.15)	.59	[-.32, .26]
	Condition x RQ, $\beta_{03M}$	-.04 (.13)	.75	[-.29, .21]	Condition x RQ, $\beta_{13M}$	-.03 (.07)	.58	[-.17, .11]
Daughter	Intercept, $\beta_{00D}$	.75 (.09)	<.001	[.57, .93]	Intercept, $\beta_{10D}$	-.22 (.05)	<.001	[-.31, -.12]
	Condition, $\beta_{01D}$	-.24 (.14)	.01	[-.51, .03]	Condition, $\beta_{11D}$	.00 (.06)	.96	[-.12, .12]
	RQ, $\beta_{02D}$	-.07 (.07)	.34	[-.21, .07]	RQ, $\beta_{12D}$	-.12 (.05)	.03	[-.22, -.02]
	Condition x RQ, $\beta_{03D}$	.09 (.10)	.38	[-.11, .29]	Condition x RQ, $\beta_{13D}$	.14 (.06)	.03	[.02, .26]

*Note.* RQ = Relationship Quality, CI = confidence interval. No Touch = 0, Touch = 1. Approximate *df* = 57.

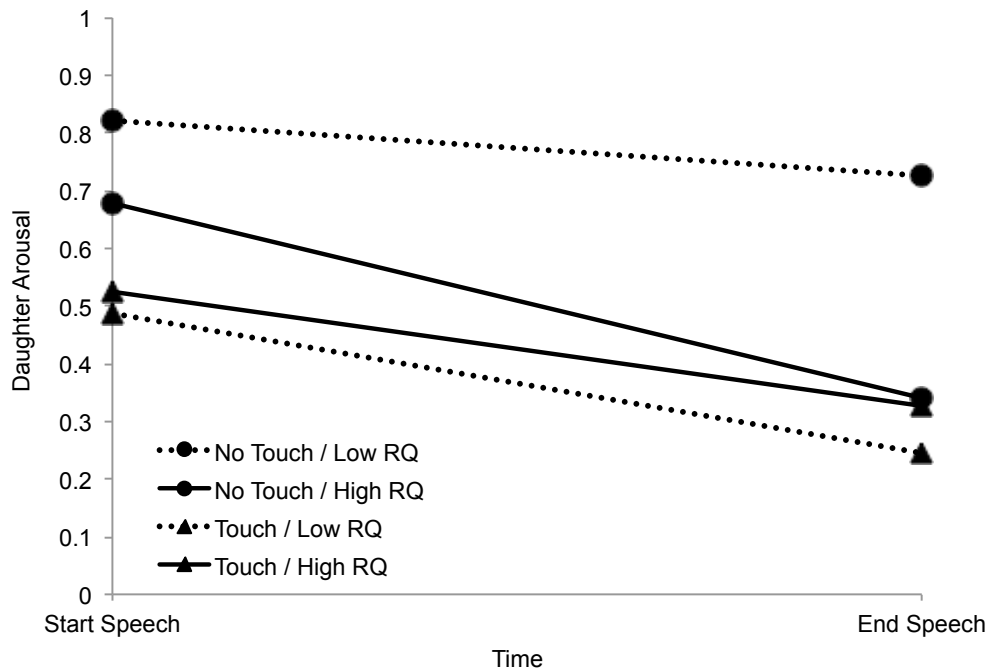


Figure 2.2. Interaction of Condition and Relationship Quality on the change in Daughter Arousal over time (Daughter Arousal Attenuation). RQ = Relationship Quality.

## Discussion

The current study was the first examination of physiological processes in both partners during load sharing (the daughter who experienced stress and the mother who shared the load). Previous research on the effects of physical closeness on stress responses have only measured outcomes in terms of the individual targeted by the threat (Beckes & Coan, 2011; Coan, Beckes, & Allen, 2013; Coan, Kasle et al., 2013; Coan et al., 2006; Conner et al., 2012). As expected, physical closeness was associated with lower adolescent arousal, but contrary to expectations, mother-to-daughter transmission of arousal dampening and adolescent arousal attenuation did not vary by physical closeness alone. Higher relationship quality was associated with lower adolescent arousal, higher mother-to-daughter transmission of arousal dampening, and larger decreases in adolescent arousal over time, as expected. Most strikingly, the finding that the effects of relationship quality were stronger in the No Touch condition compared to the Touch



condition goes against prior research that has shown an additive effect of relationship quality and physical closeness on stress responses (Coan et al., 2006). Instead, the current findings suggest that relationship quality is more strongly related to maternal load sharing of daughters' stress when mothers and daughters are unable to be in physical contact with each other.

### **Relationship Quality and Physical Closeness**

Rather than an additive effect of relationship quality and physical closeness, we found that, in the absence of physical contact, load sharing was observed only among dyads with higher relationship quality. Specifically, daughter arousal, mother-to-daughter arousal transmission, and daughters' arousal attenuation over time varied by relationship quality in the No Touch condition, but not significantly so in the Touch condition. These results may indicate that physical closeness to mothers functioned as a relationship cue to all daughters in the current sample. In other words, regardless of the quality of their relationship with their mothers, feeling the comfort of physical closeness reminded daughters that they were not alone in managing the stressful experience. As a caveat to this interpretation, we note that the average relationship quality was relatively high and variability in relationship quality was quite limited in the current sample. Nevertheless, daughters with relatively low relationship quality in the Touch condition may have been cued to the availability of support by the touch of their mother, which they otherwise may not have presumed to be available. In contrast, daughters in the No Touch condition with relatively low relationship quality did not benefit from the supportiveness cue of physical contact, and consequently, they were less able to efficiently manage their stress (i.e., their load was not shared). Although the current findings for mother-to-daughter arousal transmission should be interpreted with caution, as the relevant interaction effect was just above the conventional  $p < .05$  cutoff, these findings suggest that high relationship quality may buffer against threat similarly to the physical comfort of a loved one.

Another possible explanation for the lack of additive effects of relationship quality and physical closeness is that the regulatory processes in mother-daughter relationships differ from

regulatory processes in romantic relationships, the relationship context in which previous research has shown an additive effect (Coan et al., 2006). Primary caregiving relationships are typically the first relational context in which emotions are socialized, and the social regulation of emotion typically has a long, rich history in the mother-child relationship (Fogel, 1993; Kopp, 1989). In this way, the mother-daughter relationship is hierarchical (Smetana et al., 2006), with a long history of top-down regulation from mother to daughter. In comparison, romantic relationships typically do not form until adolescence or adulthood (Connolly, Craig, Goldberg, & Pepler, 2004), when the foundations of individuals' emotion regulation in social contexts have already been formed within the family context. Spousal relationships are not typically hierarchical but are more egalitarian, with mutual influences. It is possible that there is a floor effect of maternal regulation of daughters' stress when physical comfort is present, based on the longer history of hierarchical social regulation in mother-child relationships compared to romantic relationships. Specifically, mother-daughter interactions that vary by relationship quality (e.g., support seeking and giving, ability to resolve conflicts; Schwarz, Trommsdorff, Albert, & Mayer, 2005) are well-established, given the long relationship history and, most likely, history of living in close proximity to one another. In contrast, there is likely more variability within romantic partners in terms of the length of the relationship, and interpersonal interactions that vary by relationship quality may or may not be well established. Thus, when mothers provide physical comfort to their daughters during stress, there might be little additional comfort that can be gained by relationship quality.

### **Load Sharing and Maternal Arousal**

The influence of mothers' arousal on daughters' arousal, in the context of lower adolescent arousal and more efficient arousal attenuation, represents the distribution of adolescents' emotional response in a close mother-daughter relationship. Although we found that maternal load sharing of daughters' emotions did not influence maternal SNS activity (mothers' arousal, daughter-to-mother arousal transmission, and arousal attenuation did not vary by

physical closeness, relationship quality, or their interaction), we did find that mothers' arousal was linked to daughters' arousal. Thus, as suggested by SBT (Beckes & Coan, 2011), load sharing likely functions by decreasing the perceptions of threat in the individual experiencing stress, rather than the load sharing partner literally taking on some of the emotional load (i.e., showing increases in arousal). However, as we observed mother-to-daughter transmission of arousal dampening at higher levels of physical closeness and relationship quality, the emotional state of the load-sharing partner does play a role in how emotional loads are shared between close relationship partners.

### **Load Sharing in Temporal Interpersonal Emotion Systems**

Moment-to-moment interpersonal processes stabilize over time into enduring patterns (e.g., dyadic tendencies) and relationship characteristics such as relationship quality (Butler, 2011; Granic, 2005; Lichtwarck-Aschoff, Kunnen, & Geert, 2010). Individual emotions are situated in a broader, interpersonal context comprised of others' emotions across the life span (Butler, 2011; Fogel, 1993; Thompson, 1994). One person's emotions emerge not only from the temporal coordination of their own emotion response (e.g., physiological arousal in response to a threat) but also from the emotion responses of others (Butler, 2011; Crowell et al., 2014; Ferrer & Helm, 2013). Thus, emotions are regulated interpersonally in TIES, in which individuals' emotions are linked to their partners' (Butler, 2011). In the current study, mother-daughter TIES were observed in the real-time influence of mother arousal on daughter arousal. In the absence of physical contact, relationship closeness forged a link between mothers' and daughters' emotions in real time. In this manner, high relationship quality had the same buffering effect as physical closeness—being in a high-quality relationship is akin to feeling a relationship partner's touch during a stressful encounter. While this was observed in the current study for adolescent daughters in relation to their mothers, further research is needed to examine to what extent this generalizes to other forms of TIES (e.g., romantic couples, friends).

Results also suggest that the negative emotion regulation outcomes associated with lower

relationship quality (Beckes & Coan, 2011) can be overcome by physical contact. Physical closeness to relationship partners elicits biological processes associated with feelings of safety and well-being, such as the release of oxytocin (Matthiesen, Ransjö-Arvidson, Nissen, & Uvnäs-Moberg, 2001) and decreased neural responses to threat (Conner et al., 2012). These hormonal and neural responses may be other bases of TIES. The perceived reliability of relationship partners is important for load sharing—individuals in relationships characterized by unresponsiveness and low support rely more on their own self-regulation capacity in challenging situations and therefore have a relative deficit of resources (Beckes & Coan, 2011; Fitzsimons & Finkel, 2011), except, perhaps, for when a relationship cue is present, such as physical contact.

Taken together, the results of the current study provide support both for the TIES model (Butler, 2011) and SBT (Beckes & Coan, 2011). Emotions are inherently social, and emotions are regulated interpersonally (Campos et al., 2011). Interpersonal emotion regulation occurs through the temporal linking of close relationship partners' emotions (Butler, 2011). To examine human emotion and emotion regulation as primarily individual-level processes is to decontextualize humans from the social environment to which we have adapted through evolution (Beckes & Coan, 2011). Thus, an interpersonal approach is necessary for the study of optimal emotion and emotion regulation, as individuals isolated from the social context are functioning at a relative deficit (Beckes & Coan, 2011).

### **Limitations and Future Directions**

In interpreting the results of the current study, it is important to note several features of the sample: the average level of relationship quality and socioeconomic status were high, and only mother-daughter dyads were examined. Future research is needed to examine load-sharing processes at lower levels of relationship quality. As emotion regulation varies by socioeconomic status (Raver, 2004), load sharing should be also examined in samples that are more diverse. In addition, as emotion, its regulation, and its socialization vary by sex (Collins & Russell, 1991; Perry-Parrish & Zeman, 2011), future research is needed to examine if load sharing differs in

other parent-child dyads types. The load sharing processes examined in the current study may also not generalize to other types of close relationships (e.g., romantic partners, close friends). Another limitation of the current study was that the sample was relatively small. The presence of two outliers (one extreme high outlier on maternal GSR, one extreme low outlier on mother-daughter relationship quality) in this relatively small sample influenced the results of the study, as seen in the differences in the results with and without these outliers. We examined the data for these two dyads and found that in one dyad, the mother had relatively high depression symptoms, and in the other dyad, the daughter had relatively high social anxiety symptoms. Thus, it is possible that these two dyads differ significantly from the majority of the sample based on normative internalizing symptomatology. Further research is needed to better examine load-sharing processes in dyads across a broader range of psychosocial functioning. It is possible, for example, that dyads with elevated levels of depression would share their emotional loads less than non-depressed dyads (Crowell et al., 2014).

The current study examined load sharing in the context of one component of the emotion system, the physiological SNS arousal as indexed by electrodermal activity. TIES consist of interactions among all components of the emotion system (Butler, 2011), which includes emotional experiences and expressions in addition to physiological arousal (Hollenstein & Lanteigne, 2014). An important direction for future research is to examine concordance among emotion system components, both within individuals and the TIES of which they are a part, during load sharing with close relationship partners. Examining the complex relations between concordance at the individual level as well as the dyadic level during interpersonal emotion regulation will clarify emotion regulation mechanisms.

## **Conclusion**

In conclusion, the current study demonstrates that the temporal dynamics of emotional arousal are subject to load sharing in a dyadic context. In line with SBT, emotional load sharing is a function of physical closeness, and, at greater physical distance, relationship quality. Thus, high

relationship quality buffers against threat in a similar way to the physical comfort of a loved one. Sharing the burden of emotional distress is one benefit of close relationships.

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**Chapter 3: Socioemotional Flexibility in Mother-Daughter Dyads:  
Riding the Emotional Rollercoaster across Positive and Negative  
Contexts**

## Abstract

Socioemotional flexibility is a dyad-level indicator of adaptive interpersonal emotion regulation, and involves the temporal dynamics of shifting in and out of emotion states over time and the range of emotional states expressed during interpersonal interactions. Higher flexibility is associated with better psychosocial adjustment. In line with the Flex3 model, flexibility during interactions between 96 mothers and their adolescent daughters ( $M_{age} = 13.99$  years) at two different time scales were examined in the current study: (1) within positive and negative emotional contexts (dynamic flexibility) and (2) between positive and negative emotional contexts (reactive flexibility). Mothers and daughters completed the Emotional Rollercoaster task—a series of five 3-minute discussions on times they felt the following strong emotions towards each other: (1) Happy/Excited, (2) Worried/Sad, (3) Proud, (4) Frustrated/Annoyed, and (5) Grateful. In general, higher dynamic (within-discussion) flexibility and moderate levels of flexibility across discussions were associated with lower internalizing symptoms and higher relationship quality. Results support the Flex3 model and also suggest that in addition to emotional valence (positive versus negative), specific emotion contexts (e.g., sad versus frustrated) differentially influence socioemotional flexibility in mother-daughter dyads.

*Keywords:* Flexibility, dynamic systems, psychosocial adjustment, internalizing problems, mother-adolescent interactions

## Socioemotional Flexibility in Mother-Daughter Dyads:

### Riding the Emotional Rollercoaster across Positive and Negative Contexts

The “emotional rollercoaster” of adolescence (e.g., increased emotional intensity; Rosenblum & Lewis, 2003) is experienced in the context of close relationships, such as with parents. What does it mean to be emotionally well adjusted in relationships? Consider a mother and her adolescent daughter who are never negative towards each other, regardless of the context. At first, it might seem that they are well adjusted. However, it is sometimes adaptive to experience and express negative emotions, such as in response to interpersonal challenges (Walle & Campos, 2012). In addition, the increased emotionality of adolescence is an indicator of typical development (Hollenstein & Loughheed, 2013). Indeed, one dyadic characteristic of high-quality relationships and adaptive psychosocial adjustment is the ability to express, and recover from, negative emotions during interpersonal interactions (Granic, O’Hara, Pepler, & Lewis, 2007). Socioemotional rigidity is the tendency for a dyad to remain in the same emotional state regardless of context, and is conceptualized as an emotion regulation difficulty in which dyads are not able to modify emotions according to situational demands (Hollenstein, Potworowski, & Lichtwarck-Aschoff, 2013). In contrast, socioemotional flexibility is the adaptive ability to adjust emotions according to situational demands (Hollenstein et al., 2013; Westphal, Seivert, & Bonanno, 2010). Socioemotional flexibility has two characteristics: the temporal qualities of shifting in and out of emotion states over time (Hollenstein, 2015; Hollenstein, et al., 2013), and the ability to express a range of emotional states in accordance with situational demands (Westphal et al., 2010). Socioemotional flexibility is important for both parents’ and adolescents’ well being, as it indicates the ability to adjust to the changing emotional circumstances of adolescence (Hollenstein & Loughheed, 2013; van der Giessen, Hollenstein, et al., 2014).

Research on parent-adolescent flexibility has focused on conflict discussions that elicit a broad range of emotions (e.g., Granic et al., 2007; Hollenstein & Lewis, 2006; van der Giessen, Branje, Frijns, & Meeus, 2013). However, specific emotions that are of like kind in terms of

valence (e.g., sadness and anger are both negatively valenced) have a different functional significance for interpersonal interactions (Walle & Campos, 2012), and may be associated with flexibility in different ways. The goal of the current study was to examine flexibility in mother-daughter dyads across specific positive (e.g., happy, proud) and negative (e.g., sad, frustrated) emotional contexts, and its associations with psychosocial adjustment (depressive, general anxiety, and social anxiety symptoms; relationship quality).

### **Flexibility at Different Time Scales**

The dynamic systems approach to emotions (Butler, 2011; Camras, 2011; Hollenstein & Lewis, 2006; Lewis, 2000) emphasizes their temporal qualities, such as how they unfold at different time scales. Emotional processes at shorter time scales (e.g., emotional states within moments) give rise to processes at longer time scales (e.g., moods over days), which in turn constrain processes at shorter time scales (established moods lead to a greater likelihood of certain emotional states; Lewis, 2000). The dynamic systems approach also emphasizes the social context. Partners in close relationships form temporal interpersonal emotion systems—emotions are expressed and regulated in dyad-level systems (Butler, 2011). In line with the dynamic systems approach, there are two important distinctions to be made in research on socioemotional flexibility. First, emotional content (i.e., specific emotions observed) is distinguished from structure (i.e., emotional variability independent of content; e.g., Granic et al., 2007; Hollenstein & Lewis, 2006). An approach that focuses on dyadic emotional structure assumes that all emotional states are adaptive in at least some contexts, and that flexibility in emotions (i.e., how emotions are regulated) is more important for psychosocial adjustment than whether or not “optimal” emotion states are experienced, such as a lack of negative emotions (Granic et al., 2007; Hollenstein et al., 2013). The second distinction concerns whether the individual or dyad is the unit of analysis (Moore et al., 2013). Individual-level flexibility refers to the variability of within-person emotions, independent of the social context, whereas dyadic flexibility refers to the emotional variability of a dyadic system and thus inherently includes the social context (van der



Giessen, Hollenstein, et al., 2014). Dyad-level flexibility is a better predictor of psychosocial outcomes than individual-level flexibility in parent-adolescent interactions (van der Giessen, Hollenstein, et al., 2014). Thus, the focus of the current study was the structure of dyadic emotions as an indicator of interpersonal regulatory processes.

In line with the dynamic systems approach, the Flex3 model of socioemotional flexibility (Hollenstein, 2015; Hollenstein et al., 2013) defines flexibility as a process at three time scales. At the micro time scale, *dynamic flexibility* refers to moment-to-moment shifts in emotional states within one emotion context (e.g., a conflict discussion; Hollenstein et al., 2013). Meso-level flexibility refers to shifts in emotional states between emotion contexts (e.g., a change in discussion topics; Hollenstein et al., 2013). Shifts in emotional dynamics according to situational demands are referred to as *reactive flexibility*, which involves inhibiting previously experienced emotions so that new emotion dynamics can arise as emotional contexts change (Hollenstein et al., 2013). For example, a mother and her adolescent daughter show relatively low flexibility during a conflict interaction, in which they both display predominantly neutral emotion as they exert efforts to regulate their emotions to avoid becoming highly negative. However, after the mother makes a joke and the context shifts from a conflict to a positive interaction, flexibility increases as the mother-daughter dyad relax their regulatory efforts and easily shift in and out of a variety of emotional states. Macro-level *trait flexibility* refers to changes in flexibility across months or years (Hollenstein et al., 2013). The current study tested the Flex3 model by examining flexibility at the two shorter time scales: dynamic and reactive flexibility.

Dynamic flexibility is associated with positive psychosocial outcomes. For example, in young children, parent-child dynamic flexibility is negatively associated with children's externalizing problems over two years (Lunkenheimer, Olson, Hollenstein, Sameroff, & Winter, 2011). In addition, low parent-child dynamic flexibility (i.e., rigidity) is positively associated with children's externalizing and internalizing problems (Hollenstein, Granic, Stoolmiller, & Snyder, 2004). Among parent-child dyads seeking treatment for children's externalizing problems,

reductions in externalizing symptoms due to treatment success are associated with gains in dynamic flexibility during parent-child conflicts (Granic et al., 2007).

Reactive flexibility is also associated with positive psychosocial outcomes. Reactive flexibility can be observed in changes in dynamic flexibility across emotional contexts (Hollenstein et al., 2013). Hollenstein and Lewis (2006) examined mother-daughter dynamic flexibility across three interactions tasks with an A-B-A design, in which dyads first discussed a positive topic (e.g., planning a party), then a conflict topic, and then another positive topic. Dynamic flexibility was lowest during the conflict discussion and highest during the two positive discussions (Hollenstein & Lewis, 2006). More negative emotions were expressed during the conflict discussion than the positive discussions, which suggests that flexibility decreases in contexts that are challenging (Hollenstein & Lewis, 2006).

