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MODELLING SOCIAL SUPPORT IN THE LABORATORY: EFFECTS ON CARDIOVASCULAR FUNCTION

Thesis submitted for the Degree of Doctor of Philosophy

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July, 2012

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ABSTRACT

Introduction. The present research examines the utility and validity of social support — that aspect of social relationships involving the provision and receipt of emotional or tangible assistance — as a buffer of cardiovascular stress responses relevant to physical health. Five methodological refinements were incorporated to help advance understanding of the effects of social relationships on health. Firstly, the validity of a naturalistic support measure was established in relation to a broad personality framework measure based on Eysenck’s Personality Questionnaire. Secondly, analogues of support provision were contrasted against support receipt and social contact in order to identify effects specific to receipt, rather than general embeddedness in a network of mutual obligation. Thirdly, in contrast with studies examining only subjective measures, objective indices of well-being were utilized (namely, resting cardiovascular levels, and cardiovascular reactivity to and recovery from psychological stress). Fourthly, assessment of cardiovascular arousal was operationalized not only at the individual level but as a dyadic construct, in terms of concordance in cardiovascular arousal between dyad members. Finally, cardiovascular function during dyadic interaction was benchmarked against individual stress responses to an acute cognitive stressor.

Methods. Five empirical studies are reported. In a sample of 410 college students, Study 1 examined the proportion of variance in a naturalistic support explained by a broad framework of personality based on the Revised Eysenck Personality Questionnaire. Using a subsample of 145 healthy women this study also examined whether naturalistic support was a superior predictor of resting cardiovascular levels than trait personality. In Study 2, in order to compare support
provision and receipt effects on cardiovascular stress recovery, 72 women engaged in an acute stressor followed by an intervention designed to elicit thoughts of support provision, support receipt, or social contact. In Study 3, 90 participants (45 dyads) engaged in a supportive or collaborative interaction during which cardiovascular reactivity (CVR) was monitored. In Study 4, concordance in cardiovascular arousal between dyad members was examined in a sample of 52 mother–child dyads characterised by high interpersonal stress and a control sample of 52 dyads. In Study 5, 21 parents engaged in both an acute cognitive stressor and a dyadic interaction with their children.

Results. Study 1 indicated that only moderate variance in perceived support was explained by trait personality, and that support and personality independently predicted reduced cardiovascular levels in women. Study 2 suggested distinct effects for mentally–activated support provision and receipt on cardiovascular recovery from acute stress, and found that responses to support provision but not receipt were exacerbated for individuals high in trait hostility. In Study 3, although CVR did not differ between individuals receiving support and individuals completing a stressful task in pairs, greater dynamic concordance in CVR was observed in dyads involved in a supportive transaction compared with those simply collaborating to complete the task. In Study 4, patterns of concordance in resting cardiovascular arousal between dyad members were found to differ between high-stress and low-stress dyadic relationships. Finally, in Study 5, perceptions of one’s child influenced the degree to which parents found dyadic interaction with their child more or less stressful than an acute stressor.

Conclusions. The findings affirm social psychological theories stating that support receipt is not universally and invariably beneficial, but further, indicate that
support provision can, in some contexts, also be physiologically demanding. Comparison between naturalistic and laboratory analogues of support suggests that many of the benefits ascribed to support may be more accurately a function of social relationship quality than of support specifically. With regard to cardiovascular stress responsivity, it appears that social support and social relationships influence haemodynamic activity at both individual and dyadic levels.
ACKNOWLEDGEMENTS

This research has received funding from two sources; a College of Arts fellowship and a write-up bursary from the National University of Ireland, Galway, and a Government of Ireland scholarship from the Irish Research Council for the Humanities and Social Sciences.

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mentor and collaborator throughout this process. I can’t recall exactly who coined the phrase, but if I can be “half the Siobhán Siobhán is”, I will consider that a high achievement. Also classmates from the B.A. course, who have been friends and supports since those days, Claire, Lisa, Marie, Annette, Lisa, Clare, Sarah, and Daragh. I wish you all well in your careers. Finally, I am very grateful to Dr. Brian Hughes, for his time and dedication to supervision.