### **Flexibility in Parent-Adolescent Dyads**

Adolescents are particularly susceptible to psychosocial adjustment difficulties (e.g., internalizing problems), which are related to the heightened emotional intensity of typical adolescent development (Graber, Sontag, Lerner, & Steinberg, 2004; Hollenstein & Loughheed, 2013). The ability to flexibly adjust to changing emotional contexts in parent-adolescent interactions is related to adolescent well being (van der Giessen, Hollenstein, et al., 2014). Dynamic flexibility in mother-adolescent conflict interactions is associated with lower mother and adolescent internalizing symptoms (van der Giessen, Hollenstein, et al., 2014) and higher mother-adolescent relationship quality (van der Giessen, Branje, et al., 2014). Regarding reactive flexibility, in the Hollenstein and Lewis (2006) study described previously, dyads who experienced higher levels of stress showed lower reactive flexibility across the interactions than dyads who experienced lower stress, indicating that dyads who experienced higher levels of stress were less able to adapt to changing emotional circumstances.

Previous research has examined parent-adolescent flexibility in contexts that are generally positive (e.g., brainstorming a fun activity) or negative (e.g., conflict discussion;

Hollenstein & Lewis, 2006; van der Giessen, Branje, et al., 2014; van der Giessen, Hollenstein, et al., 2014). However, specific positive (happy, proud) and negative (sad, frustrated) emotions likely differ in terms of interpersonal processes, based on their unique functional significance (Walle & Campos, 2012). The current study extends previous research by examining both dynamic and reactive flexibility across (1) multiple reversals of positive and negative emotions, and (2) in the context of specific positive (e.g., happy, proud) and negative (e.g., sad, frustrated) emotions, in line with the Flex3 model (Hollenstein et al., 2013). Previous studies have involved an A-B-A design to examine reactive flexibility (Granic et al., 2007; Hollenstein & Lewis, 2006). The current study employed a novel A-B-A-B-A design with the Emotional Rollercoaster task, in which there were four switches between positive and negative emotional contexts. We expected this design to yield a more nuanced picture of how flexibility is associated with psychosocial adjustment—not only might flexibility vary by specific emotions, but it might be more difficult to regain flexibility after the experience of some negative emotions than others.

### **The Current Study**

We examined dynamic and reactive flexibility between mothers and their adolescent daughters with the Emotional Rollercoaster task, in which the valence of the emotional interaction alternated from positive to negative in the following sequence: (1) Happy/Excited, (2) Worried/Sad, (3) Proud, (4) Frustrated/Annoyed, and (5) Grateful. Mothers and their daughters were the focus of the current study, rather than other parent-adolescent dyad types (e.g., father-daughter, mother-son), as adolescents females tend to share more with their parents than adolescent males, and women tend to be more emotionally expressive than males (Brebner, 2003; Collins & Russell, 1991; Perry-Parrish & Zeman, 2011). Psychosocial adjustment was examined in terms of internalizing symptoms (e.g., depression, anxiety) as females show a higher risk for internalizing symptoms in adolescence compared to other psychosocial adjustment issues (e.g., externalizing symptoms; Graber et al., 2004).

The first objective of the current study was to examine associations between dynamic

flexibility and psychosocial adjustment (mother and daughter internalizing symptoms; relationship quality). In line with the Flex3 model and previous research, we hypothesized that higher dynamic flexibility would be associated with better psychosocial adjustment (lower mother and daughter internalizing symptoms, higher relationship quality). The second objective was to examine heterogeneity in mother-daughter reactive flexibility using multivariate latent class growth analysis (Nagin, 2005). This approach classifies dyads into profiles based on similarities among multiple indicators, and was selected because it can be used to test non-linear trajectories (Berlin et al., 2014; Nagin, 2005). We hypothesized that a range of latent classes would emerge, with some dyads showing higher reactive flexibility across contexts (i.e., a more pronounced zig-zag shape of dynamic flexibility across discussions) than other dyads in line with previous research and theory (e.g., Hollenstein & Lewis, 2006; Hollenstein et al., 2013). We did not have hypotheses regarding the associations between dynamic or reactive flexibility and specific emotional contexts as no research to date has examined these associations, but we examined these associations in an exploratory manner. The third objective was to examine associations between individual differences in reactive flexibility and psychosocial adjustment. We hypothesized that higher reactive flexibility would be associated with better psychosocial adjustment than lower reactive flexibility.

## **Method**

### **Participants**

Participants were a community sample of 96 typically-developing adolescent females and their mothers. Adolescents' ages ranged from 13 to 16 years old ( $M = 13.99$ ,  $SD = .87$ ). Mothers' ages ranged from 32 to 57 years old ( $M = 44.68$ ,  $SD = 5.40$ ). Participants were recruited by telephone from a participant database maintained by the Department of Psychology at a university in Southern Ontario, and through posters in community and online locations such as malls, libraries, and Kijiji. Approximately 50% of families had a gross family income greater than \$100,000 per year, 25% had an income between \$75,000 and \$100,000 per year, 15% had an

income between \$40,000 and \$75,000 per year, 6% had an income between \$25,000 and \$40,000 per year, and 4% had an income less than \$25,000 per year. Mothers reported their marital status as married (77%), living with a domestic partner (8%), divorced (6%), separated (6%), and single (2%). Mothers identified their own ethnicities as European Canadian (82%), Other (10%), First Nations Canadian (4%), Central/South American (2%), African (1%), and East Asian (1%). Mothers identified their daughters' ethnicities as European Canadian (77%), Other (15%), First Nations Canadian (5%), Central/South American (2%), and South Asian (1%). Mothers and daughters each received \$15 for participating.

### **Procedure**

At the beginning of the laboratory session, mothers and daughters received a letter of information. Mothers provided informed consent for themselves and their daughter, and daughters provided assent to participate. The laboratory session took place in an observation room and participants were seated in comfortable chairs beside each other. The observation room was equipped with obscured video cameras and psychophysiological recording equipment that were monitored from an adjacent room. After informed consent was obtained, a female experimenter introduced participants to the general procedures of the study, and then participants filled out a series of questionnaires online. Questionnaires pertained to demographics, internalizing symptoms, and relationship quality. Participants then completed a paper questionnaire to indicate their baseline self-reported feelings (see Measures for details).

Next, physiological sensors were applied to participants by female experimenters to measure electrodermal activity, heart rate, and respiration. Then, to measure participants' normal resting physiological states, participants sat quietly while watching a neutral nature film clip for approximately 2.5 minutes. Physiological data were not analyzed as part of the current study. Following the baseline phase, participants filled out a questionnaire, developed for the current study, to determine the topics for the five discussions of the Emotional Rollercoaster task. The questionnaire consisted of five items, one to brainstorm a topic for each emotion discussion.

Participants were asked to list one or two possible topics in response to the following five questions: (1) “I felt happy or excited about my mother/daughter when...” (e.g., happy about spending time together); (2) “I felt worried or sad about my mother/daughter when...” (e.g., worried about her well-being); (3) “I felt proud of my mother/daughter when...” (e.g., proud of her accomplishments); (4) “I felt frustrated or annoyed towards my mother/daughter when...” (e.g., annoyed at communication difficulties); and (5) “I felt grateful for or positive towards my mother/daughter when...” (e.g., when she does something nice for me). Participants used these completed questionnaires as reminders for what they wanted to talk about for each of the discussions. Then, in the Emotional Rollercoaster task, participants had a series of five 3-minute discussions about the emotions they felt towards each other, with the valence of the emotion topics switching from positive to negative and back to positive several times in a fixed order: (1) Happy/Excited, (2) Worried/Sad, (3) Proud, (4) Frustrated/Annoyed, and (5) Grateful. All participants were debriefed and compensated at the end of the lab session.

## **Measures**

### **Psychosocial adjustment questionnaires.**

**Depressive symptoms.** The Beck depression inventory, second edition (BDI-II; Beck, Steer, & Brown, 1996) measures the presence and severity of depressive symptoms in adolescents and adults with 21 items (Krefetz, Steer, Gulab, & Beck, 2002). For each item, participants selected one of four statements that reflect the extent to which they have experienced each symptom in the last two weeks (e.g., 0 = *I do not feel sad*; 1 = *I feel sad much of the time*; 2 = *I am sad all the time*; and 3 = *I am so sad or unhappy I can't stand it*). Two items from the original questionnaire, pertaining to sex and suicidal thoughts, were omitted from the adolescent daughters' form to comply with the institutional research ethics board. The item pertaining to sex remained on the mother form. The BDI-II showed high internal consistency for mothers ( $\alpha = .89$ ) and daughters ( $\alpha = .96$ ). Depressive Symptoms used in analyses was the mean of all items.

**General anxiety symptoms.** Anxiety symptoms were assessed with the Beck anxiety

inventory (BAI; Beck, Epstein, Brown, & Steer, 1988). The BAI is a 21-item scale that measures the presence and severity of anxiety symptoms in adolescents and adults. For each item (e.g., “Unable to relax”, “Nervous”), participants selected one of four statements that reflect the extent to which they have experienced each symptom in the last two weeks (0 = *not at all*; 3 = *Severely, I could barely stand it*). The BAI showed high internal consistency for mothers ( $\alpha = .90$ ) and daughters ( $\alpha = .91$ ). General Anxiety Symptoms used in analyses was the mean of all items.

***Social anxiety symptoms.*** The social anxiety scale for adolescents, short form (SAS-A; Myers, Stein, & Aarons, 2002) is a 13-item questionnaire that measures social anxiety (fear of negative evaluation by others, social avoidance and distress). For each item, daughters indicated on a 5-point scale (1 = *not at all*; 5 = *all the time*) the extent to which each statement is characteristic of them (e.g., “I’m afraid that others will not like me”). The SAS-A short form showed high internal consistency ( $\alpha = .93$ ). Daughter Social Anxiety Systems used in analyses was the mean of all items.

The Liebowitz social anxiety scale (LSAS; Liebowitz, 1987) is a 24-item questionnaire that measures adults’ social anxiety symptoms. Mothers indicated on a 4-point scale how much fear they experience during (0 = *none*; 3 = *severe*) and how frequently (0 = *never*; 3 = *usually*) they avoid situations (e.g., “Going to a party”, “Being the center of attention”). The LSAS showed high internal consistency ( $\alpha = .97$ ). Mother Social Anxiety Symptoms used in analyses was the mean of all items.

***Relationship quality.*** Relationship quality was measured with a questionnaire developed by Beazer (1998) based on three separate relationship quality scales (Cicirelli, 1980; Esposito, 1995; Risman & Park, 1988). Participants rated eight items (e.g., “How much do you feel that you can turn to your mother/daughter when you are in need of help or guidance?”, “In general, how close to you feel to your mother/daughter?”) on a 7-point scale (1 = *not at all*, 7 = *very, very much or very, very close*). The relationship quality questionnaire showed high internal consistency for mothers ( $\alpha = .90$ ) and daughters ( $\alpha = .93$ ). Mother- and daughter-reported mean

relationship quality scores were moderately, positively correlated ( $r = .55, p < .001$ ). In line with previous research using this measure (Lougheed, Koval, & Hollenstein, in press), a dyadic measure of Relationship Quality was derived by calculating the mean of mothers' and daughters' scores to examine associations between flexibility and the overall level of relationship quality.

#### **Laboratory measures.**

***Self-reported emotions.*** Self-reported emotions at baseline (prior to the discussion tasks) and after each of the five emotion discussions were measured with a modified version of the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). In the current study, the PANAS consisted of 10 emotion items of positive and negative emotional valence and were selected to reflect the topics of the five emotion discussions. The positive emotion items were Happy, Excited, Valued, Proud, and Grateful. The negative emotion items were Guilty, Irritated, Worried, Nervous, and Frustrated. Participants indicated the extent to which they felt each emotion on a 5-point scale (1 = *Not at all*, 5 = *Extremely*). The means of all positive and negative items, separately, were calculated as measures of self-reported Positive Emotion and Negative Emotion, respectively. The internal consistency of the Positive Emotion scale was acceptable across all tasks for mothers ( $\alpha$  range .72-.90) and daughters ( $\alpha$  range .80-.89). The internal consistency of the Negative Emotion scale was acceptable across all tasks for mothers ( $\alpha$  range .68-.79) and daughters ( $\alpha$  range .78-.88).

***Observed emotions.*** Using the videotaped observations, each participant was coded with a 5-code version of the Specific Affect Code (SPAFF5; Gottman, McCoy, Coan, & Collier, 1995) developed for this study (Lougheed & Hollenstein, 2014). SPAFF5 codes are based on facial expressions, body language, and verbal characteristics to capture moment-to-moment changes in emotional tone. The five mutually exclusive SPAFF5 codes were based on combining the original codes into the following categories: (1) Positive Emotions (humor, joy, and affection); (2) Interest; (3) Neutral; (4) Internalizing Negative Emotions (e.g., fear, sadness); and (5) Externalizing Negative Emotions (e.g., contempt, anger). Coding was completed by a team of



four undergraduate research assistants using Noldus Observer 11.0. The onset and offset times for all codes were applied to mothers and daughters, continuously in real time. The inter-rater reliability was good, with the average percent agreement for frequency-sequence based analyses of 77% and  $K = .72$ , and an average duration-sequence-based analyses of 99%. The frequency of mothers' and daughters' observed Positive Emotions, Interest, Internalizing Negative Emotions, and Externalizing Negative Emotions were used in analyses.

**Flexibility.** Flexibility measures were derived from the SPAFF5 data using GridWare 1.1 (Lamey, Hollenstein, Lewis, & Granic, 2004). GridWare was used to create trajectories of dyadic emotions on a 5 by 5 grid, with mothers' expressed emotions on the x-axis and daughters' expressed emotions on the y-axis (see Figure 3.1). Two measures of dynamic flexibility were derived from the grids, each representing a primary aspect of flexibility (Hollenstein, 2013; van der Giessen, Branje, et al., 2014). *Dispersion* reflects the range of dyadic states across the grid, and is the sum of the squared proportional duration across all cells, adjusted by the total number of cells on the grid. This value is then inverted so that values range from 0, indicating no dispersion (all behavior occurred in one cell) to 1, indicating maximum dispersion (behavior was equally distributed across the grid). The formula for dispersion is:

$$1 - \frac{[(n \sum (d_i/D)^2) - 1]}{n - 1}$$

where  $D$  is the total duration of the discussion,  $d_i$  is the duration in cell  $i$ , and  $n$  is the total number of possible cells in the grid. The second measure of flexibility, *Transitions*, refers to the number of changes between cells on the grid. For both Dispersion and Transitions, higher values indicate greater flexibility.

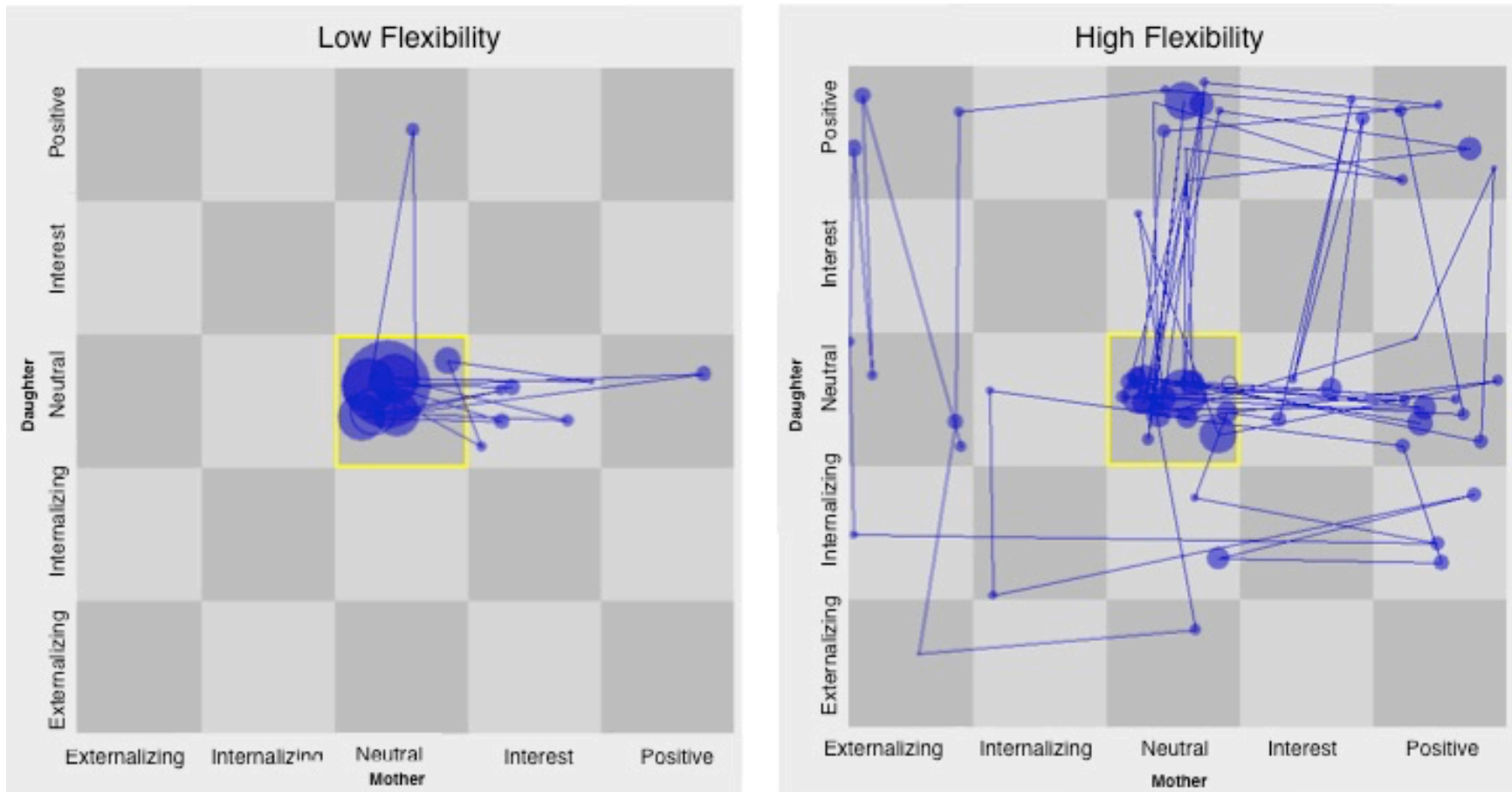


Figure 3.1. Two plots derived from GridWare (Lamey et al., 2004) showing trajectories of mothers' and daughters' observed emotions during a discussion task for two different dyads, one showing low flexibility and one showing high flexibility.

## Results

### Preliminary Analyses

Table 3.1 shows the means, standard deviations, and correlations for internalizing symptoms, Relationship Quality, and dynamic flexibility (Dispersion and Transitions) during the five discussions. Observational data were missing for all discussions for one dyad due to issues with recording equipment, so this dyad was excluded from all analyses. Observational data were missing for Discussion 2 (Worried/Sad) for one dyad due to issues with recording equipment, but these data were retained as missing data were imputed with full information maximum-likelihood estimation with Mplus software version 7.3 for the main analyses (Muthén & Muthén, 2015). Thus, analyses were run on a total of 95 dyads. All variables were inspected for normality and outliers. Several variables (daughter Depressive Symptoms; mother General Anxiety Symptoms and Social Anxiety Symptoms; daughter self-reported Negative Emotion at Discussions 1, 2, 3, and 5; mother self-reported Negative Emotion at Baseline, and Discussions 1 through 3; observed Positive Emotions for mothers at Discussion 1; observed Interest for mothers at Discussion 3 and for daughters at Discussions 1, 3, and 4; observed Internalizing Negative Emotions for mothers at all Discussions and for daughters at Discussions 1, 3, 4, and 5; and observed Externalizing Negative Emotions for mothers and daughters at all Discussions) had univariate outliers ( $z > 3.5$ ), which were Winsorized to reduce their influence. To overcome issues of non-normal distributions in internalizing symptom measures and mother- and daughter-reported and observed emotions, bootstrapping (Mooney & Duval, 1993) was used in analyses with these variables. Bootstrapping is a non-parametric approach that is not based on assumptions of normality of the theoretical sampling distribution, as it approximates sampling distributions by sampling from the data with replacement.

Table 3.1

*Means and Standard Deviations of Internalizing Symptoms, Relationship Quality, and Flexibility (Dispersion and Transitions) and their Correlations*

	Mother Symptoms			Daughter Symptoms			Relationship Quality	<i>M (SD)</i>
	Depressive	General Anxiety	Social Anxiety	Depressive	General Anxiety	Social Anxiety		
Mother Symptoms								
Depressive	—							.46 (.36)
General Anxiety	.71**	—						.35 (.30)
Social Anxiety	.59**	.48**	—					.68 (.45)
Daughter Symptoms								
Depressive	.12	.13	.13	—				.57 (.59)
General Anxiety	.05	.07	.04	.13	—			.49 (.41)
Social Anxiety	.16	.19	.10	.64**	.51**	—		2.59 (.96)
Relationship Quality	-.15	-.15	-.11	-.42**	-.29**	-.25**	—	5.78 (.93)
Discussion 1 Dispersion	-.22*	-.32**	-.20	-.01	-.19	.08	.18	.52 (.14)
Discussion 2 Dispersion	-.02	-.02	-.01	-.09	-.17	-.12	.10	.41 (.17)
Discussion 3 Dispersion	-.19	-.29**	-.15	.00	-.12	.09	.10	.42 (.15)
Discussion 4 Dispersion	-.34**	-.26*	-.25*	-.05	-.18	-.02	.05	.50 (.17)
Discussion 5 Dispersion	-.17	-.22*	-.19	.06	-.04	.12	.00	.38 (.17)
Discussion 1 Transitions	-.08	-.13	-.12	.02	-.02	.12	.26*	44.21 (14.48)
Discussion 2 Transitions	-.11	-.13	-.10	-.15	-.15	-.13	.22*	32.02 (13.78)
Discussion 3 Transitions	-.13	-.09	-.03	-.04	-.05	.04	.30**	34.34 (12.84)
Discussion 4 Transitions	-.26*	-.19	-.24*	-.03	-.12	-.04	.25*	36.58 (15.39)
Discussion 5 Transitions	-.04	-.09	-.13	-.07	-.08	.01	.14	30.56 (13.48)

*Note.* \* $p < .05$ , \*\* $p < .01$ . Discussion 1 is Happy/Excited, Discussion 2 is Worried/Sad, Discussion 3 is Proud, Discussion 4 is Frustrated/Annoyed, and Discussion 5 is Grateful.

To examine if the Emotional Rollercoaster task successfully elicited emotions, we ran two doubly multivariate MANOVAs comparing self-reported emotions at baseline and each of the five discussions to examine differences in: (1) self-reported Negative Emotion and (2) self-reported Positive Emotion. In each analysis, self-reported Negative Emotion and Positive Emotion at baseline and each of the five discussions were included as dependent variables, respectively, and participant (mother versus daughter) was included as a within-subjects factor. We expected to find that: (1) self-reported Negative Emotion would be higher in the negative discussions (Discussions 2 and 4) than the positive discussions (Discussions 1 and 3) that preceded them; and (2) self-reported Positive Emotion would be higher in Discussion 1 than at the baseline measure, and higher in the positive discussions (Discussions 3 and 5) than in the negative discussions (Discussions 2 and 4) that preceded them. Figure 3.2 shows self-reported Negative Emotion and Positive Emotion at baseline and the five discussions.

Figure 3.2 shows the results for the planned within-subjects contrasts comparing each task to the previous task. For self-reported Negative Emotion, the significant multivariate effect indicated that self-reported Negative Emotions differed across the baseline and five discussion tasks,  $F(5, 89) = 45.61, p < .001, \eta_p^2 = .72$ . As expected, self-reported Negative Emotion was significantly higher at the negative discussions (Discussions 2 and 4) compared to the positive discussions (Discussions 1 and 3) that preceded them (see Figure 3.2a).

For self-reported Positive Emotion, the significant multivariate effect indicated that self-reported Positive Emotion differed across the baseline and five discussion tasks,  $F(5, 89) = 54.25, p < .001, \eta_p^2 = .75$ . As expected, self-reported Positive Emotion was significantly higher at the positive discussions (Discussions 1, 3, and 5) compared to the negative discussions (Discussions 2 and 4) and the baseline measure that preceded them (see Figure 3.2b). Taken together, the discussion tasks successfully elicited negative and positive emotions in both mothers and daughters.

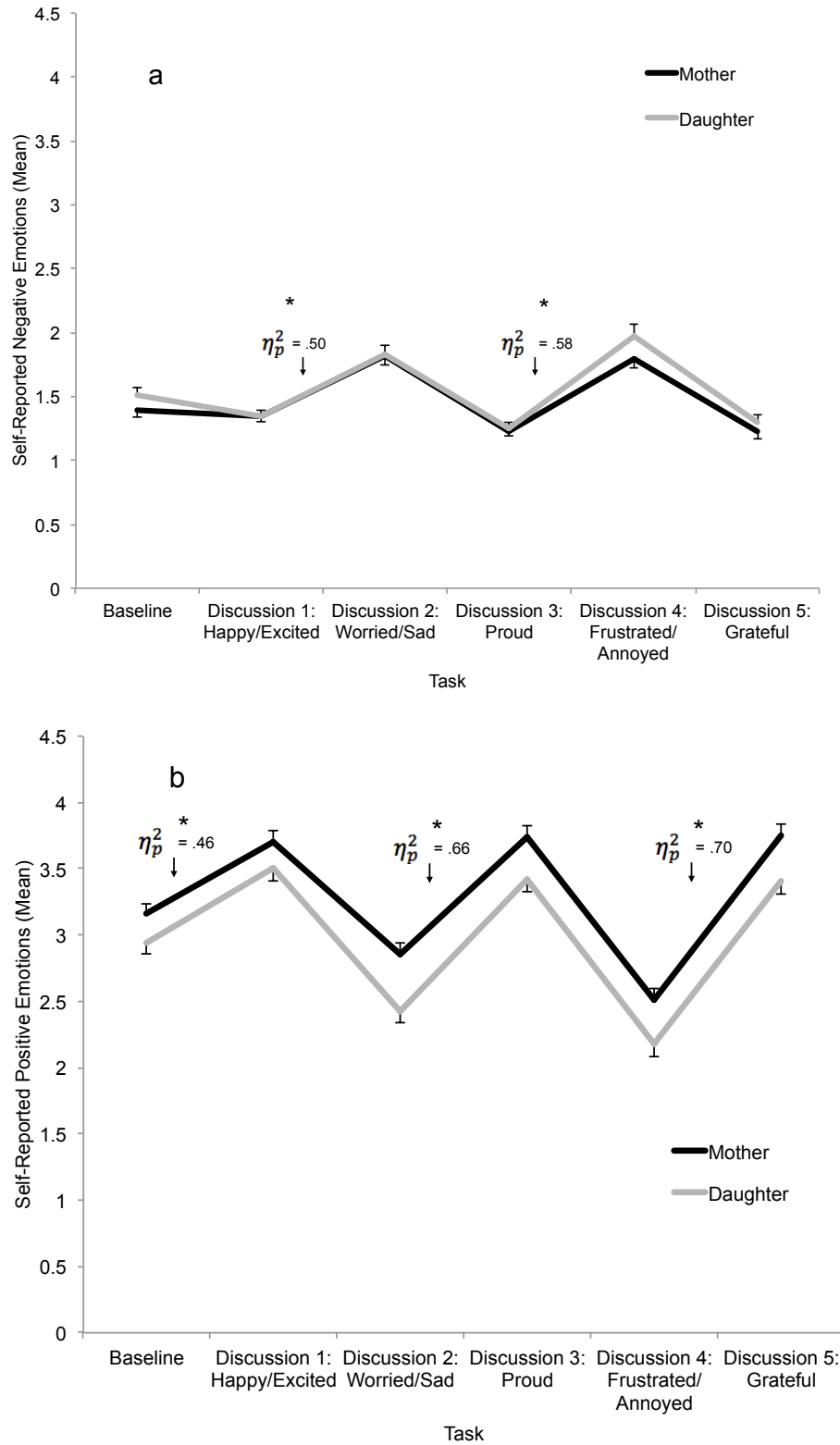


Figure 3.2. Self-reported negative and positive emotions at Baseline and the 5 discussions. *Note.* Error bars represent the standard error of the mean. *Note.* \* $p < .001$ .

Next, to examine if each discussion elicited specific observed emotions, we ran four doubly multivariate MANOVAs comparing observed emotions at each of the five discussions with the following dependent variables: (1) observed Positive Emotions, (2) observed Interest, (3) observed Internalizing Negative Emotions, and (4) observed Externalizing Negative Emotions. In each analysis, observed emotions at each of the five discussions were included as dependent variables, and participant (mother versus daughter) was included as a within-subjects factor. Deviation contrasts, which compare all but one dependent variable to the grand mean of dependent variables, compared observed emotions to the grand mean across tasks. Discussion 5 observed emotions were selected as the variable to exclude in each contrast because it appeared to elicit the lowest frequency of observed emotion of all discussions (see Figure 3.3) and because no observed emotion category was expected to map on as directly to Discussion 5 (Grateful) as with the other discussions. We expected to find that Positive Emotion was higher than the grand mean in Discussions 1 and 3, Interest was higher than the grand mean in Discussions 1 and 3, Internalizing Negative Emotions were higher than the grand mean in Discussion 2, and Externalizing Negative Emotions were higher than the grand mean in Discussion 4. Figure 3.3 shows the means of observed emotions across tasks.

For observed Positive Emotions, the multivariate effect of Discussion was significant,  $F(4, 90) = 42.43, p < .001, \eta_p^2 = .65$ . See Figure 3.3a for the contrast results. For observed Interest, the multivariate effect of Discussion was significant,  $F(4, 90) = 17.27, p < .001, \eta_p^2 = .43$ . See Figure 3.3b for the contrast results. For observed Internalizing Negative Emotions, the multivariate effect of Discussion was significant,  $F(4, 90) = 14.39, p < .001, \eta_p^2 = .39$ . See Figure 3.3c for the contrast results. For observed Externalizing Negative Emotions, the multivariate effect of Discussion was significant,  $F(4, 90) = 13.28, p < .001, \eta_p^2 = .37$ . See Figure 3.3d for contrast results. The results were generally as expected, with Positive Emotions and Interest being significantly higher than the grand mean in Discussion 1 (but, contrary to

expectations, not in Discussion 3), Internalizing Negative Emotions being higher than the grand mean in Discussion 2, and Externalizing Negative Emotions being higher than the grand mean in Discussion 4.



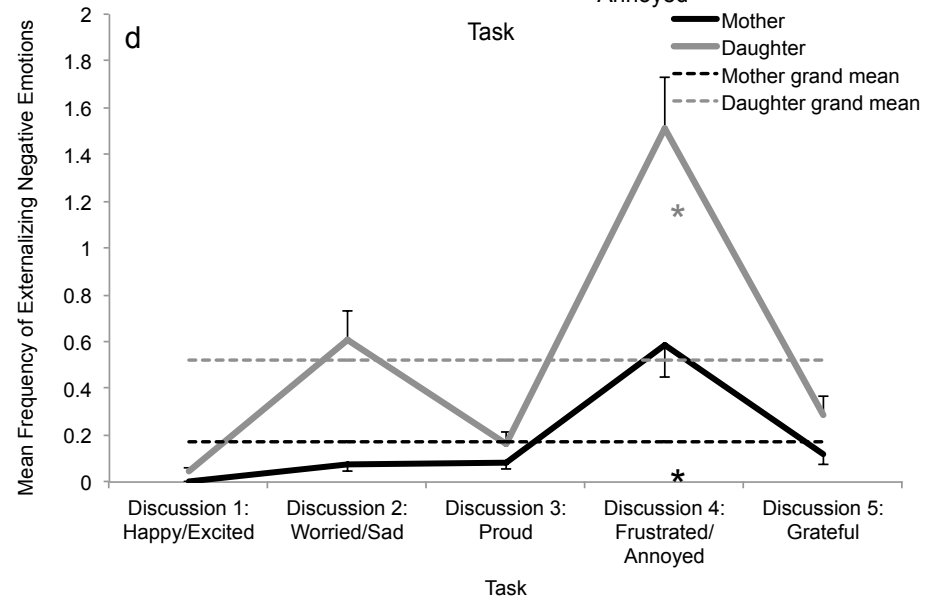
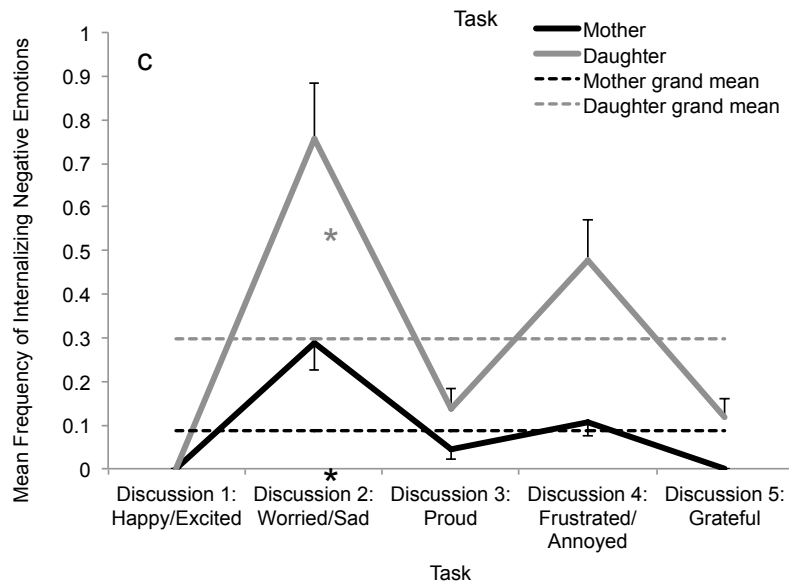
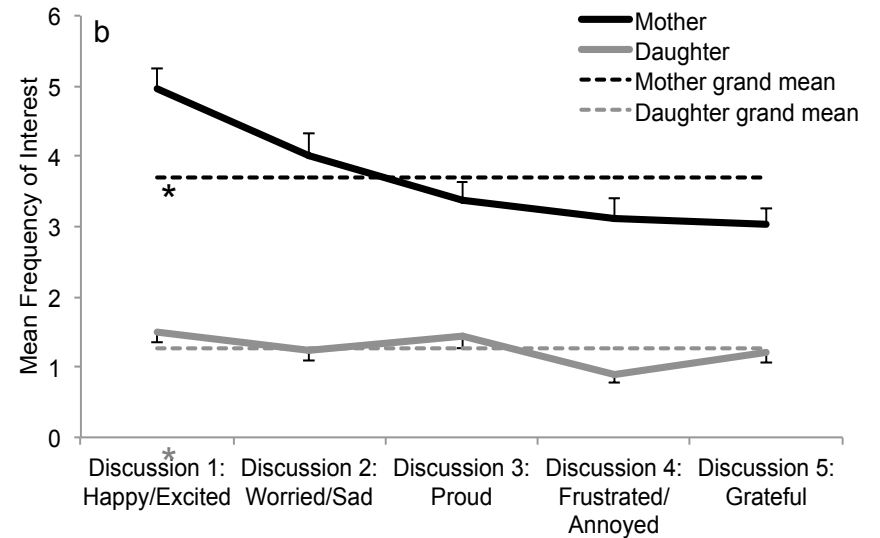
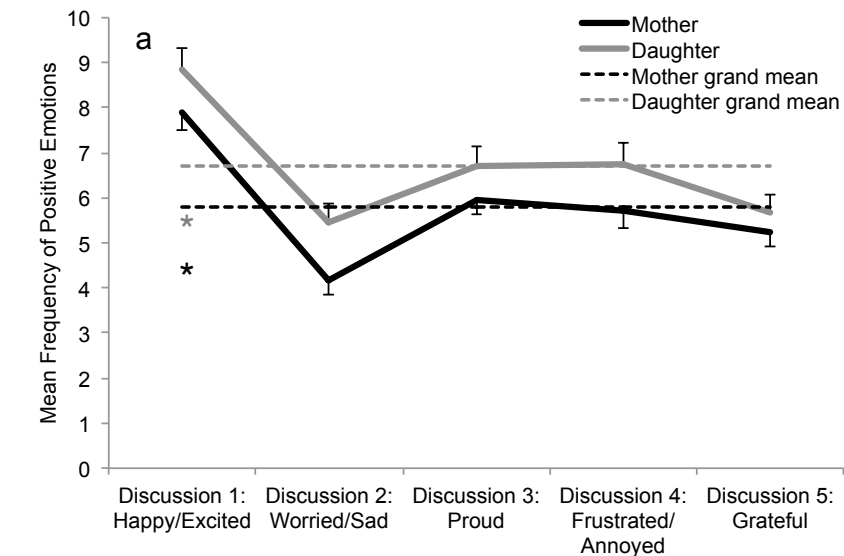


Figure 3.3. Means of observed emotions across the discussion tasks. Note.  $*p < .001$  for contrasts that compared mother and daughter observed emotions to their respective grand means. Results reported for hypothesized effects only.

## **Dynamic Flexibility and Psychosocial Adjustment**

Bivariate correlations were used to test the hypothesis that higher dynamic flexibility would be associated with better psychosocial adjustment (lower mother and daughter internalizing symptoms, higher Relationship Quality). Bivariate correlations between Dispersion and Transitions were positive and significant at each of the five discussions, ranging from  $r = .63$  to  $r = .73$  ( $p < .001$  at all discussions). Table 3.1 shows the correlations between internalizing symptoms, Relationship Quality, and Dispersion and Transitions at each of the five discussions. In line with expectations, maternal Depressive Symptoms were negatively correlated with Dispersion (Discussions 1 and 4) and Transitions (Discussion 4), General Anxiety Symptoms were negatively correlated with Dispersion (Discussions 1, 3, 4, 5), and Social Anxiety Symptoms were negatively correlated with Dispersion (Discussion 4) and Transitions (Discussion 4). Contrary to expectations, daughters' Depressive Symptoms, General Anxiety Symptoms, and Social Anxiety Symptoms were not correlated with Dispersion or Transition in any of the discussions. In partial support of expectations, Relationship Quality was positively correlated with Transitions (Discussions 1 through 4) but not Dispersion.

## **Reactive Flexibility across Positive and Negative Contexts**

We used multivariate latent class growth analysis (MLCGA; Nagin, 2005) to examine individual differences in reactive flexibility across positive and negative contexts. MLCGA estimates individual differences in longitudinal or repeated measures data by deriving latent classes that reflect heterogeneous patterns of change over time, and can be used to examine non-linear trajectories (Nagin, 2005). In line with previous research and theoretical descriptions of flexibility (e.g., Hollenstein & Lewis, 2006; Hollenstein et al., 2013; Lunkenheimer et al., 2011; van der Giessen, Branje, et al., 2014; van der Giessen et al., 2013), we examined flexibility via multiple indicators, Dispersion and Transitions, in a multivariate approach.

Following general recommendations for latent variable mixture models (Berlin et al., 2014; Ram & Grimm, 2007), we conducted the analyses in a series of steps. First, we identified

the shape of change of flexibility measures (Dispersion and Transitions) across the five discussions to use as the base model for mixture analyses. We used both theory and empirical evidence to make this decision. In accordance with the Flex3 model, which suggests that dynamic flexibility is higher in positive emotion contexts and lower in negative emotion contexts (Hollenstein et al., 2013), we expected to find that a 4<sup>th</sup>-order polynomial function would fit the data the best, in which flexibility was higher in the positive discussions (Discussions 1, 3, and 5) than the negative discussions (Discussions 2 and 4). To test this empirically, we fit a series of univariate latent growth models separately to Dispersion and Transitions data, starting with a linear slope and progressively adding quadratic, cubic, and 4<sup>th</sup>-order polynomial effects using Mplus 7.3 (Muthén & Muthén, 2012). For Dispersion, chi-square difference tests indicated that the quadratic model did not fit significantly better than the linear slope model, but that the cubic model fit significantly better than the quadratic model,  $X^2(5) = 27.06, p < .001$ . The 4<sup>th</sup>-order polynomial model did not converge. Similarly, for Transitions, chi-square difference tests indicated that the quadratic model did not fit significantly better than the linear slope model, but that the cubic model fit significantly better than the quadratic model,  $X^2(5) = 22.77, p < .001$ . The 4<sup>th</sup>-order polynomial model did not converge. Visual inspection of mean-level patterns of Dispersion and Transitions confirmed that a cubic function fit the data pattern best (see the plots of the sample means for Dispersion and Transitions in Figure 3.4a and b).

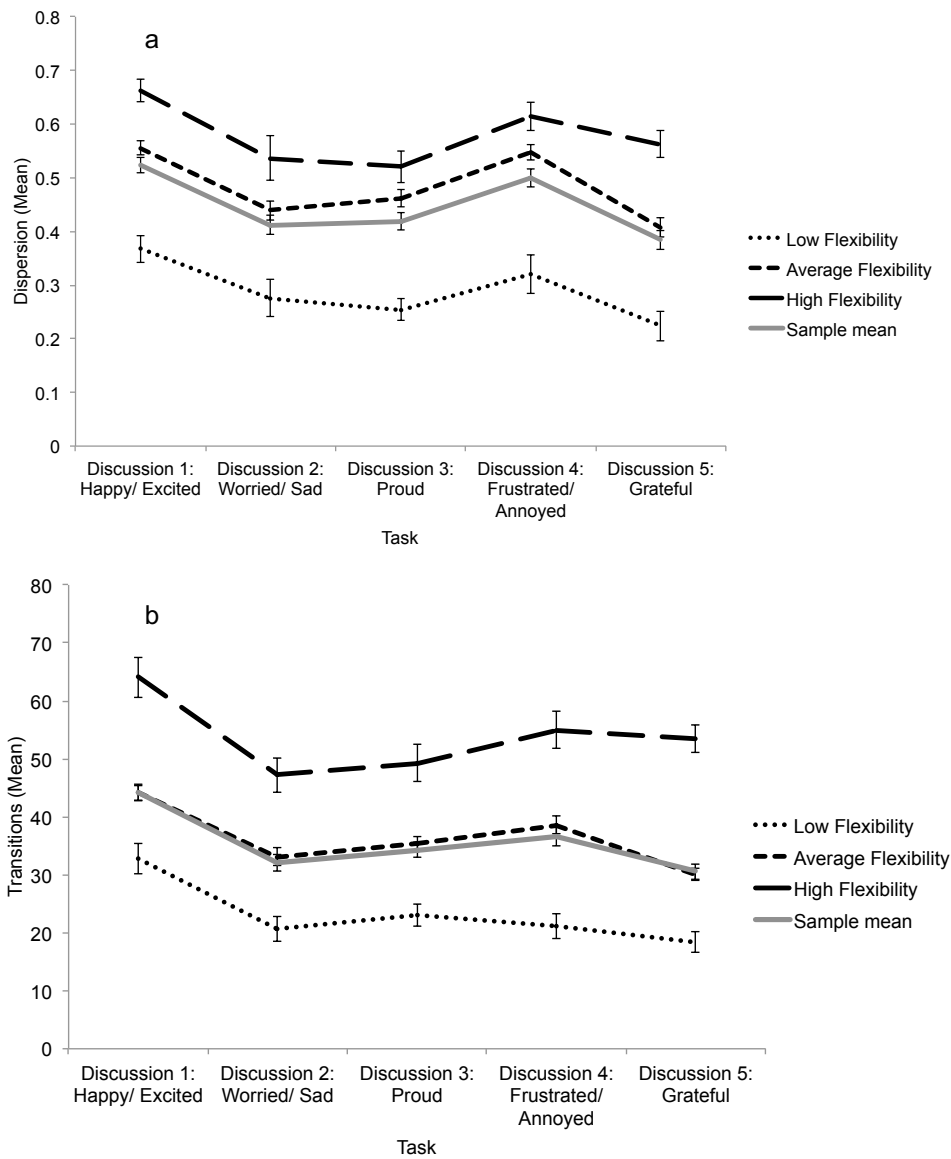


Figure 3.4. Plots of the changes in flexibility across the five discussion tasks in terms of (a) Dispersion and (b) Transitions. *Note.* Error bars represent the standard error of the mean.

Second, we examined individual differences in flexibility using MLCGA. We used an exploratory approach in the model specification and estimation steps to determine the number of latent classes (Berlin et al., 2014). Dispersion and Transitions across the five discussions were used as indicators of latent flexibility classes. A two-class model was specified first, and additional classes were added one at a time until the addition of a class did not improve model fit. Several indicators of relative model fit were used to determine the number of classes extracted by the model. Models with lower values on the Bayesian information criterion (BIC; Schwarz, 1978), adjusted Bayesian information criterion (adjusted BIC; Sclove, 1987), and Akaike information criterion (AIC; Akaike, 1973) indicate better model fit than models with higher values on these information criteria (Nylund, Asparouhov, & Muthén, 2007). Entropy indicates classification accuracy, with better classification indicated as values approach 1 (Celeux & Soromenho, 1996). The Vuong-Lo-Mendell-Rubin (VLMR) adjusted Lo-Mendell-Rubin (adjusted LMR) likelihood ratio tests were used to examine if the estimated models fit the data better than a model with one fewer group (Nylund et al., 2007). In addition, models needed to have groups that consisted of a minimum of 5% of the sample in order for meaningful interpretation and to be analyzed further (Muthén & Muthén, 2000; Nagin, 2005).

MLCGAs with two to four latent classes were estimated. The BIC, adjusted BIC, and AIC were lower in the 3-class solution (3234.92, 3121.26, and 3142.98, respectively) than the 2-class solution (3309.11, 3223.86, and 3240.15, respectively), entropy was higher in the 3-class solution (.92) than the 2-class solution (.89), and the results of the likelihood ratio tests both indicated that the 3-class solution fit significantly better than the 2-class solution (both  $ps = .04$ ). Although the 4-class solution had lower BIC, adjusted BIC, and AIC than 3-class solution (3207.57, 3065.49, and 3092.64, respectively), one class in this solution consisted of only 4 individuals, which was less than 5% of the sample and therefore resulted in a model that was less interpretable than the 3-class solution. Thus, the 3-class model was retained as the best fit.

Figure 3.4 shows the sample mean and each class's mean Dispersion (Figure 3.4a) and

Transitions (Figure 3.4b) across the discussions. Two within-subjects MANOVAs were used to compare (1) Dispersion and (2) Transitions across the discussions to determine which discussions showed the highest and lowest flexibility. We expected that flexibility would be highest in Discussion 1, 3, and 5, and lowest in Discussion 2 and 4. For Dispersion, the multivariate effect of Discussion was significant,  $F(4, 90) = 33.61, p < .001, \eta_p^2 = .60$ . Pairwise comparisons with a Bonferroni correction indicated that the sample mean for Dispersion was significantly higher at Discussion 1 than Discussion 2 ( $p < .001$ ), Discussion 3 ( $p < .001$ ). Contrary to expectations, it was significantly higher than Discussion 5 ( $p < .001$ ), and not significantly different from Discussion 4 ( $p = .99$ ). Also contrary to expectations, the sample mean for Dispersion was significantly lower at Discussion 5 than at Discussion 1 ( $p < .001$ ) and Discussion 4 ( $p < .001$ ) but not Discussion 2 ( $p = .99$ ) or Discussion 3 ( $p < .20$ ). For Transitions, the multivariate effect of Discussion was significant,  $F(4, 90) = 33.60, p < .001, \eta_p^2 = .60$ . Pairwise comparisons with a Bonferroni correction indicated that the sample mean for Transitions was significantly higher at Discussion 1 compared to all other discussions (all  $ps < .001$ ). Contrary to expectations, the sample mean for Transitions was significantly lower at Discussion 5 than Discussion 1 ( $p < .001$ ), Discussion 3 ( $p = .01$ ), and Discussion 4 ( $p < .001$ ), but was not different from Discussion 2 ( $p = .99$ ). Classes were labeled according to their pattern of Dispersion and Transitions: Low Flexibility ( $n = 24$ ), Average Flexibility ( $n = 57$ ), and High Flexibility ( $n = 14$ ). Table 3.2 shows the estimated parameters for the 3-class solution. Each class showed significant cubic slopes for Dispersion and Transitions, except for the Low Flexibility class in which the cubic slope for transitions was not significant.

Table 3.2

*Estimated Parameters for the 3-Class Solution*

	Low Flexibility			Average Flexibility			High Flexibility		
	$\beta$	<i>SE</i>	95% CI	$\beta$	<i>SE</i>	95% CI	$\beta$	<i>SE</i>	95% CI
Intercepts									
Dispersion	.38***	.04	.32, .43	.55***	.02	.53, .58	.67***	.02	.63, .70
Transitions	32.87***	2.98	27.96, 37.78	43.96***	1.36	41.72, 46.02	63.75***	4.95	55.62, 71.89
Linear slopes									
Dispersion	-.23**	.08	-.36, -.09	-.29***	.03	-.34, -.23	-.29***	.07	-.40, -.17
Transitions	-17.88**	6.12	-27.95, -7.80	-21.71***	3.14	-26.88, -16.54	-.30.10***	7.85	-43.01, -17.18
Quadratic Effects									
Dispersion	.13*	.06	.03, .22	.19***	.02	.15, .22	.16***	.04	.09, .23
Transitions	8.48*	4.00	1.90, 15.05	12.95***	2.13	9.44, 16.46	15.64**	5.08	7.29, 23.99
Cubic Effects									
Dispersion	-.02*	.01	-.04, -.004	-.03***	.00	-.04, -.03	-.02***	.01	-.03, -.01
Transitions	-1.23 <sup>†</sup>	.65	-2.30, -.16	2.10***	.36	-2.68, -1.52	-2.20**	.84	-3.58, -.81

Note. \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ , <sup>†</sup> $p = .06$ .

### **Associations between Reactive Flexibility and Psychosocial Adjustment**

With MLCGA, each dyad receives an estimate of the conditional probability of membership in each class. These probabilities can be used as variables in follow-up analyses. To test our hypotheses that higher flexibility would be associated with better psychosocial adjustment (i.e., lower internalizing problems, higher Relationship Quality), we examined the correlations between the probability of membership in the Low Flexibility, Average Flexibility, and High Flexibility classes and mother and daughter Depressive Symptoms, General Anxiety Symptoms, Social Anxiety Symptoms, and mother-daughter Relationship Quality. Contrary to expectations, the probability of membership in the High Flexibility group was not associated with mother and daughter Depressive Symptoms ( $r = .04, p = .67$ ;  $r = -.11, p = .29$  respectively), General Anxiety Symptoms ( $r = -.11, p = .28$ ;  $r = -.12, p = .26$  respectively), Social Anxiety Symptoms ( $r = -.08, p = .44$ ;  $r = -.08, p = .44$  respectively), and Relationship Quality ( $r = .01, p = .96$ ). However, the probability of membership in the Average Flexibility group was negatively associated with maternal Depressive Symptoms ( $r = -.32, p = .01$ ) and positively associated with mother-daughter Relationship Quality ( $r = .22, p = .03$ ). Also in line with expectations, the probability of membership in the Low Flexibility group was positively associated with maternal Depressive Symptoms ( $r = .32, p = .01$ ), General Anxiety Symptoms ( $r = .25, p = .01$ ), and Social Anxiety Symptoms ( $r = .25, p = .02$ ), and it was negatively associated with mother-daughter Relationship Quality ( $r = -.25, p = .02$ ). All other correlations were not significant.

### **Discussion**

The goal of the current study was to examine the associations between socioemotional flexibility and mothers' and daughters' psychosocial adjustment. We used the novel Emotional Rollercoaster task to elicit multiple reversals between positively- and negatively-valenced interpersonal contexts. As predicted by the Flex3 model, higher dynamic flexibility was associated with better psychosocial adjustment in terms of lower maternal internalizing symptoms and higher mother-daughter relationship quality. We had expected to see individual differences in



reactive flexibility, such as some profiles being relatively flat and others showing a zig-zag pattern across tasks. However, the resulting profiles indicated differences in overall levels of flexibility rather than individual differences in patterns across tasks (reactive flexibility). The highest level of flexibility across discussions (High Flexibility group) was unrelated to psychosocial adjustment, whereas moderate levels of flexibility (Average Flexibility group) were associated with positive psychosocial outcomes (lower maternal depressive symptoms and higher relationship quality), and low levels of flexibility (Low Flexibility group) were associated with negative psychosocial outcomes (higher maternal depressive, general anxiety, and social anxiety symptoms; lower relationship quality). Taken together, moderate levels of flexibility within and across emotional contexts were associated with positive maternal psychosocial adjustment and mother-daughter relationship quality.

### **Dynamic Flexibility**

The associations between dynamic flexibility and psychosocial adjustment were generally in the expected directions, but it was unexpected that dynamic flexibility was not related to daughter internalizing symptoms. Parent-adolescent relationships are still hierarchical in early- to mid-adolescence, with parents guiding and monitoring their adolescents in social, academic, and emotional domains (Collins & Laursen, 2004). This top-down control might also be reflected in moment-to-moment interaction dynamics, with maternal psychosocial adjustment guiding the extent of socioemotional flexibility in mother-daughter interactions.

Although we did not have hypotheses about this, we found that dispersion and transitions were differentially related to psychosocial adjustment indicators. In general, dispersion was negatively associated with maternal internalizing symptoms, whereas transitions were positively associated with mother-daughter relationship quality. We suggest that these differences reflect that dispersion and transitions are different aspects of flexibility, although they are strongly correlated. Dispersion reflects the range, or repertoire, of observed emotions, and a restricted range of emotional expression (“flat” affect) is associated with internalizing symptoms (Kashdan

& Rottenberg, 2010). In contrast, the number of transitions represents the shifts between emotions within an emotional repertoire, and may be related to interpersonal responsiveness, which is an aspect of relationship quality (van der Giessen, Branje, et al., 2014).

### **Reactive Flexibility**

One unexpected result was the association between positive and negative emotional contexts and flexibility. Based on prior research and theory (Hollenstein & Lewis, 2006; Hollenstein et al., 2013), we expected flexibility to be higher during positive contexts and lower during negative contexts. Instead, we found a cubic effect where flexibility was higher in Discussions 1 (Happy/Excited) and 4 (Frustrated/Annoyed), and lower in Discussions 2 (Sad/Worried), 3 (Proud) and 5 (Grateful). The relationship between flexibility and emotional context may depend on which specific positive and negative emotions are experienced and expressed. For example, the interpersonal functions of internalizing negative emotions such as sadness and worry, as elicited in Discussion 2, include seeking security and comfort from others (Walle & Campos, 2012). In contrast, the interpersonal functions of externalizing negative emotions, as elicited in Discussion 4, include asserting dominance (Walle & Campos, 2012). When discussing issues of interpersonal frustration and annoyance, mothers and daughters may show a greater range of emotional states and a higher number of transitions between them in an effort to maintain composure when faced with a potentially challenging interpersonal interaction. In addition, discussing issues of interpersonal frustration and annoyance might require greater emotional adjustments to partners' points of view than when discussing sadness and worry. Sadness and worry are emotions that pull for affiliative behaviors in interpersonal contexts (Joiner, Coyne, & Blalock, 1999). Thus, in internalizing contexts, individuals may not need to buffer against potential negative interpersonal consequences with greater flexibility. Regarding the unexpected relatively low flexibility during Discussions 3 (Proud) and 5 (Grateful), it is possible that carry-over and fatigue effects played a role—mothers and daughters may have found it difficult to recover from the negative emotions experienced in Discussions 2 and 4.

Another unexpected finding was the lack of individual differences in reactive flexibility. Individual differences in reactive flexibility would have been observed in differences in the profiles of dynamic flexibility across tasks (some profiles being relatively flat, others showing differences across tasks). Reactive flexibility was observed in the cubic profiles of dispersion and transitions across discussion tasks, but individual differences only appeared in terms of the overall level (high, average, or low) of flexibility, not in the shape of their profile. Thus, reactive flexibility was observed, but individual differences in reactive flexibility were not. This unexpected null result might be related to the characteristics of the sample, which consisted of typically-developing adolescents and their mothers. Extremely low emotional flexibility (i.e., rigidity) may indicate moderate to severe forms of psychopathology (Koval, Kuppens, Allen, & Sheeber, 2012; Kuppens, et al., 2012), which were not examined in the current study.

We had also expected that membership in the High Flexibility group would be negatively associated with internalizing symptoms, but we found that they were not significantly associated. Instead, we found that membership in the Average Flexibility group was associated with lower levels of maternal internalizing symptoms and higher levels of relationship quality. Thus, the Average Flexibility group likely showed optimal levels of flexibility for the emotional contexts examined in the current study. It is possible that dyads in the High Flexibility group showed a greater range of emotional states, and transitions between them, than what was adaptive in the emotional context of the current study, but not to the extent that it was maladaptive (positively related to internalizing symptoms). Greater emotional variability in some contexts indicates a lack of emotional stability (Houben, van den Noortgate, & Kuppens, 2015), and it might be possible to identify the level at which emotional variability changes from adaptive flexibility into emotional instability by examining a sample with a broad range of psychosocial functioning.

### **Limitations and Future Research**

Several limitations should be noted in interpreting the results of the current study. First, the average level of relationship quality and socioeconomic status were high, and the sample was

predominantly European Canadians in families with married mothers and fathers. Thus, the results might not generalize to other populations and further research is needed to examine socioemotional flexibility in more diverse samples. In addition, only mother-daughter dyads were examined. Previous research indicates that the relationship between children's psychosocial adjustment and flexibility in parent-child interactions differs depending on whether the child is interacting with the mother versus the father (Lunkenheimer et al., 2011). Emotional expressions, socialization, and emotion regulation vary by sex (Collins & Russell, 1991; Perry-Parrish & Zeman, 2011). Thus, future research is also needed to examine the role of different family relationships (e.g., mother, father, sibling) and adolescent sex to more fully understand the associations between flexibility in adolescent family relationships and psychosocial adjustment.

Our decision to use the discussions of the Emotional Rollercoaster task in a fixed order allowed us to examine, across all participants, how dyads were able to recover from experiencing internalizing and externalizing emotions towards each other. However, because the positive and negative discussion topics were not counterbalanced within valence, it was not possible to distinguish effects related to the elicitation of discrete emotions from potential fatigue effects. Previous research examining socioemotional flexibility using observational designs elicited positive and negative emotions in general such as by asking participants to engage in a fun brainstorming task (e.g., planning a party) to elicit positive emotions and to discuss a topic of mutually-agreed upon conflict (e.g., household chores, curfews) to elicit negative emotions (Hollenstein & Lewis, 2006; van der Giessen, Branje, et al., 2014; van der Giessen, Hollenstein, et al., 2014; van der Giessen et al., 2013). The emotion elicitation task in the current study is markedly different from previous research as it elicited specific positive and negative emotions that mothers and daughters experience towards each other, rather than conflict discussions that may elicit a range of emotions depending on the specific topic and relationship context. It will be an important line of inquiry for future research to use nuanced emotion elicitation tasks such as the one employed in the current study in a counterbalanced design to better understand the

relationship between socioemotional flexibility and specific positive and negative emotions.

In line with the Flex3 model (Hollenstein et al., 2013), another important direction for future research is to also incorporate the macro time scale into observational designs aimed at examining flexibility at the micro and meso time scales. Trait flexibility at the macro time scale can be measured in several ways (Hollenstein et al., 2013). One method is to use experience sampling methods (ESM) to examine moods over weeks or longer periods of time (e.g., Koval et al., 2012; Kuppens et al., 2012). Future research could employ both observational and ESM methods to examine the associations between observed dynamic and reactive flexibility and self-reported trait flexibility. Another possible way to incorporate flexibility at all three time scales is to conduct repeated observational sessions consisting of more than one emotion elicitation task over the course of several months or years around an expected developmental transition. Such designs will be key to explaining the role of flexibility in psychosocial adjustment.

### **Conclusion**

Mother-daughter relationships during adolescence are arguably one of the most emotionally charged parent-child relationships—an emotional rollercoaster. Socioemotional flexibility enables successful adaptation to the novel emotional ups and downs of adolescence. Moreover, negative emotions themselves are not necessarily associated with negative outcomes—what matters to mother-daughter psychosocial adjustment is the structure of interpersonal emotion dynamics. Taken together, whether the emotional rollercoaster of adolescent emotions is primarily exciting or stressful depends on how flexibly mothers and daughters are able to adjust to the ride.

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**Chapter 4: Arousal Transmission in Mother-Daughter Dyads across  
Positive and Negative Emotional Contexts in Adolescence**

## Abstract

Partners in close relationships can experience similar emotional fluctuations during interpersonal interactions. One emotion dynamic through which partners “pick up” on each others’ emotions is arousal transmission—the extent to which partners’ arousal levels predict each others’ over time. Mother-daughter dyads in adolescence experience increased emotional intensity and lability during their interpersonal interactions compared to childhood, and arousal transmission may indicate the extent to which mothers’ and daughters’ emotions covary. In the current study, the transmission of sympathetic nervous system arousal from both mother-to-daughter and daughter-to-mother were examined in terms of their associations with relationship quality and changes across positive and negative emotional contexts. Participants were 96 mothers and their adolescent daughters ( $M_{age} = 13.99$  years) who completed a series of 5 3-minute discussions regarding times they experiences the following emotions towards each other: (1) Happy/Excited, (2) Worried/Sad, (3) Proud, (4) Frustrated/Annoyed, and (5) Grateful. In general, mother-to-daughter and daughter-to-mother arousal transmission were observed. Daughter-to-mother arousal transmission decreased from Discussion 1 to Discussion 2, but contrary to expectations, there were no other differences in arousal transmission between discussions. Arousal transmission was not associated with relationship quality.

*Keywords:* mother-daughter interactions, adolescence, interpersonal emotion dynamics, positive emotion, negative emotion

## Arousal Transmission in Mother-Daughter Dyads across Positive and Negative Emotional Contexts in Adolescence

Partners in high quality close relationships (e.g., parent-child, romantic partner) are often described, colloquially, as being “in tune” with one another. Partners who “get” each other can understand the other’s perspective without lengthy verbal description—one can “pick up” what the other is “putting down” in a manner that may seem extraordinary. Psychologists have spent decades examining the relationship characteristics described by the many colloquial phrases referring to the extraordinary connections that can occur in close relationships (Butler, 2011; Di Mascio, Boyd, Greenblatt, & Solomon, 1955; Feldman, 2007; Field, 2012; Fogel, 1993; Levenson & Gottman, 1983; Levenson & Ruef, 1992; Timmons, Margolin, & Saxbe, 2015). Many of the processes underlying such connections are emotional in nature (Anderson, Keltner, & John, 2003; Butler, 2015). In fact, humans are hard-wired to form meaningful emotional connections with others (Beckes & Coan, 2011). Thus, “being on the same page” as those closest to you—experiencing the same rises and falls in emotional arousal—is likely the norm, not the exception. However, experiencing the same emotions as close relationship partners is not always beneficial. The benefits or costs of emotional connectedness depend of several factors, including the quality of the relationship and the emotional context (Butler, 2011; Timmons et al., 2015).

Close relationships throughout the lifespan can be conceptualized as temporal interpersonal emotion systems (TIES), in which components of each partners’ emotion systems (e.g., physiological arousal) are linked via their temporal dynamics (Butler, 2011). Typically, the first TIES that form in development are between primary caregivers and infants (Kopp, 1989). Emotions are co-constructed and regulated through repeated mother-infant interactions that stabilize over development into interpersonal patterns (Fogel, 1993; Granic, 2005). *Arousal transmission* is one interpersonal emotion process in TIES, in which partners’ arousal levels predict each other at subsequent points in time (Butler, 2011; Larson & Almeida, 1999; Larson & Gillman, 1999; Randall & Butler, 2013; Thompson & Bolger, 1999). Parent-adolescent dyads are

TIES in flux, as they experience many changes involving the adolescent's emotions (e.g., increased intensity and lability; Rosenblum & Lewis, 2003) and changes in the nature of the parent-adolescent relationship (e.g., increased adolescent autonomy; increased conflicts; Hollenstein & Loughheed, 2013). Parent-adolescent relationships are also arguably one of the most emotionally-intense TIES in typical development (Hollenstein & Lewis, 2006). The vast majority of research on arousal transmission to date has focused on parent-infant and adult romantic TIES, and so little is understood about arousal transmission in parent-adolescent TIES. The current study examined the associations between relationship quality and arousal transmission across positive and negative emotional contexts in mother daughter dyads during adolescence.

### **Arousal Transmission in Close Relationships**

Research on arousal transmission (often also referred to as synchrony, linkage, or attunement) to date has focused mostly on two different TIES: (1) mother-infant dyads (see Feldman, 2007b, and Field, 2012 for reviews), and (2) adult romantic partners (see Timmons et al., 2015 for a review). High arousal transmission refers to a strong positive prediction between interaction partner's emotions over time, whereas low arousal transmission refers to a lower prediction between partner's emotions (Butler, 2011). The functions of arousal transmission in TIES depend on several factors such as the quality of the relationship, the component of the emotion system in which transmission is observed (e.g., experienced emotions, autonomic arousal), and the emotional context (Butler, 2011; Helm, Sbarra, & Ferrer, 2014; Timmons et al., 2015). For example, one characteristic of high quality mother-infant relationships is that mothers adjust their responses according to the changing needs of their infant. Before infants become over-stimulated during mother-infant interactions, dyads with high relationship quality may show arousal transmission that leads to decreased arousal levels over time in both mother and infant (Field, 2007). However, in mother-infant dyads of low relationship quality, mothers who are less sensitive to their infants' needs might over-stimulate their infants, leading to increased arousal levels over time in both mother and infant (Field, 2012; Papoušek, 2007). Both are examples of

arousal transmission—positive covariation in partners’ arousal over time—but arousal transmission is not optimal in the context of maternal insensitivity.

The emotional context in which arousal transmission occurs also plays a functional role. There are some emotional contexts in which the transmission of higher arousal levels is appropriate, such as the up-regulation of positive emotions (Ramsey & Gentzler, 2015). For example, a mother expressing affection to her daughter might elicit feelings of affection in the daughter, which may in turn enhance the mother’s feelings of affection. Such bi-directional (mother-to-child and child-to-mother) emotion transmission is one interpersonal process associated with the development and maintenance of high-quality parent-child relationships over development (Ramsey & Gentzler, 2015). However, in the context of interpersonal conflict, the transmission of higher arousal levels can indicate escalating negative emotions, and is associated with distressed relationships (Levenson & Gottman, 1983). Taken together, both the relationship context and emotional valence play important functional roles in arousal transmission in close relationships.

**The transmission of sympathetic arousal.** Sympathetic nervous system (SNS) activity is one indicator of emotional arousal that has been examined in terms of transmission in TIES (Timmons et al., 2015). SNS activity increases in stressful situations (the “fight or flight” response), and higher levels of SNS activity are associated with negative emotions such as anxiety and anger (Kreibig, 2010; Timmons et al., 2015). SNS activity is also related to positive emotions, showing increases during affection, happiness, and pride (see Kreibig, 2010, for a review). Thus, SNS activity is an indicator of emotional arousal in both negative and positive emotions (Kreibig, 2010).

SNS arousal transmission is associated with relationship quality in different ways, depending on the emotional context (i.e., positive versus negative interpersonal contexts). Because SNS activity increases during stress and negative emotions, SNS arousal transmission can indicate dyadic amplification of negative emotions (Timmons et al., 2015). One study



comparing distressed and non-distressed married couples found that greater SNS arousal transmission during a conflict discussion characterized distressed, compared to non-distressed, couples (Levenson & Gottman, 1983). However, in typically-functioning dyads and in less negatively-valenced interpersonal contexts, SNS arousal transmission is associated with greater accuracy in perceiving partner's negative emotion states and empathic responding (Chatel-Goldman, Congedo, Jutten, & Schwartz, 2014; Levenson & Ruef, 1992). Thus, the functions of SNS arousal transmission depend on the characteristics of the TIES and the specific emotional contexts in which transmission occurs (Butler, 2011; Timmons et al., 2015).

**Parent-adolescent TIES.** Relatively little is known about arousal transmission in parent-adolescent TIES, which is surprising because there are several characteristics of these TIES that suggest that it would be important at this developmental period. First, adolescents typically experience greater emotional lability and intensity than in childhood (Hollenstein & Loughheed, 2013; Rosenblum & Lewis, 2003). Second, parent-adolescent relationships reorganize, as adolescents begin to gain autonomy within the family (Collins & Laursen, 2004; Smetana, Campionne-Barr, & Metzger, 2006). Parent-adolescent conflicts increase during the reorganization of the relationship (Granic, Hollenstein, Dishion, & Patterson, 2003; Laursen & Collins, 2009), and thus the day-to-day emotional dynamics of parent-adolescent TIES change. The transmission of SNS arousal across positive and negative emotional contexts in parent-adolescent TIES is likely related to the quality of the relationship and psychosocial functioning (Crowell et al., 2014).

To date, only a couple of studies have examined SNS arousal in the context of parent-adolescent interactions. One study showed that greater adolescent SNS reactivity during stress was positively associated with behavioral warmth during mother-adolescent interactions two years later, although the concurrent associations between adolescent SNS reactivity and behavioral warmth with mothers was not examined (Diamond & Cribbet, 2013). Another study showed that adolescent girls in high-quality mother-daughter relationships were able to more

efficiently regulate SNS arousal (i.e., showed steeper decreases in SNS arousal) during social stress than girls in lower-quality mother-daughter relationships (Lougheed, Koval, & Hollenstein, 2016). Taken together, these studies show that SNS arousal is regulated in the context of parent-adolescent TIES, but the dynamics of SNS arousal transmission across different emotional contexts are currently unknown.

### **The Current Study**

We examined sympathetic arousal transmission across positive and negative emotional contexts and its associations with mother-daughter relationship quality with the Emotional Rollercoaster task (Lougheed & Hollenstein, in press), a series of five emotion elicitation discussions in which the valence of the emotional interaction alternated from positive to negative and back to positive, several times in a fixed order: (1) Happy/Excited, (2) Worried/Sad, (3) Proud, (4) Frustrated/Annoyed, and (5) Grateful. The Emotional Rollercoaster task was designed to provide opportunities to measure arousal transmission across specific positive and negative emotional situations (Lougheed & Hollenstein, in press).

The first objective of the current study was to examine daughters' and mothers' experienced emotions across the discussions, as a manipulation check of the Emotional Rollercoaster task. We expected that both daughters and mothers would report higher positive emotions during positive discussions than negative discussions, and higher negative emotions during negative discussions than positive discussions (Hypothesis 1). The second objective was to examine, in general, if mother-daughter dyads show arousal transmission in adolescence. In line with previous research and theory on the bi-directional nature of interpersonal arousal regulation in parent-child TIES (Field, 2012; Fogel, 1993), we expected to find that arousal would be transmitted from both mother-to-daughter and daughter-to-mother (Hypothesis 2). The third objective was to examine differences in arousal transmission between positive and negative emotional contexts. Shifting from positive to negative emotional contexts presents a different interpersonal challenge than shifting from negative to positive emotional contexts, as negative

emotions can carry over into positive contexts that follow them (Granic, O'Hara, Pepler, & Lewis, 2007; Woltering, Lishak, Elliott, Ferraro, & Granic, 2015). Thus, to examine differences in arousal transmission during shifts from positive to negative versus negative to positive emotion contexts, we compared arousal transmission between each discussion and the discussion that preceded it. In line with previous research showing that SNS arousal transmission is greater in negative emotional contexts than positive contexts (Levenson & Gottman, 1983; Timmons et al., 2015), we expected that dyads would show greater arousal transmission during negative emotional contexts (Discussions 2 and 4) compared to positive contexts (Discussions 1 and 3) that preceded them (Hypothesis 3a), and lower arousal transmission during positive emotional contexts (Discussions 3 and 5) than the negative contexts (Discussions 2 and 4) that preceded them (Hypothesis 3b). The fourth and final objective was to examine the association between mother-daughter relationship quality and arousal transmission. In line with previous research showing that dyads with high relationship quality show less arousal transmission during interpersonally negative emotional contexts than dyads with low relationship quality (Levenson & Gottman, 1983; Timmons et al., 2015), we expected that relationship quality would moderate changes in arousal transmission across emotional contexts. Specifically, we expected to see less arousal transmission in negative compared to positive emotional contexts at higher levels of relationship quality (Hypothesis 4).

## **Method**

### **Participants**

The current study used an extant community sample of 96 typically-developing adolescent females and their mothers (see Lougheed & Hollenstein, in press). Adolescent participants' ages ranged from 13 to 16 years old ( $M = 13.99$ ,  $SD = .87$ ), and mothers' ages ranged from 32 to 57 years old ( $M = 44.68$ ,  $SD = 5.40$ ). Participants were recruited via telephone from a database maintained by the Department of Psychology at a university in Southern Ontario, and through posters in community and online locations (e.g., malls, libraries, and Kijiji). Gross

family income per year was greater than \$100,000 for approximately 50% of families, between \$75,000 and \$100,000 for 25% of families, between \$40,000 and \$75,000 for 15% of families, between \$25,000 and \$40,000 for 6% of families, and less than \$25,000 for 4% of families. Seventy-seven percent of mothers reported their marital status as married, 8% as living with a domestic partner, 6% as divorced, 6% as separated, and 2% as single. Eighty-two percent of mothers identified their own ethnicities as European Canadian, 10% as Other, 4% as First Nations Canadian, 2% as Central/South American, 1% as African, and 1% as East Asian. Seventy-seven percent of mothers identified their daughters' ethnicities as European Canadian, 15% as Other, 5% as First Nations Canadian, 2% as Central/South American, and 1% as South Asian. Mothers and daughters received \$15 each for participating.

### **Procedure**

Mothers and daughters received a letter of information at the beginning of the laboratory session. After reviewing the letter of information, mothers provided informed consent to participate for themselves and their daughter, and daughters provided assent to participate. The laboratory session took place in an observation room, in which mothers and daughters were seated in comfortable chairs beside each other. The observation room was equipped with psychophysiological recording equipment and obscured video cameras, which were monitored from an adjacent room. After obtaining informed consent, a female experimenter introduced participants to the general study procedures, and then participants filled out a series of questionnaires online pertaining to demographics and relationship quality. Participants then indicated their baseline self-reported feelings using a paper questionnaire (see Measures for details).

Next, physiological sensors were applied to participants by female experimenters. Sympathetic physiological arousal was measured via galvanic skin response (GSR) with an SS3 electrodermal response transducer (BioPac Systems Inc., 2007) that was attached to the tips of the middle and ring fingers of each participant's non-dominant hand. Continuous recordings of GSR

were obtained with an MP150 amplifier (BioPac Systems Inc., 2007) at 200 Hz and GSR was calculated as level of conductance in micromhos. Respiration and heart rate were also measured but were not analyzed as part of the current study.

Once physiological sensors were recording, participants sat quietly while watching a neutral nature film clip for approximately 2.5 minutes to measure participants' normal resting physiological states. Following the resting baseline phase, and prior to the Emotional Rollercoaster task, mothers and daughters each filled out a questionnaire to determine what they would discuss for each of the five discussions of the Emotional Rollercoaster task. Participants listed one or two possible topics in response to the following questions: (1) "I felt happy or excited about my mother/daughter when..." (e.g., happy about spending time together); (2) "I felt worried or sad about my mother/daughter when..." (e.g., worried about her well-being); (3) "I felt proud of my mother/daughter when..." (e.g., proud of her accomplishments); (4) "I felt frustrated or annoyed towards my mother/daughter when..." (e.g., annoyed at communication difficulties); and (5) "I felt grateful for or positive towards my mother/daughter when..." (e.g., when she does something nice for me). The completed questionnaires were used by participants as reminders for what they wanted to talk about for each discussion. The final task of the study was the Emotional Rollercoaster task, during which participants had five 3-minute discussions about the emotions they felt towards each other. Finally, participants were debriefed and compensated at the end of the laboratory session.

## **Measures**

### **Questionnaires.**

***Relationship quality.*** Relationship quality was measured using a questionnaire developed by Beazer (1998), which was based on three separate relationship quality scales (Cicirelli, 1980; Esposito, 1995; Risman & Park, 1988). Participants responded to eight items (e.g., "How much do you feel that you can turn to your mother/daughter when you are in need of help or guidance?", "In general, how close to you feel to your mother/daughter?") on a 7-point scale (1 =

*not at all, 7 = very, very much or very, very close*). Internal consistency on the relationship quality questionnaire was high for mothers ( $\alpha = .90$ ) and daughters ( $\alpha = .93$ ). Mothers' and daughters' mean relationship quality scores showed a moderate, positive correlation ( $r = .55, p < .001$ ). A dyadic measure of Relationship Quality ( $M = 5.77, SD = .94$ ) was derived by calculating the mean of mothers' and daughters' scores to examine associations between arousal transmission and the overall level of dyadic relationship quality, in line with previous research (Lougheed et al., 2016).

### **Laboratory measures.**

***Baseline arousal.*** Continuous recordings of GSR were obtained during the baseline task. These recordings were smoothed at a sampling rate of 1000 Hz with AcqKnowledge 4.2 (AcqKnowledge, 2011) to yield a continuous measure. Mothers' and daughters' GSR averages for the baseline task were calculated from this continuous measure.

***Arousal during the Emotional Rollercoaster task.*** To examine arousal transmission across positive and negative contexts, mothers' and daughters' GSR were measured continuously during each of the five discussions of the Emotional Rollercoaster task. Acqknowledge 4.2 (AcqKnowledge, 2011) was used to process the GSR time series data. Continuous GSR recordings were smoothed at a sampling rate of 1000 Hz, which were then exported into 5-second epochs separately for each 3-minute discussion. The time unit of 5 seconds was selected as latencies for electrodermal responses can range up to 5 seconds (Boucsein, 2012). Thus, for each 3-minute discussion, there were 35 epochs, and the value for each epoch was the mean GSR value for that 5-second period. Finally, to control for individual differences in baseline GSR and to facilitate interpretation across participants (Boucsein, 2012), each individual's baseline GSR mean was subtracted from their GSR mean for each 5-second epoch of each discussion of the Emotional Rollercoaster task.

***Self-reported emotions.*** Self-reported positive and negative emotions at baseline and after each of the five emotion discussions of the Emotional Rollercoaster task were measured

with a modified version of the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). The modified PANAS consisted of 10 items (emotions of positive and negative valence), which were selected to reflect the topics of the five emotion discussions. The positive emotion items were Happy, Excited, Valued, Proud, and Grateful. The negative emotion items were Guilty, Irritated, Worried, Nervous, and Frustrated. For each item, participants indicated the extent to which they felt each emotion on a 5-point scale (1 = *Not at all*, 5 = *Extremely*). The means of all positive items were calculated as a measure of self-reported Positive Emotion, and the means of all negative items were calculated as a measure of self-reported Negative Emotion. The internal consistency of self-reported Positive Emotion was acceptable across all tasks for daughters ( $\alpha$  range .80-.89) and mothers ( $\alpha$  range .72-.90). The internal consistency of self-reported Negative Emotion was acceptable across all tasks for daughters ( $\alpha$  range .78-.88) and mothers ( $\alpha$  range .68-.79).

## **Results**

### **Preliminary Analyses**

Data from four dyads were excluded from analyses due to technical problems that resulted in either missing or unusable GSR data. Variables were inspected for normality of distributions, univariate and multivariate outliers, and missing values. Several variables (self-reported Negative Emotion at Discussions 1, 2, 3, and 5) had univariate outliers ( $z > 3.5$ ), which were Winsorized to reduce their influence. Several self-reported emotion variables showed negative skew (self-reported Positive Emotion at Discussions 1, 3, and 5), and several variables showed positive skew (self-reported Negative Emotion at baseline and all five discussions). Preliminary analyses using self-reported emotions were run with bootstrapping, a non-parametric approach, to overcome issues of non-normal distributions. Bootstrapping approximates sampling distributions by sampling from the data with replacement (Mooney & Duval, 1993). The variables used in multilevel modeling (Relationship Quality, daughter and mother GSR during the

Emotional Rollercoaster task) met the assumptions required for this analysis as the residuals were normally distributed.

### **Positive and Negative Emotions across Emotional Contexts**

In order to examine if positive and negative emotions were successfully elicited by the Emotional Rollercoaster task, we ran two doubly-multivariate MANOVAs to examine differences in (1) self-reported Positive Emotion and (2) self-reported Negative Emotion across discussions, and to compare average differences in mother- and daughter-reported emotion. In each MANOVA, self-reported Positive Emotion and Negative Emotion at baseline and each of the discussion tasks were included as the dependent variables, respectively. The two within-subjects factors in each MANOVA were task and participant (i.e., daughter versus mother). In line with Hypothesis 1, we expected to find that: (1) self-reported Positive Emotion would be higher in Discussion 1 than at the baseline measure, and higher in the positive discussions (Discussions 3 and 5) than in the negative discussions (Discussions 2 and 4) that preceded them; and (2) self-reported Negative Emotion would be higher in the negative discussions (Discussions 2 and 4) than the positive discussions (Discussions 1 and 3) that preceded them.

Figure 4.1 shows self-reported Positive Emotion and Negative Emotion at baseline and the five discussions, separately for daughters and mothers. For self-reported Positive Emotion, the significant multivariate effect indicated that self-reported Positive Emotions differed across the baseline and five discussion tasks,  $F(5, 87) = 62.91, p < .001, \eta_p^2 = .75$ . Figure 4.1a shows the results of the planned within-subjects contrasts comparing each discussion to the previous discussion. As expected, self-reported Positive Emotion was significantly higher at the positive discussions (Discussions 1, 3, and 5) compared to baseline and the negative discussions (Discussions 2 and 4), respectively. The significant multivariate effect for participant indicated that on average, mothers showed higher self-reported Positive Emotion than daughters,  $F(1, 91) = 11.21, p < .001, \eta_p^2 = .11$ .



For self-reported Negative Emotion, the significant multivariate effect indicated that self-reported Negative Emotion differed across the baseline and five discussion tasks,  $F(5, 87) = 45.99, p < .001, \eta_p^2 = .73$ . Figure 4.1b shows the results of the planned within-subjects contrasts comparing each discussion to the previous discussion. As expected, self-reported Negative Emotion was significantly higher at the negative discussions (Discussions 2 and 4) compared to the positive discussions that preceded them (Discussions 1 and 3). The multivariate effect of participant was not significant, indicating that, on average, daughters and mothers did not differ self-reported Negative Emotion than mothers.

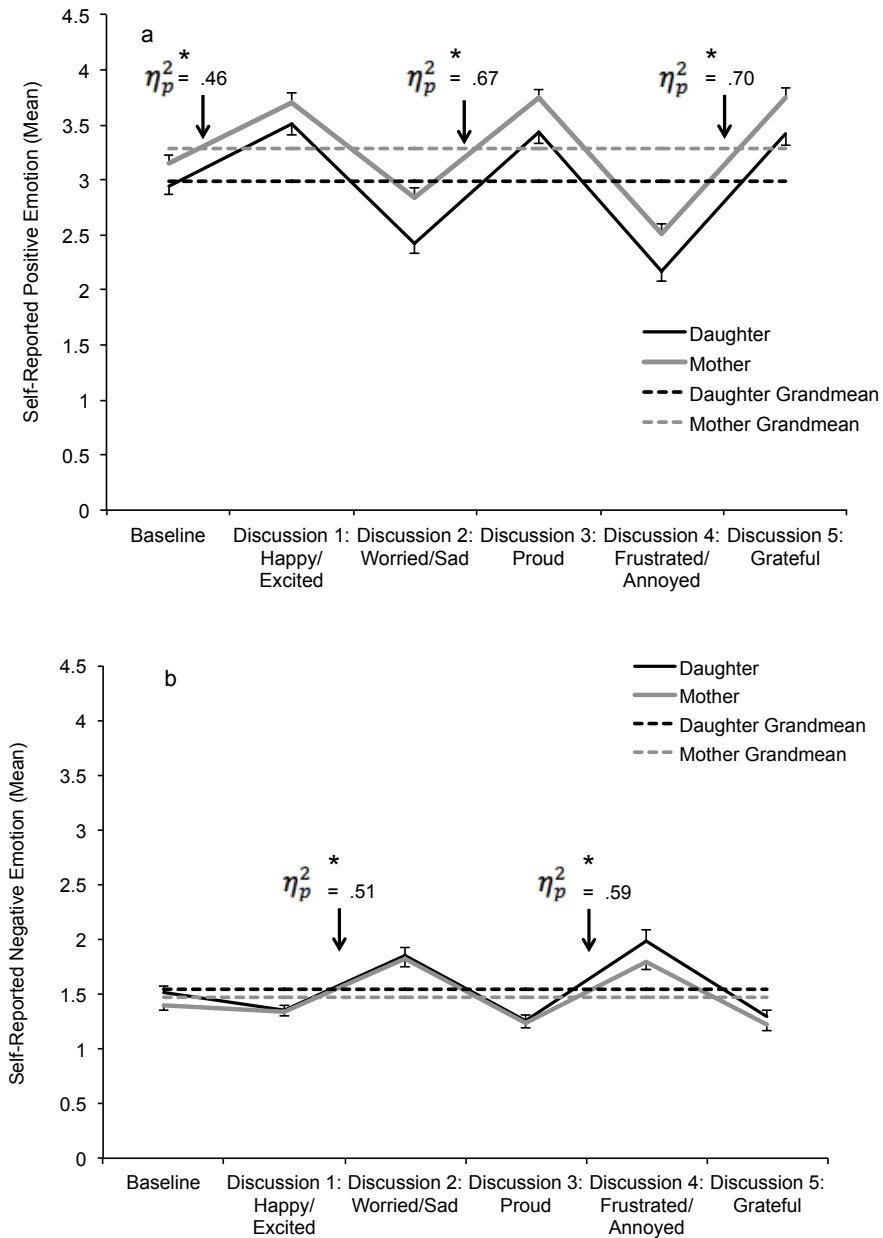


Figure 4.1. Self-reported Positive Emotion (Panel A) and Negative Emotion (Panel B) at baseline and the five discussion tasks. Note. Error bars represent the standard error of the mean. \*  $p < .001$ .

## Arousal Transmission and Relationship Quality across Emotional Contexts

We used multilevel modeling to examine (1) the average levels of mother-to-daughter and daughter-to-mother arousal transmission, (2) differences in arousal transmission across emotional contexts, and (3) Relationship Quality as a moderator of between-context differences in arousal transmission. We used a two-level model for distinguishable dyads using Mplus version 7.3 (Muthén & Muthén, 2015) in which daughter and mother arousal measures in 5-second epochs at Level 1 were nested within dyads at Level 2 (Laurenceau & Bolger, 2012). Using this approach enabled us to estimate separate parameters for mothers and daughters simultaneously. An unstructured covariance matrix was used in model estimation. We examined the extent to which dyadic partners' arousal levels (i.e., GSR) predicted each others' arousal over time. An individual's arousal level at time  $t$  (the current 5-second epoch) was predicted by her own and her partner's arousal level at time  $t-1$  (the previous 5-second epoch) using cross-lagged regression. We estimated separate intercepts and slopes for mothers (indicated by the subscript  $M$ ) and daughters (indicated by the subscript  $D$ ) according to the recommendations of Bolger and Laurenceau (2013), as shown in the equation below:

Level 1:

$$\text{Arousal}_{i,t} = \pi_{0Di} + \pi_{0Mi} + \pi_{1Di} (\text{Mother GSR}_{t-1,i}) + \pi_{1Mi} (\text{Daughter GSR}_{t-1,i}) + e_{it}$$

Level 2:

$$\pi_{0Di} = \beta_{00D} + \beta_{01D} (\text{RQ}_i) + \beta_{02D} (\text{D1 vs. D2}_i) + \beta_{03D} (\text{D2 vs. D3}_i) + \beta_{04D} (\text{D3 vs. D4}_i) +$$

$$\beta_{05D} (\text{D4 vs. D5}_i) + \beta_{06D} (\text{RQ*D1 vs. D2}_i) + \beta_{07D} (\text{RQ*D2 vs. D3}_i) +$$

$$\beta_{08D} (\text{RQ*D3 vs. D4}_i) + \beta_{09D} (\text{RQ*D4 vs. D5}_i) + r_{0Di}$$

$$\pi_{0Mi} = \beta_{00M} + \beta_{01M} (\text{RQ}_i) + \beta_{02M} (\text{D1 vs. D2}_i) + \beta_{03M} (\text{D2 vs. D3}_i) + \beta_{04M} (\text{D3 vs. D4}_i) +$$

$$\beta_{05M} (\text{D4 vs. D5}_i) + \beta_{06M} (\text{RQ*D1 vs. D2}_i) + \beta_{07M} (\text{RQ*D2 vs. D3}_i) +$$

$$\beta_{08M} (\text{RQ*D3 vs. D4}_i) + \beta_{09M} (\text{RQ*D4 vs. D5}_i) + r_{0Mi}$$

$$\pi_{1Di} = \beta_{10D} + \beta_{11D} (\text{RQ}_i) + \beta_{12D} (\text{D1 vs. D2}_i) + \beta_{13D} (\text{D2 vs. D3}_i) + \beta_{14D} (\text{D3 vs. D4}_i) +$$

$$\beta_{15D} (\text{D4 vs. D5}_i) + \beta_{16D} (\text{RQ*D1 vs. D2}_i) + \beta_{17D} (\text{RQ*D2 vs. D3}_i) +$$

$$\beta_{18D} (\text{RQ}*\text{D3 vs. D4}_i) + \beta_{19D} (\text{RQ}*\text{D4 vs. D5}_i) + r_{1Di}$$

$$\pi_{1Mi} = \beta_{10M} + \beta_{11M} (\text{RQ}_i) + \beta_{12M} (\text{D1 vs. D2}_i) + \beta_{13M} (\text{D2 vs. D3}_i) + \beta_{14M} (\text{D3 vs. D4}_i) +$$

$$\beta_{15M} (\text{D4 vs. D5}_i) + \beta_{16M} (\text{RQ}*\text{D1 vs. D2}_i) + \beta_{17M} (\text{RQ}*\text{D2 vs. D3}_i) +$$

$$\beta_{18M} (\text{RQ}*\text{D3 vs. D4}_i) + \beta_{19M} (\text{RQ}*\text{D4 to D5}_i) + r_{1Mi}$$

At Level 1, the outcome (Arousal<sub>ti</sub>) reflects each person in dyad *i*'s arousal at time *t*, which was modeled as a function of two random intercepts ( $\pi_{0Di}$  and  $\pi_{0Mi}$ ) and two random slopes ( $\pi_{1Di}$  and  $\pi_{1Mi}$ ). The Level 1 slopes  $\pi_{1Di}$  and  $\pi_{1Mi}$  reflect the cross-lagged associations between each person's GSR arousal at time *t* and their partner's GSR arousal at time *t-1* (i.e., arousal transmission) for dyad *i*. The lagged predictors (Mother GSR<sub>t-1i</sub> and Daughter GSR<sub>t-1i</sub>) were person-mean centered so that they reflect deviations from each person's mean level (Laurenceau & Bolger, 2012). Because the lagged predictors were centered, the Level 1 intercepts  $\pi_{0Di}$  and  $\pi_{0Mi}$  reflect the average levels of arousal for daughters and mothers, respectively, in each dyad *i*.

At Level 2, the Level 1 intercepts and slopes were allowed to vary randomly across dyads and were modeled as a function of differences across discussions and Relationship Quality (abbreviated to RQ in equations). Specifically, mean levels of arousal and arousal transmission were predicted by Relationship Quality, and compared between discussions through a set of contrasts that compared discussion topics successively: D1 vs. D2 compared Discussion 1 (Happy/Excited) to Discussion 2 (Worried/Sad); D2 vs. D3 compared Discussion 2 to Discussion 3 (Proud); D3 vs. D4 compared Discussion 3 to Discussion 4 (Frustrated/Annoyed); and D4 vs. D5 compared Discussion 4 to Discussion 5 (Grateful). Thus, the Level 2 intercept  $\beta_{00D}$  is the estimated average level of adolescent arousal at the average level of Relationship Quality,  $\beta_{01D}$  represents the association between Relationship Quality and the mean level of adolescent arousal,  $\beta_{02D}$  represents the comparison between Discussions 1 and 2 on the mean level of adolescent arousal,  $\beta_{03D}$  represents the comparison between Discussions 2 and 3 on the mean level of adolescent arousal,  $\beta_{04D}$  represents the comparison between Discussions 3 and 4 on the mean level of adolescent arousal, and  $\beta_{05D}$  represents the comparison between Discussions 4 and 5 on the

mean level of adolescent arousal. Interactions between each of the contrasts comparing discussions and Relationship Quality were represented by the parameters  $\beta_{06D}$ ,  $\beta_{07D}$ ,  $\beta_{08D}$ , and  $\beta_{09D}$ . Parameters  $\beta_{00M}$ ,  $\beta_{01M}$ ,  $\beta_{02M}$ ,  $\beta_{03M}$ ,  $\beta_{04M}$ ,  $\beta_{05M}$ ,  $\beta_{06M}$ ,  $\beta_{07M}$ ,  $\beta_{08M}$ , and  $\beta_{09M}$  are the corresponding estimates for mothers.

The final set of parameters estimated at Level 2 represent arousal transmission. The parameter  $\beta_{10D}$  is the estimated average level of mother-to-daughter arousal transmission at the average level of Relationship Quality.  $\beta_{11D}$  represents the association between Relationship Quality and the mean level of mother-to-daughter arousal transmission,  $\beta_{12D}$  represents the comparison between Discussions 1 and 2 on mother-to-daughter arousal transmission at the average level of Relationship Quality,  $\beta_{13D}$  represents the comparison between Discussions 2 and 3 on mother-to-daughter arousal transmission at the average level of Relationship Quality,  $\beta_{14D}$  represents the comparison between Discussions 3 and 4 on mother-to-daughter arousal transmission at the average level of Relationship Quality, and  $\beta_{15D}$  represents the comparison between Discussions 4 and 5 on mother-to-daughter arousal transmission at the average level of Relationship Quality. Interactions between each of the contrasts comparing discussions and Relationship Quality were represented by the parameters  $\beta_{16D}$ ,  $\beta_{17D}$ ,  $\beta_{18D}$ , and  $\beta_{19D}$ . Parameters  $\beta_{10M}$ ,  $\beta_{11M}$ ,  $\beta_{12M}$ ,  $\beta_{13M}$ ,  $\beta_{14M}$ ,  $\beta_{15M}$ ,  $\beta_{16M}$ ,  $\beta_{17M}$ ,  $\beta_{18M}$ , and  $\beta_{19M}$  are the corresponding estimates for daughter-to-mother arousal transmission.

**Daughters' mean level of arousal.** Parameter estimates for daughters' mean level of arousal are shown in Table 4.1. The non-significant parameter estimates for  $\beta_{01D}$ ,  $\beta_{02D}$ ,  $\beta_{03D}$ ,  $\beta_{04D}$ ,  $\beta_{05D}$ ,  $\beta_{06D}$ ,  $\beta_{07D}$ ,  $\beta_{08D}$ , and  $\beta_{09D}$  indicated that the mean level of adolescent arousal did not vary by Relationship Quality, by comparisons between discussions, or by the interactions between Relationship Quality and the comparisons between discussions.

**Mothers' mean level of arousal.** Parameter estimates for mothers' mean level of arousal are shown in Table 4.1. The significant parameter estimate for  $\beta_{01M}$  indicated that Relationship Quality was negatively associated with mothers' mean level of arousal (i.e., mothers with lower

levels of Relationship Quality showed greater levels of arousal). The non-significant parameter estimates for  $\beta_{02M}$ ,  $\beta_{03M}$ ,  $\beta_{04M}$ ,  $\beta_{05M}$ ,  $\beta_{06M}$ ,  $\beta_{07M}$ ,  $\beta_{08M}$ , and  $\beta_{09M}$  indicated that the mean level of maternal arousal did not vary by comparisons between discussions, or by the interactions between Relationship Quality and the comparisons between discussions.

Table 4.1  
*Fixed Effect Estimates for Mean-Levels of Daughter and Mother Arousal*

Outcome	Parameter	Estimate (SE)	<i>p</i>	95% CI
Daughter Arousal	Intercept, $\beta_{00D}$	2.23 (.07)	<.001	[2.11, 2.35]
	Relationship Quality, $\beta_{01D}$	-.08 (.08)	.27	[-.21, .04]
	Happy/Excited to Worried/Sad, $\beta_{02D}$	.18 (.13)	.17	[-.04, .40]
	Worried/Sad to Proud, $\beta_{03D}$	.25 (.17)	.14	[-.03, .53]
	Proud to Frustrated/Annoyed, $\beta_{04D}$	.22 (.18)	.22	[-.07, .52]
	Frustrated/Annoyed to Grateful, $\beta_{05D}$	.13 (.15)	.40	[-.12, .38]
	Relationship Quality x Happy/Excited to Worried/Sad, $\beta_{06D}$	.07 (.15)	.66	[-.18, .31]
	Relationship Quality x Worried/Sad to Proud, $\beta_{07D}$	.08 (.18)	.66	[-.22, .39]
	Relationship Quality x Proud to Frustrated/Annoyed, $\beta_{08D}$	.06 (.19)	.76	[-.25, .37]
Relationship Quality x Frustrated/Annoyed to Grateful, $\beta_{09D}$	.05 (.16)	.77	[-.21, .30]	
Mother Arousal	Intercept, $\beta_{00M}$	1.42 (.07)	<.001	[1.31, 1.52]
	Relationship Quality, $\beta_{01M}$	-.18 (.07)	.01	[-.30, .07]
	Happy/Excited to Worried/Sad, $\beta_{02M}$	-.12 (.13)	.33	[-.34, .09]
	Worried/Sad to Proud, $\beta_{03M}$	-.13 (.16)	.40	[-.39, .13]
	Proud to Frustrated/Annoyed, $\beta_{04M}$	-.08 (.13)	.61	[-.34, .18]
	Frustrated/Annoyed to Grateful, $\beta_{05M}$	-.06 (.13)	.65	[-.27, .16]
	Relationship Quality x Happy/Excited to Worried/Sad, $\beta_{06M}$	.04 (.14)	.77	[-.19, .28]
	Relationship Quality x Worried/Sad to Proud, $\beta_{07M}$	.03 (.17)	.88	[-.26, .31]
	Relationship Quality x Proud to Frustrated/Annoyed, $\beta_{08M}$	-.02 (.18)	.91	[-.31, .27]
Relationship Quality x Frustrated/Annoyed to Grateful, $\beta_{09M}$	-.04 (.15)	.80	[-.28, .20]	

*Note.* CI = confidence interval.

**Mother-to-daughter arousal transmission.** Parameter estimates for the cross-lagged influence of mother arousal on daughter arousal are shown in Table 4.2. The significant intercept ( $\beta_{10D}$ ) indicated that, on average, there was significant mother-to-daughter arousal transmission (i.e., daughters “picked up” on their mothers’ arousal), in line with expectations for Hypothesis 2. Mother-to-daughter arousal transmission did not vary by the comparisons between discussions ( $\beta_{12D}$  through  $\beta_{15D}$ ), contrary to expectations for Hypothesis 3a and 3b. The interaction between Relationship Quality and the comparison between Discussion 2 (Worried/Sad) and Discussion 3 (Proud) was marginally significant ( $p = .06$ , see  $\beta_{17D}$ ). Because this study was exploratory in nature, this marginally significant interaction was followed up with a simple slopes analysis to facilitate interpretation. Figure 4.2 plots mother-to-daughter arousal transmission for the comparison of mother-to-daughter arousal transmission between Discussion 2 and Discussion 3, comparing low (1 *SD* below the mean) and high (1 *SD* above the mean) Relationship Quality. The results of the simple slopes analysis showed that the simple slope at high Relationship Quality was significant,  $\beta = -.18$ ,  $SE = .08$ ,  $p = .02$ , 95% CI [-.31, -.06], indicating that mother-to-daughter arousal transmission decreased significantly from Discussion 2 to Discussion 3 at relatively high levels of Relationship Quality, which was the opposite of expectations for Hypothesis 4. The simple slope at low Relationship Quality was not significant, which indicated no significant difference in mother-to-daughter arousal transmission between Discussion 2 and Discussion 3.

**Daughter-to-mother arousal transmission.** Parameter estimates for the cross-lagged influence of daughter arousal on mother arousal are shown in Table 4.2. The significant intercept ( $\beta_{10M}$ ) indicated that, on average, there was significant daughter-to-mother arousal transmission (i.e., mothers “picked up” on their daughters’ arousal), in line with expectations for Hypothesis 2. The main effect comparing Discussion 1 (Happy/Excited) to Discussion 2 (Worried/Sad) was significant (see  $\beta_{12M}$ ), indicating that daughter-to-mother arousal decreased, on average, from Discussion 1 to Discussion 2, contrary to expectations for Hypothesis 3a. All other remaining



main effects and interaction terms were not significant. The effect size of all of the Level 2 predictors was modest, accounting for 8% of the between-dyad variance in mother-to-daughter arousal transmission.

Table 4.2

*Fixed Effect Estimates for Cross-Lagged Regression Weights of Daughter and Mother Arousal (Arousal Transmission)*

Outcome	Parameter	Estimate (SE)	<i>p</i>	95% CI
Mother-to-Daughter Arousal Transmission	Intercept, $\beta_{10D}$	.78 (.05)	<.001	[.70, .86]
	Relationship Quality, $\beta_{11D}$	-.01 (.03)	.70	[-.05, .03]
	Happy/Excited to Worried/Sad, $\beta_{12D}$	-.08 (.05)	.13	[-.16, .01]
	Worried/Sad to Proud, $\beta_{13D}$	-.06 (.06)	.31	[-.16, .04]
	Proud to Frustrated/Annoyed, $\beta_{14D}$	-.05 (.06)	.47	[-.15, .06]
	Frustrated/Annoyed to Grateful, $\beta_{15D}$	-.01 (.06)	.89	[-.11, .09]
	Relationship Quality x Happy/Excited to Worried/Sad, $\beta_{16D}$	-.04 (.05)	.37	[-.13, .04]
	Relationship Quality x Worried/Sad to Proud, $\beta_{17D}$	-.13 (.07)	.06	[-.24, -.02]
	Relationship Quality x Proud to Frustrated/Annoyed, $\beta_{18D}$	-.07 (.06)	.29	[-.17, .04]
Relationship Quality x Frustrated/Annoyed to Grateful, $\beta_{19D}$	-.06 (.06)	.29	[-.16, .03]	
Daughter-to-Mother Arousal Transmission	Intercept, $\beta_{10M}$	.50 (.03)	<.001	[.45, .54]
	Relationship Quality, $\beta_{11M}$	.01 (.02)	.68	[-.02, .03]
	Happy/Excited to Worried/Sad, $\beta_{12M}$	-.07 (.03)	.02	[-.12, -.02]
	Worried/Sad to Proud, $\beta_{13M}$	-.07 (.04)	.09	[-.13, .00]
	Proud to Frustrated/Annoyed, $\beta_{14M}$	-.03 (.04)	.53	[-.09, .04]
	Frustrated/Annoyed to Grateful, $\beta_{15M}$	-.01 (.03)	.86	[-.06, .05]
	Relationship Quality x Happy/Excited to Worried/Sad, $\beta_{16M}$	-.04 (.03)	.23	[-.09, .02]
	Relationship Quality x Worried/Sad to Proud, $\beta_{17M}$	-.05 (.04)	.22	[-.11, .02]
	Relationship Quality x Proud to Frustrated/Annoyed, $\beta_{18M}$	.00 (.04)	.92	[-.06, .07]
Relationship Quality x Frustrated/Annoyed to Grateful, $\beta_{19M}$	.02 (.04)	.64	[-.05, .08]	

*Note.* CI = confidence interval.

## **Discussion**

The goal of the current study was to examine arousal transmission across positive and negative emotion contexts in mother-daughter TIES during adolescence. In line with expectations, daughters and mothers showed greater self-reported positive emotions during positive discussions than during negative discussions, and greater self-reported negative emotions during negative discussions than during positive discussions. Also in line with expectations, both daughters and mothers “picked up” on each others’ emotional arousal, as both mother-to-daughter and daughter-to-mother arousal transmission were observed. However, our hypotheses regarding differences in arousal transmission across emotional contexts, and relationship quality as a moderator of changes in arousal transmission across contexts, were not supported. Taken together, the unexpected results of the current study demonstrate the complexity of the associations between SNS arousal transmission, positive and negative emotional contexts, and relationship quality in mother-daughter TIES in adolescence.

### **Arousal Transmission across Emotional Contexts**

In line with previous research (Levenson & Gottman, 1983; Timmons et al., 2015), we had expected that SNS arousal transmission would be greater during negative emotional contexts than during positive contexts. Contrary to expectations, mother-to-daughter arousal transmission did not vary across emotional contexts. Daughter-to-mother arousal transmission decreased from Discussion 1 (Happy/Excited) to Discussion 2 (Worried/Sad), which was contrary to the expected direction. Daughter-to-mother arousal transmission did not vary between other emotional contexts, which was also contrary to expectations. Previous research suggests that SNS arousal transmission is associated with both negative (e.g., amplification of negative emotions; Levenson & Gottman, 1983) and positive (e.g., empathy; Chatel-Goldman et al., 2014; Levenson & Ruef,

1992) interpersonal processes. The greater daughter-to-mother arousal transmission in Discussion 1 compared to Discussion 2 observed in the current study may reflect that mothers “picked up” on their daughters’ arousal (e.g., excitement) in Discussion 1, and then disengaged (in relative, not absolute, terms) during Discussion 2 in order to avoid “picking up” on their daughter’s internalizing negative emotions. In typically-developing relationships, mothers are accustomed to providing emotional support to their daughters by helping them to down-regulate negative emotions (Lougheed, Hollenstein, & Lewis, in press), and mothers may adjust their own arousal in order to enable them to better support their daughters. By receiving less of the arousal transmitted by the daughter in Discussion 2 compared to Discussion 1, mothers may have been better able to participate in a discussion with their daughters about sensitive and negative emotional issues, rather than amplifying their own (and potentially also their daughters’) negative emotion states. Alternatively, mothers’ own experiences of internalizing emotions during Discussion 2 may be related to the lower daughter-to-mother arousal transmission in Discussion 2 compared to Discussion 1—it may be more difficult for mothers to “pick up” on their daughters’ emotional arousal when mothers experience sadness or worry compared to positive emotions.

Regarding the lack of differences in arousal transmission across emotion contexts more broadly, it is possible that the emotions elicited in the Emotional Rollercoaster task were not strong enough to be reflected in differences in arousal transmission. Daughters and mothers showed relative differences in self-reported positive and negative emotions across positive and negative discussions, but the absolute differences were relatively small. For example, self-reported positive emotions were rather high during positive discussions, and were moderately high during negative discussions. In addition, even though greater negative emotions were reported during negative discussions compared to positive discussions, the absolute levels of self-

reported negative emotions were low in general. Research on mother-infant TIES has shown differences in SNS arousal transmission between social interactions with more extreme differences in emotional valence, such as the still face and reunion episodes of the Face-to-Face-Still-Face paradigm (Ham & Tronick, 2009). In the current study, it is possible that differences in arousal transmission across emotional contexts would have been observed in mother-daughter TIES in more emotionally intense or polarized positive and negative discussions.

An alternative explanation is that arousal transmission in close relationships does not typically vary between emotional contexts, and is more a feature of dyad-level tendencies than situational factors. Of the relatively few studies to date that have examined arousal transmission across different emotional contexts, several studies of adult romantic partner TIES have shown no differences in arousal transmission across emotional contexts (Chatel-Goldman et al., 2014; Levenson & Gottman, 1983; Reed, Randall, Post, & Butler, 2013). One study of adult romantic partners showed associations between physiological arousal transmission and trait-level empathy (Chatel-Goldman et al., 2014), and it is possible that the transmission of physiological arousal is an indicator of individual differences in empathy.

### **Arousal Transmission and Relationship Quality**

In line with previous research (Levenson & Gottman, 1983; Timmons et al., 2015), we had expected that relationship quality would moderate changes in arousal transmission across emotional contexts, specifically by being associated with lower arousal transmission in negative emotional contexts at higher levels of relationship quality compared to lower levels of relationship quality. Contrary to expectations, relationship quality did not moderate changes in arousal transmission across emotional contexts, although there was a marginally significant interaction between relationship quality and the comparison between Discussion 2 (Worried/Sad)

and Discussion 3 (Proud) on mother-to-daughter arousal transmission. A cautious interpretation of this marginal effect is that daughters in relationships of higher quality showed sensitivity to context in terms of the arousal they received from their mothers whereas daughters in lower-quality relationships did not. Regarding the general lack of significant results more broadly, one possible reason for these null results is that the sample of mother-daughter dyads was relatively high in relationship quality. Previous research that has demonstrated associations between relationship quality and arousal transmission has focused on samples with greater diversity in relationship quality and psychosocial functioning (e.g., distressed versus non-distressed married couples; Levenson & Gottman, 1983).

One unexpected finding that emerged in the current study, which was not related to our primary research questions, was that mothers with higher levels of relationship quality showed lower average levels of SNS arousal during the Emotional Rollercoaster task. Because this association was not hypothesized, we cautiously interpret this finding by suggesting that, at lower levels of relationship quality, mothers perceived the Emotional Rollercoaster task as more threatening than mothers with higher relationship quality. Discussing personal emotions, especially discussing negative emotions experienced toward a relationship partner with that very relationship partner, can be a vulnerable experience (Chaparro & Grusec, 2015). One feature of higher-quality parent-adolescent relationships is the ability for both partners to disclose emotional experiences, which is less stress-inducing within a relationship that is warm and supportive than one that is not (Chaparro & Grusec, 2015; Collins & Sroufe, 1999). Thus, mothers in higher quality mother-daughter relationships may be better able than mothers in lower quality relationships to discuss sensitive emotional topics with their daughters without experiencing relatively higher SNS arousal. Another possibility is that discussing emotional issues occurs more

frequently in higher quality relationships than in lower quality relationships, and therefore is less novel (and less arousing in terms of SNS activity).

Taken together, the lack of associations between relationship quality and arousal transmission were unexpected. However, it is notable that the current study, to our knowledge, was the first examination of real-time arousal transmission in mother-daughter TIES during adolescence. The majority of research to date that has demonstrated associations between arousal transmission and relationship quality has examined mother-infant TIES (see Field, 2012 for a review) and adult romantic partner TIES (see Timmons et al., 2015 for a review). There are characteristics that differentiate mother-adolescent TIES from other TIES that may be related to the null results in the current study. Mother-adolescent TIES are TIES in flux—typically-developing adolescents experience changes in several domains, such as increased emotional intensity and lability, increased parent-adolescent conflicts, and reorganizing parent-adolescent relationships as adolescents gain autonomy within the family (Collins & Laursen, 2004; Hollenstein & Loughheed, 2013; Rosenblum & Lewis, 2003; Smetana et al., 2006). Thus, it is possible that mother-adolescent TIES have less stable interpersonal arousal transmission dynamics than other TIES (mother-infant, romantic partner), which do not necessarily experience as much moment-to-moment and day-to-day variation in emotion processes as part of the normative adolescent transition. Several characteristics of typical adolescent development play a role in the variability of adolescent emotion dynamics, including puberty, and increased internalizing symptoms, emotional lability, and family conflicts (Hollenstein & Loughheed, 2013). Therefore, coordinated interpersonal dynamics such as arousal transmission in parent-adolescent TIES may not vary systematically with dyadic characteristics such as relationship quality compared to other TIES.

## **Limitations and Future Directions**

The current study was the first test of real-time arousal transmission in mother-daughter TIES during adolescence, and it is also one of the first studies to examine differences in arousal transmission across specific emotional contexts (Timmons et al., 2015). The results of the current study suggest that bi-directional arousal transmission occurs in mother-daughter TIES during adolescence, but that it may not vary across moderately positive and negative emotion contexts or be related to mother-daughter relationship quality. We caution against interpreting the null results of the current study for several reasons, some which pertain to the limitations of null hypothesis significance testing (Cohen, 1994), and others which pertain to the limitations of the current study. As noted previously, one limitation of the current study is that the Emotional Rollercoaster task elicited relatively low levels of self-reported negative emotions during the negative discussions. In addition, the sample consisted of typically-developing adolescents and their mothers with relatively high levels of relationship quality. Both the low intensity of negative emotions and the overall high quality of participants' relationships could relate to the lack of differences in arousal transmission across contexts and relationship quality.

It should also be noted that the results of the current study may not be generalizable to populations that were not examined in the current study. The sample consisted of dyads with relatively high relationship quality and socioeconomic status, who were predominantly European-Canadian in families with married mothers and fathers. Further research is needed to examine arousal transmission in more diverse samples. In addition, only mother-daughter dyads were examined, and thus the results may not generalize to other parent-adolescent TIES such as mother-son and father-daughter TIES. Emotional expressions and parental emotion socialization vary by sex (Collins & Russell, 1991; Perry-Parrish & Zeman, 2011), and these emotion



processes within families influence the interpersonal regulation of physiological arousal (Repetti, Taylor, & Seeman, 2002). Thus, another important future direction for research is to examine sex differences (e.g., mother versus father, son versus daughter) in arousal transmission.

Finally, we used the discussions of the Emotional Rollercoaster task in a fixed order so that we could examine, across all participants, how arousal transmission differed in the transition from specific positive to specific negative emotion contexts, and vice versa. However, it was not possible to examine if fatigue effects played a role in the lack of significant findings of the current study. An important direction for future research is to employ nuanced emotion elicitation tasks, such as the Emotional Rollercoaster task, in counterbalanced designs to better understand the associations between discrete emotions and arousal transmission.

### **Conclusion**

Anecdotally, mothers of adolescent girls report difficulties “getting on the same page” as their daughter emotionally, and describe the marked differences from their interpersonal dynamics in childhood. What were once reasonably predictable patterns of emotions have transformed into an “emotional rollercoaster” full of unexpected twists and turns, that neither mothers nor daughters can explain. Our attempt to systematically examine variations in mother-daughter arousal transmission across the contexts of emotional valence and relationship quality showed some contextual variations in arousal transmission, but also left much to explain by future studies. Mother-daughter TIES show bi-directional arousal transmission in adolescence, but future research is required to better understand the role of arousal transmission in mother-daughter TIES.

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## **Chapter 5: General Discussion**

## General Discussion

The overarching goal of this dissertation was to examine mother-daughter emotion dynamics across specific positive and negative emotional contexts. The three studies of this dissertation (see Table 5.1 for a summary of study characteristics) provided important insights into the associations between real-time emotion dynamics and psychosocial adjustment (i.e., relationship quality, internalizing symptoms). In the following sections, I will expand upon the results, implications, and future directions of the studies in this dissertation in terms of their contributions to: (1) our understanding of mother-daughter relationship quality; (2) knowledge gained regarding mother-daughter arousal transmission; and (3) developmental processes.

Table 5.1  
*Summary of Study Characteristics*

	Daughter Age Range (years)	<i>N</i>	Emotion Elicitation Task	Emotion Dynamics	Psychosocial Adjustment
Study 1	14-16	66	Daughter speech	Arousal transmission and attenuation	Relationship quality
Study 2	13-16	96	Emotional Rollercoaster	Socioemotional flexibility	Relationship quality; internalizing symptoms
Study 3	13-16	96	Emotional Rollercoaster	Arousal transmission	Relationship quality

### Mother-Daughter Relationship Quality

The three studies of this dissertation provided key insights into the emotion dynamics associated with relationship quality in mother-daughter dyads during adolescence. Across samples in both Studies 1 and 3, an association between relationship quality and sympathetic nervous system (SNS) arousal was found. Lower levels of relationship quality were associated

with greater SNS responses for adolescents during social stress (Study 1) and for mothers during discussions with their daughters about the emotions they felt towards each other (Study 3). Both of the emotion elicitation tasks used in this dissertation likely resulted in different emotional experiences for mothers and daughters. The spontaneous speech task (Study 1) was designed to elicit social stress specifically in the daughters but not the mothers, at least not directly. The Emotional Rollercoaster task (Studies 2 and 3) was not designed with the intention of eliciting different emotional experiences for mothers and daughters, so why would relationship quality be associated with mothers' but not also daughters' SNS arousal levels?

It is possible that mothers perceived the Emotional Rollercoaster task to be more challenging than daughters did. The mother-daughter relationship is still hierarchical in early-to-mid adolescence (Collins & Laursen, 2004; Smetana et al., 2006), and adolescent girls might be accustomed to their mothers taking the lead during their interactions by setting the emotional tone and facilitating turn-taking (Sillars, Smith, & Koerner, 2010). The maternal role of monitoring and facilitating discussions may be more of a challenge for mothers with lower levels of relationship quality than for those with higher levels of relationship quality, and thus be associated with greater SNS arousal. Mothers may also show greater SNS arousal at lower levels of relationship quality in anticipation of the negative emotions that their daughter might express during this task. Mothers with lower levels of relationship quality can be less accepting of their children's negative emotions than mothers with higher levels of relationship quality, and may see negative emotions as something to be dismissed (Gottman, Katz, & Hooven, 1996; Yap, Allen, Leve, & Katz, 2008). For this reason, mothers with lower relationship quality may experience more threat or challenge (and therefore increased SNS arousal) when confronted with a task that explicitly involves discussing their own and their daughters' negative emotions. When considered

together with the Study 1 results showing that daughters with lower levels of relationship quality regulated their SNS arousal less efficiently during social stress than at higher levels of relationship quality, the findings of this dissertation support the SBT tenet (Beckes & Coan, 2011) that one function of relationship quality is to distribute the collective efforts expended on regulating SNS arousal by not allowing SNS arousal levels to get very high.

Considering all three studies of this dissertation together, relationship quality was associated with emotion dynamics in mother-daughter dyads in several ways during adolescence. Relationship quality was related to how much SNS arousal mothers and daughters experienced in different emotional contexts, to efficient arousal attenuation during daughters' social stress, and to the ability for dyads to transition between emotions during interactions. The extent to which mothers and daughters feel that they can trust each other and experience warmth in their interactions in a general sense likely sets the tone for the emotion dynamics in any interaction—in other words, relationship quality is the link that forges TIES.

The results of this dissertation point to several open questions regarding mother-daughter relationship quality that will be important directions for future research. First, there are several individual and dyadic aspects of relationships that are likely to be associated with emotional load sharing in addition to relationship quality as examined in the current study. One example is that individuals in a relationship may differ in their ability to self-regulate emotions (Karimiha, Rehman, & Macdonald, 2015), potentially leading to asymmetries in the extent of emotional load sharing between partners. Karimiha et al. (2015) examined the psychosocial costs among adult romantic partners of providing emotional support to partners who are inconsolable—individuals who have difficulties benefiting from the comfort and emotional support provided by others. Individuals are not always receptive to emotional support that may be offered, and the results of

Karimiha et al.'s (2015) study showed that supporting partners can be distressing if the efforts expended appear to be ineffective. Put into the parlance of SBT (Beckes & Coan, 2011), it can be costly to the load sharer to expend energy on emotional load sharing if it is futile. Compared to adult romantic partners, mother-daughter relationships are expected to be asymmetrical (i.e., hierarchical) in some ways, with mothers likely doing the majority of emotional load sharing within the context of that relationship. However, if the developmentally-expected asymmetry is augmented by some form of adolescent emotion regulation difficulty (e.g., inconsolability), mothers' attempts at emotional load sharing may be met with frustration and exhaustion, leading over time to maternal distress and decreases in dyadic relationship quality. It is not uncommon for typically-developing adolescents to experience some form of emotion regulation difficulty (e.g., internalizing symptoms; Hollenstein & Loughheed, 2013), so a related question for future research is if there is a temporary but normative decrease in parent-adolescent load sharing while adolescents experience emotion regulation difficulties.

Second, parent-adolescent relationship quality varies over years (van der Giessen et al., 2013), but it may also vary in response to daily variations in emotion dynamics and life stressors. Another direction for future research is to examine if load sharing varies according to fluctuations in relationship quality. There are two ways that future research could do so. One direction would be to take a naturalistic approach with the experience-sampling method (Csikszentmihalyi & Larson, 1987). In an experience-sampling design, mothers and daughters could report on their relationship quality, emotional experiences, stressors, and mother-daughter interactions at random intervals over the course of several weeks. Changes in relationship quality could be analyzed in terms of their associations with emotional experiences and whether or not mother-daughter interactions result in attenuated negative emotions. Another direction would be to experimentally

manipulate perceptions of relationship quality, such as by priming negative or positive relationship perceptions in mothers and daughters. This priming procedure could be combined with the social stress task used in Study 1 to examine if positive or negative perceptions of relationship quality are associated with load sharing in the moments when participants perceive their relationship as more or less positive.

A third direction for future research is to examine if the benefits of load sharing are unilateral or bilateral. In Study 1, the spontaneous speech task was designed to elicit social stress in daughters and not mothers. However, there are situations in which both partners experience negative emotions at the same time, such as the negative discussions in the Emotional Rollercoaster task. It is important to examine the effects of emotional load sharing on the person taking on the burden, as it may have consequences for both individual and dyadic functioning (Karimiha et al., 2015). Although maternal responses during load sharing were examined in Study 1, no associations between physical or relationship closeness on maternal arousal regulation were found. Thus, a study design that elicits challenging emotional experiences in both partners may allow for an examination of bi-lateral load sharing processes. Future research could combine the designs of Studies 1 and 3 in the current dissertation by experimentally manipulating physical closeness during the Emotional Rollercoaster task to examine how loads are shared between partners when both have a burden to bear. This suggested design could also be used to examine if and when adolescents develop the ability to share their mother's emotional load.

### **Mother-Daughter Arousal Transmission**

In general, the results of this dissertation demonstrated that SNS arousal is transmitted both from mother to daughter and daughter to mother in the context of adolescent social stress (Study 1) and across a series of positively- and negatively-valenced emotional discussions (Study

3). However, it was surprising that arousal transmission was not associated with relationship quality in both Studies 1 and 3, and that in general, it did not vary by emotional context in Study 3. It is possible that arousal transmission reflects a general trait-like capacity for empathy, or a general tendency to synchronize with close relationship partners at the physiological level. Interpersonal synchronization has been examined across many modalities (e.g., postural, behavioural, physiological, expressive) and in several dyad types (e.g., strangers, close relationship partners) as an automatic form of establishing social connection (Feldman, 2012; Harrist & Waugh, 2002; Miles, Nind, & Macrae, 2009; Schmidt & Richardson, 2008; Vacharkulksemsuk & Fredrickson, 2012). It is certainly not the case that the emotional experiences of any two interacting humans will mirror each others' experiences perfectly, but rather more likely that humans have evolved to vicariously experience portions of others' emotions as one form of communication (Decety & Meyer, 2008). The extent to which interaction partners are able to do so likely varies by the nature of the relationship, such as between strangers versus family members (Vacharkulksemsuk & Fredrickson, 2012). Moreover, the specific modalities through which partners are able to establish some form of synchronization likely also depends on the nature of the relationship. For example, partners who are relatively unfamiliar with each other may experience the greatest synchronization through observable channels (e.g., postural, verbal, expressive), whereas relationship partners with an established history of interaction patterns may additionally synchronize in more subtle ways, such as physiologically, because they are better able to anticipate each others' changes in emotions (Chatel-Goldman et al., 2014). The ability to synchronize emotional experiences with close relationship partners may be one interpersonal emotion dynamic that underlies the evolved capacity for emotional load sharing. Unlike physical burdens, emotional burdens cannot be

alleviated without the load sharer understanding its contents. If our load-sharing partners are not aware of our emotional burdens, we may feel alone in our struggles along with the emotional weight that accompanies feelings of loneliness (Cacioppo, Hawkley, & Berntson, 2003).

Going forward, there are several important directions for future research on arousal transmission in mother-daughter dyads. One direction is the associations between arousal transmission and empathic processes. Arousal transmission is one physiological substrate that underlies empathy (Chatel-Goldman et al., 2014; Levenson & Ruef, 1992). Adolescence is considered a sensitive period for the development of empathy (Choudhury, Blakemore, & Charman, 2006), as the continued development of empathy in adolescence is associated with a range of long-term outcomes such as the ability to develop and maintain relationships in adulthood (Allemand, Steiger, & Fend, 2015; van Lissa et al., 2014). Empathy factors in to the parent-adolescent relationship in several ways that likely influence emotion dynamics: parental empathy is associated with adolescent empathy, and low adolescent empathy is associated with greater parent-adolescent conflict (van Lissa et al., 2015). Thus, future research on the associations between empathy, parent-adolescent relationship quality, and arousal transmission may shed light on the functions of arousal transmission in parent-adolescent relationships.

Another direction for future research relates to distinguishing the transmission of arousal to others from the reception of others' arousal. The focus of arousal transmission in the current dissertation was on the latter (reception of arousal from others) as an indicator of the extent to which relationship partners “pick up” on each others' arousal. However, there are individual differences emotional concordance—the extent to which emotional expressions, experiences, and arousal levels are correlated within person (Lanteigne et al., 2014; Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005). Some adolescent girls experience blunted physiological arousal



responses during social stress, despite experiencing distress and displaying self-conscious emotions (Lanteigne et al., 2014). This discordant profile of emotional responding is associated with emotion regulation difficulties and internalizing problems (Lanteigne et al., 2014). In the social context, would this pattern of within-person emotional discordance disrupt arousal transmission from the sender to the receiver?

## **Developmental Processes**

**Parent-adolescent relationships.** It is generally accepted in the broader literature on adolescent development that parent-child relationships reorganize during adolescence (Collins & Laursen, 2004; Larsen, Richards, Moneta, Holmbeck, & Duckett, 1996; Smetana et al., 2006; Steinberg, 2001). Extrafamilial relationship partners (e.g., peers, romantic partners) have a substantial influence on adolescent development—adolescents highly value the opinions and expectations of their peers, and peer relationships shape adolescents' attitudes, interests, activities, behaviours, and psychosocial adjustment (Brown & Larson, 2009; Connolly et al., 2015; Smetana et al., 2006). To what extent do parental influences give way to extrafamilial influences? It is worthwhile to take stock of the role that parents do play in adolescent development, given the confluence of reorganizing parent-adolescent relationships and burgeoning relationships with peers.

Fifteen years ago, Steinberg (2001) summarized the state of knowledge on parent-adolescent relationships. At that time, it had been well established that certain types of parenting styles (e.g., authoritative) were associated with more positive developmental outcomes than others (e.g., authoritarian), and that an important aspect of authoritative parenting is granting opportunities for adolescents to develop autonomy (Steinberg, 2001). Parenting practices at the developmental time scale (i.e., individual differences in trait-like parenting practices) are still

considered to play an important role in adolescent development (Morris, Cui, & Steinberg, 2013; Smetana et al., 2006). However, since the publication of Steinberg's (2001) review, the examination of nuanced, real-time processes has been enabled by numerous advances in the accessibility of statistical methods (e.g., Hamaker et al., 2015; Lewis, Lamey, & Douglas, 1999). Such methodological advances, combined with the growing popularity of the DS perspective (Hollenstein, 2011), has led to a small body of research on real-time dynamics in parent-adolescent interactions (e.g., Allen, Kuppens, & Sheeber, 2012; Granic et al., 2003; Hollenstein, 2007; Hollenstein, Allen, & Sheeber, 2016; Hollenstein & Lewis, 2006; Lichtwarck-Aschoff et al., 2009; Loughed, Craig, et al., in press; Loughed, Hollenstein, et al., in press; Sheeber et al., 2012; Sheeber, Allen, Davis, & Sorensen, 2000; van der Giessen et al., 2014). The current dissertation adds to this body of research by demonstrating links between parent-adolescent relationship quality and several emotion dynamics that are related to adolescents' ability to adjust to challenging or changing circumstances (e.g., arousal attenuation, socioemotional flexibility). Therefore, the importance of parent-adolescent relationships to adolescent development spans the range of time scales from momentary emotion dynamics to macro-level trends in parenting tendencies.

One of the main areas of importance for future research identified in Steinberg's (2001) review was parental psychosocial adjustment. Adolescence is not only a developmental transition for youth, as having an adolescent in the household influences parents' daily lives. Parents may also experience developmental transitions of their own at the same time as their children go through adolescence. For example, it is common for parents to transition into middle age during their children's adolescence, and middle age is often accompanied by changes in self-perceptions and biological transitions such as menopause (Steinberg, 2001). Another factor related to the

mental health of parents with teenagers is that parents may be more adversely affected by the emotional intensity and lability of adolescence than their adolescent children are (Steinberg, 2001). Parent-adolescent conflicts can be heated and frequent, but Steinberg (2001) observed that it seems to be parents, and not adolescents, who hold on to the ensuing negativity from conflicts and have greater difficulties recovering from such interactions. If parents are more concerned with maintaining family cohesion than adolescents (Sillars et al., 2010), the increased frequency and intensity of parent-adolescent conflicts would very likely be more distressing for parents than adolescents. These characteristics of parental experiences during their children's adolescence may decrease parents' ability to share their adolescents' emotional burdens and to "get on the same page" as their adolescent via arousal transmission.

Since Steinberg's (2001) review, a small body of research has examined the psychosocial adjustment of parents of adolescents (e.g., Salafia, Gondoli, & Grundy, 2008; Seiffge-Krenke & Pakalniskiene, 2011; Silverberg & Steinberg, 1990; van der Giessen et al., 2013). The results from Study 2 of the current dissertation showed that maternal psychosocial adjustment (depressive, anxious, and socially anxious symptoms), but not daughters' psychosocial adjustment, was related to dyadic socioemotional flexibility. Going forward, it will be important to continue to examine parent-adolescent interactions as TIES, rather than focusing solely on adolescent outcomes. The relationships between emotion dynamics and psychosocial adjustment within TIES are complex (see Figure 1.1), and numerous direct and indirect effects are potential avenues for future research. For example, does maternal psychosocial adjustment mediate the associations between dyadic emotion dynamics and adolescent psychosocial adjustment? Or, does maternal psychosocial adjustment have a direct effect on adolescent psychosocial adjustment?

Another important future direction for research on parent-adolescent TIES is to incorporate the real-time emotion dynamics of all components of the emotion system (experience, expression, arousal; see Figure 1.1). In the current dissertation, the real-time dynamics of expression (Study 2) and arousal (Studies 1 and 3) were examined. The dynamics of emotional experiences were examined at a larger time scale in Studies 2 and 3 in terms of changes after each of the five discussions of the Emotional Rollercoaster task. Future research could incorporate measures of the real-time dynamics of emotional experience through video-mediated recall (e.g., Ehrmantrout, Allen, Leve, Davis, & Sheeber, 2011), which involves participants watching videos of their social interactions while providing continuous ratings of emotional intensity and valence.

**Age-related changes and development over time.** The current dissertation consisted of two cross-sectional samples of adolescent girls and their mothers within a relatively restricted range of adolescent ages. Thus, these samples provide a snapshot of mother-daughter dynamics during adolescence, and inferences about age-related changes or longitudinal developments cannot be made from the current dissertation. The DS perspective (Butler, 2011; Hollenstein et al., 2013; Lewis, 2000) is the meta-theoretical perspective that underlies the three studies of this dissertation. According to the DS perspective (Butler, 2011; Hollenstein et al., 2013), real-time interpersonal dynamics self-organize over repeated interactions and lead to the emergence of higher-order system attributes such as relationship quality and psychosocial adjustment. In turn, these higher-order attributes constrain the real-time dynamics of the system (see Figure 1.1). Circular causality refers to bidirectional causation across levels (real time, developmental time) of a system (e.g., mother-daughter TIES; Lewis, 2005). The current dissertation is a first step towards understanding these system dynamics, in terms of both physiological arousal and observed emotions, in mother-daughter TIES during adolescence.

In all three studies of the current dissertation, self-reported psychosocial adjustment (relationship quality, internalizing systems) was assumed to reflect stable system attributes such as dyad- or trait-level tendencies. Future research could build on this dissertation by examining changes in mother-daughter emotion dynamics and psychosocial adjustment longitudinally to better understand if circular causality characterizes the associations between emotion dynamics and psychosocial adjustment. Important research questions for future research include: (1) How do real-time emotion dynamics predict changes in mothers' and daughters' psychosocial adjustment longitudinally? and (2) Are longitudinal changes in psychosocial adjustment related to changes in real-time emotion dynamics? Incorporating multiple time scales into study designs—while costly to conduct—will shed light on the momentary features of parent-adolescent interactions that give rise to both parent and adolescent psychosocial adjustment. Understanding such associations across time scales are of immense benefit to informing interventions for parents and their youth who experience psychosocial adjustment difficulties (Granic et al., 2007).

**A new perspective on adolescent development.** A core theme running through decades of research on adolescent development is adolescence as a period of “storm and stress” (Arnett, 1999; Berzonsky, 1982; Casey et al., 2010; Hollenstein & Lougheed, 2013; Larson & Ham, 1993; Montemayor, 1986). The terms storm and stress were first applied to adolescent development by G. Stanley Hall (1905) to refer to the decreases in self-control (storm) and increases in emotionality (stress) that were believed to characterize typical adolescent development (Hollenstein & Lougheed, 2013). The characterization of adolescence as a period of storm and stress pervaded adolescent research literature for several decades and is still present in colloquial descriptions of adolescent behaviour, such as through descriptions of typical adolescent development as pathological, and stereotypes of adolescents as unreasonable (Arnett, 1999;

Hollenstein & Lougheed, 2013). Characterizations of adolescence as a period of storm and stress were questioned by Arnett (1999), who provided the more nuanced perspective that, although the experience of storm and stress is more likely during adolescence than at other points in the life span, it is neither ubiquitous nor inevitable.

More recently, Hollenstein and Lougheed (2013) reexamined the construct of adolescent storm and stress in a review of recent research, and concluded that the perspective was outmoded as a developmental framework. In place of the storm and stress view, Hollenstein and Lougheed (2013) put forward the 4T approach, which is based on the complex biopsychosocial developments of adolescents in terms of typicality, temperament, transactions, and timing. The 4T approach (Hollenstein & Lougheed, 2013) provides a useful developmental framework for considering the implications of the current dissertation.

**Typicality.** The vast majority of research on adolescent development has focused on atypical developmental processes, such as problem behaviours and psychopathology (Hollenstein & Lougheed, 2013; Steinberg & Morris, 2001). Although it is crucial to understand the factors related to atypical development, from the perspective of developmental psychopathology, a dominant focus on atypical processes will only partially answer questions regarding the emergence of problem behaviours and psychopathology (Cicchetti & Rogosch, 2002). We need to also understand what is typical about adolescent development in order to best understand atypical development.

The associations between emotion dynamics and psychosocial adjustment in typically-developing samples of adolescent girls and their mothers were examined in the current dissertation in an effort towards understanding typical mother-daughter dynamics. These and other such studies (e.g., Lougheed, Craig, et al., in press; Lougheed, Hollenstein, et al., in press;

van der Giessen et al., 2013) are crucial for identifying the characteristics of TIES that fall within the range of what can be considered typical in adolescence. The range of “normal” in adolescence is likely to be broad across biological, psychological, and social developments, and thus examinations of individual differences within typically-developing samples (such as Study 2 of the current dissertation) take steps towards identifying the limits on those ranges (Hollenstein & Lougheed, 2013).

**Temperament.** According to the 4T approach (Hollenstein & Lougheed, 2013), the term temperament refers to general patterns of emotional response tendencies in specific moments (e.g., emotional sensitivity and regulation), which may vary over development. Hollenstein and Lougheed (2013) argue that most typical adolescent developments are related to emotions, either by being affected by temperamental responses (e.g., risk-taking), or by affecting temperamental responses (e.g., puberty). All studies of the current dissertation describe the co-construction of adolescent girls’ temperaments through interactions with their mothers in TIES. The emotion dynamics examined in the current dissertation (arousal transmission and attenuation, socioemotional flexibility) also describe adolescent girls’ temperamental responses in various emotional contexts (social stress, positively- and negatively-valenced interpersonal emotion discussions). In line with the discussion above, understanding the range of typical adolescent temperamental responses in various socioemotional contexts will better enable the identification of atypical development such as psychopathology.

**Transactions.** Transactions between adolescents’ physiological processes and their various environments (e.g., physical, family, school) are the drivers of adolescent development, according to the 4T approach (Hollenstein & Lougheed, 2013). Transactions between daughters’ and mothers’ temperamental responses and psychosocial adjustment in several emotion contexts

(Studies 1 and 3), and between dyadic temperamental responses (i.e., socioemotional flexibility) and psychosocial adjustment (Study 2) were examined in the current dissertation. As called for by Steinberg (2001), insights on adolescent development will be gained when research moves beyond unidirectional associations from parent to adolescent. The results of the current dissertation demonstrated that transactions within mother-daughter TIES reflect a range of temperamental responses (arousal transmission and attenuation, socioemotional flexibility) that are likely associated with parents' and adolescents' ability to successfully manage stressful situations and adapt to changing circumstances.

**Timing.** In the 4T approach, timing refers to both the timing of developmental events (e.g., puberty, school transitions) and the temporal dynamics underlying temperamental responses such as parent-adolescent emotion dynamics (Hollenstein & Loughheed, 2013). Timing in terms of the latter definition factored into all three studies of the current dissertation. Examining changes in multiple indicators of emotion (e.g., physiological arousal, observed emotions) over time is the best way to approximate temperamental responses such as emotion regulation (Cole, Martin, & Dennis, 2004; Hollenstein, 2015). The current dissertation demonstrated that mother-daughter emotion dynamics across diverse emotion contexts are associated with psychosocial adjustment.

**Summary.** Taken together, examining the current dissertation from several developmental perspectives highlights several strengths of this collection of studies. The current dissertation involved sophisticated dyadic methodological approaches, multiple indicators of emotion (i.e., physiological arousal, observed responses), and parallel streams of data on emotion dynamics and psychosocial adjustment from both daughters and mothers. These attributes of the current dissertation provide nuanced information on the typicality, temperamental aspects, transactions, and timing of adolescent emotional development. In line with the 4T approach



(Hollenstein & Loughheed, 2013), one of the most pressing areas of future research is to examine the associations between the timing of multiple developmental events (e.g., puberty, school transitions, life stressors) on the associations between parent-adolescent emotion dynamics and psychosocial adjustment. The confluence of multiple developmental transitions, according to the DS perspective (Granic et al., 2003; Lewis, 2000), can indicate a phase transition, which involves a reorganization of all components of a system as old structures give way to the emergence of new structures. Developmentally, adolescence is not unlike the transformation of a caterpillar to a butterfly. The unique processes that underlie the metamorphosis of adolescents set the stage for adaptive functioning in adulthood and beyond.

### **Conclusion**

The emotion dynamics between parents and children form the foundation of psychosocial adjustment across the lifespan (Fogel, 1993; Granic, 2005). Changes in the structure of parent-child relationships during adolescence are met with changes to the emotion dynamics of parent-adolescent interactions. An understanding of the bidirectional associations between parent-adolescent emotion dynamics and psychosocial adjustment will beget a better understanding of both typical and atypical adolescent development. Together, the SBT (Beckes & Coan, 2011) and DS (Butler, 2011; Hollenstein et al., 2013; Lewis, 2000) perspectives provide a rich account of the development of emotions and relationships in adolescence.

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## Appendix A

### Relationship Quality Questionnaires

#### Relationship Quality Questionnaire—Daughter Form

Please read each of the items below and circle a number that corresponds with how often you and your mother do that activity or how you feel about the relationship in general. Please mark how you USUALLY interact and feel about the relationship, not what you think you should think or do.

	Not At All					Very	
1. How much do you feel that you can turn to your mother when you are in need of help or guidance?	1	2	3	4	5	6	7
2. How much do you feel that you can discuss your work and activities with your mother?	1	2	3	4	5	6	7
3. How considerate are you and your mother of each other's feelings?	1	2	3	4	5	6	7
4. How much do you and your mother take care of one another?	1	2	3	4	5	6	7
5. Considering the ups and downs of lasting relationships, how much do you and your mother generally get along?	1	2	3	4	5	6	7
6. In general, how close do you feel to your mother?	1	2	3	4	5	6	7
7. In general, how satisfied are you in your relationship with your mother?	1	2	3	4	5	6	7
8. How often do you feel affectionate to your mother?	1	2	3	4	5	6	7

### Relationship Quality Questionnaire—Mother Form

Please read each of the items below and circle a number that corresponds with how often you and your daughter do that activity or how you feel about the relationship in general. Please mark how you USUALLY interact and feel about the relationship, not what you think you should think or do.

	Not At All					Very	
1. How much do you feel that you can turn to your daughter when you are in need of help or guidance?	1	2	3	4	5	6	7
2. How much do you feel that you can discuss your work and activities with your daughter?	1	2	3	4	5	6	7
3. How considerate are you and your daughter of each other's feelings?	1	2	3	4	5	6	7
4. How much do you and your daughter take care of one another?	1	2	3	4	5	6	7
5. Considering the ups and downs of lasting relationships, how much do you and your daughter generally get along?	1	2	3	4	5	6	7
6. In general, how close do you feel to your daughter?	1	2	3	4	5	6	7
7. In general, how satisfied are you in your relationship with your daughter?	1	2	3	4	5	6	7
8. How often do you feel affectionate to your daughter?	1	2	3	4	5	6	7

## Appendix B

### Positive and Negative Affect Schedule Questionnaires

#### Baseline PANAS—DAUGHTER AND MOTHER FORM

This scale consists of a number of words that describe different feelings and emotions. Read each item and then select the response that best describes how strongly you feel for each item. Indicate to what extent you feel each item **right now**.

**RIGHT NOW, I FEEL...**

	Not at All	A Little	Moderately	Quite a Bit	Extremely
1. Excited	1	2	3	4	5
2. Happy	1	2	3	4	5
3. Guilty	1	2	3	4	5
4. Valued	1	2	3	4	5
5. Proud	1	2	3	4	5
6. Irritated	1	2	3	4	5
7. Worried	1	2	3	4	5
8. Grateful	1	2	3	4	5
9. Nervous	1	2	3	4	5
10. Frustrated	1	2	3	4	5

## Post-Discussion PANAS—DAUGHTER FORM

This scale consists of a number of words that describe different feelings and emotions. Read each item and then select the response that best describes how strongly you felt for each item. Indicate to what extent you felt each item during the discussion you just had.

**DURING THE DISCUSSION I JUST HAD ABOUT FEELING<sup>5</sup> \_\_\_\_\_ MY MOTHER, I FELT...**

	Not at All	A Little	Moderately	Quite a Bit	Extremely
1. Excited	1	2	3	4	5
2. Happy	1	2	3	4	5
3. Guilty	1	2	3	4	5
4. Valued	1	2	3	4	5
5. Proud	1	2	3	4	5
6. Irritated	1	2	3	4	5
7. Worried	1	2	3	4	5
8. Grateful	1	2	3	4	5
9. Nervous	1	2	3	4	5
10. Frustrated	1	2	3	4	5

**(1) HAPPY/EXCITED ABOUT**

**(2) WORRIED/SAD ABOUT**

**(3) PROUD OF**

**(4) FRUSTRATED/ANNOYED TOWARDS**

**(5) GRATEFUL/POSITIVE TOWARDS**

---

<sup>5</sup> Note: There were five variants of the post-discussion PANAS form that were worded to pertain specifically to each discussion. These variants are listed at the end of the list of items.

## Post-Discussion PANAS—MOTHER FORM

This scale consists of a number of words that describe different feelings and emotions. Read each item and then select the response that best describes how strongly you felt for each item. Indicate to what extent you felt each item during the discussion you just had.

**DURING THE DISCUSSION I JUST HAD ABOUT FEELING<sup>6</sup> \_\_\_\_\_ MY DAUGHTER, I FELT...**

	Not at All	A Little	Moderately	Quite a Bit	Extremely
1. Excited	1	2	3	4	5
2. Happy	1	2	3	4	5
3. Guilty	1	2	3	4	5
4. Valued	1	2	3	4	5
5. Proud	1	2	3	4	5
6. Irritated	1	2	3	4	5
7. Worried	1	2	3	4	5
8. Grateful	1	2	3	4	5
9. Nervous	1	2	3	4	5
10. Frustrated	1	2	3	4	5

- (1) HAPPY/EXCITED ABOUT**
- (2) WORRIED/SAD ABOUT**
- (3) PROUD OF**
- (4) FRUSTRATED/ANNOYED TOWARDS**
- (5) GRATEFUL/POSITIVE TOWARDS**

---

<sup>6</sup> Note: There were five variants of the post-discussion PANAS form that were worded to pertain specifically to each discussion. These variants are listed at the end of the list of items.

## Appendix C

### SPAFF5 “Crib Sheet”—A Brief Description of Coding Categories

#### SPAFF5 Crib Sheet

All codes in the SPAFF5 are scored based primarily on affect demonstrated. Some codes like Interest/Curiosity rely more heavily on verbal content than others. The gestalt of cues used to score the emotions that are observed will include vocal tone, facial affect and body posture and/or orientation.

#### **(99) Positive Affect**

- Caring/Affection
- Laughter/Smiling
- Enjoyment
- General Positive Affect

#### **(77) Interest/Curiosity**

- Non-Verbal Attentive/Positive Energy
- Elaboration/ Clarification Seeking
- Opinion question
- Paraphrasing
- Validation

#### **(55) Neutral**

- Resting Affect
- Shock
- Surprise

#### **(11) Internalizing Negative Affect**

- Resignation/Passivity
- Crying
- Feels Hurt
- Slow Sighing
- Fear/Tension
- Fidgeting
- Fear Face
- Nervous Avoidance
- Speech Disturbances
- Nervous Laughter

#### **(33) Externalizing Negative Affect**

- Raised Voice
- Irritation/Annoyance
- Constrained Anger
- Physical cues of anger (jerks, twitches)
- Physical cues of interpersonal disgust (nose wrinkle)
- Invalidation
- Lecturing/patronizing
- Contempt

#### **(m) Missing**

- Talking to experimenter
- Speaking in another language



## **Appendix D**

### **Ethics Approval Documentation**



## **Amendment Acknowledgment/Approval Letter**

September 04, 2013

Dr. Thomas Patrick Hollenstein  
Department of Psychology  
Queen's University  
Kingston ON K7L 3N6

**RE: File #6004467 PSYC-082-08 Individual Differences in Psychophysiological Responsivity While Regulating Emotion in Adolescence**

Dear Dr. Hollenstein:

I am writing to acknowledge receipt of the following:

- List of Questionnaires added since the last amendment
- List of Questionnaires removed from the current study
- Final list of questionnaires
- Social Anxiety Scale
- Debriefing Form: Parent-questionnaire only, version September 4, 2013
- Lab Visit: Final Consent (Parent-questionnaire only), version September 4, 2013
- Lab Visit: Initial Consent (Parent-questionnaire only)
- Information Sheet for Participants (Parent-Questionnaire only)
- Information Sheet for Participants (Child)
- Information Sheet For Participants (Parent)
- Basic Empathy Scale

I have reviewed these amendments and hereby give my approval. Receipt of these amendments will be reported to the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board.

Yours sincerely,

*Albert F. Clark*

Albert Clark, Ph.D.  
Chair  
Health Sciences Research Ethics Board



## **Amendment Acknowledgment/Approval Letter**

September 15, 2014

Dr. Thomas Hollenstein  
Department of Psychology  
Queen's University

**RE: File #6004467 PSYC-082-08 Individual Differences in Psychophysiological  
Responsivity While Regulating Emotion in Adolescence**

Dear Dr. Hollenstein:

I am writing to acknowledge receipt of the following:

- Notification of some slight modifications to discussion tasks and related questionnaires
- Discussion Topic Questionnaire for Adolescents
- Discussion Topic Questionnaire for Parents
- Positive and Negative Affect Schedule for baseline measure, Adolescent form
- Positive and Negative Affect Schedule for baseline measure, Parent form
- Positive and Negative Affect Schedule for after the Happy/Excited discussion, Adolescent form
- Positive and Negative Affect Schedule for after the Happy/Excited discussion, Parent form
- Positive and Negative Affect Schedule for after the Worried/Sad discussion, Adolescent form
- Positive and Negative Affect Schedule for after the Worried/Sad discussion, Parent form
- Positive and Negative Affect Schedule for after the Proud discussion, Adolescent form
- Positive and Negative Affect Schedule for after the Proud discussion, Parent form
- Positive and Negative Affect Schedule for after the Frustrated/Annoyed discussion, Adolescent form
- Positive and Negative Affect Schedule for after the Frustrated/Annoyed discussion, Parent form
- Positive and Negative Affect Schedule for after the Grateful discussion, Adolescent form
- Positive and Negative Affect Schedule for after the Grateful discussion, Parent form
- Sequence of lab tasks

I have reviewed these amendments and hereby give my approval. Receipt of these amendments will be reported to the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board.

Yours sincerely,

A handwritten signature in cursive script that reads "Albert Clark".

Albert Clark, Ph.D.  
Chair  
Health Sciences Research Ethics Board

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 Queen's University  
 62 Arch Street, Room 232 Humphrey Hall  
 Kingston, Ontario K7L 3N6  
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- Loughheed, J. P., & Hollenstein, T. (2016). Socioemotional Flexibility in Mother-Daughter Dyads: Riding the Emotional Rollercoaster Across Positive and Negative Contexts. *Emotion*. Advance online publication. <http://dx.doi.org/10.1037/emo0000155>

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