This thesis is dedicated to my grandmother, for teaching me to read and tell the time.
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LIST OF ACRONYMS

-2LL: -2 log likelihood
AIC: Akaike Information Criterion
ANOVA: Analysis of variance
ANCOVA: Analysis of covariance
APIM: Actor-Partner Interdependence Model
BD: Between-dyad
BIC: Bayesian Information Criterion
bpm: Beats per minute
BMI: Body mass index
CAD: Coronary artery disease
CHD: Coronary heart disease
CI: Confidence interval
CM: Child maltreatment
CO: Cardiac output
CV: Cardiovascular
CVD: Cardiovascular disease
DBP: Diastolic blood pressure
EAS-TS: EAS Temperament Survey
ECG: Electrocardiograph
EPQ: Eysenck Personality Questionnaire
EPQ-R: Revised Eysenck Personality Questionnaire
HADS: Hospital Anxiety and Depression Scale
HR: Heart rate
HRV: Heart rate variability
IMT: Intima-medial thickness
ISEL: Interpersonal Support Evaluation List
LVH: Left ventricular hypertrophy
LVM: Left ventricular mass
MAP: Mean arterial pressure
MI: Myocardial infarction
ML: Maximum likelihood
mmHg: Millimetres of mercury
ms: Milliseconds
MSPSS: Multi-dimensional Scale of Perceived Social Support
NA: Negative affect
PA: Positive affect
PANAS: Positive and Negative Affect Schedule
PCPRS: Pianta Child–Parent Relationship Scale
PEP: Pre-ejection period
pru: Peripheral resistance units
REML: Restricted estimation maximum likelihood
SBP: Systolic blood pressure
SDR: Socially desirable responding
SES: Socio-economic status
SSQ6: Short-form Social Support Questionnaire
SV: Stroke volume
TPR: Total peripheral resistance
VIF: Variance inflation factor
WD: Within-dyad
LIST OF WORKS

Below is a list of publications and conference presentations stemming from this thesis.

PUBLICATIONS


PRESENTATIONS


5. **Creaven, A-M.,** & Hughes, B. M. Socially relevant traits are more predictive of cardiovascular reactivity than perceived social support. Poster presented at the American Psychosomatic Society Annual Meeting in San Antonio, Texas, March 2011.


Chapter 1: INTRODUCTION

Social Support: Conceptualizations, History, and Measurement

Overview

Since the 1970s, many studies have promulgated the belief that social support, or a social network’s provision of psychological and material resources intended to benefit an individual’s ability to cope with stress (S. Cohen, 2004) is inherently positive, and beneficial if not essential for physical and psychological well-being. Empirical research has for some time been weighted in favour of expanding this hypothesis, rather than determining its veracity. However, social and personality psychology theories suggest that several of the benefits ascribed to support may be accounted for by alternative explanations. For example, classic conceptualizations of support fail to account for individual differences in personality, preferences for support, the variety and variable utility of support types, and the fact that receiving and perceiving support may be confounded with several other aspects of social interaction. Arising from these issues is the notion that studies purportedly assessing perceived and received support are measuring proxies for both personality and tendencies for support provision, which might help rationalize the mixed utility of support in the empirical literature. The present thesis aims to identify the effects of social support on a range of cardiovascular markers, accounting for social psychology concerns that are typically neglected in studies of support and well-being. This chapter outlines a history of support research, identifies issues in theory and

measurement, and describes how social psychology theories might provide a framework for the study of support effects on physical health.

History

The idea of social support arose from discussions on the nature of suicide and subsequent sociological investigations of cross-sectional links between social networks and good health. Emile Durkheim’s ([1897]1951) observations focused on suicide as a social rather than individual phenomenon. Durkheim’s analysis drew on data suggesting different rates of suicide in Catholic and Protestant communities, which he attributed to the socially integrative (and later, regulatory) properties of Catholicism. While Durkheim’s ideas were later shown to rely on inadequate notions of religion (for example, he neglected the Catholic system’s under-reporting of suicide owing to the heavy stigma it incurred the family [Stark & Rushing, 1983]), his basic hypothesis evoked widespread interest in the meaning of social ties for health. Several decades later, a meeting address by Cobb (1976) sparked interest in the concept of social support for psychologists rather than sociologists alone. Following from this, epidemiological studies identified the broad notion of support as a correlate of better health and notably, lower mortality rates, initially focusing on relatively crude indices of social integration (SI) or social network structure (Berkman & Syme, 1979), before progressing to assessment of both structural and functional aspects. Although early research in the arena controlled only for subjective baseline assessments of well-being (e.g., Berkman & Syme, 1979), these observations were subsequently confirmed controlling for biomedically assessed indices of health (House, Robbins, & Metzner, 1982). Since then, researchers have generally found that persons who have larger social networks or who perceive that support is available
when needed have better personal and interpersonal outcomes. In a meta-analysis of 81 studies, Uchino, Cacioppo, and Kiecolt-Glaser (1996) concluded that social support is reliably linked to enhanced cardiovascular, endocrine, and immune functioning. In a meta-analysis of 55 studies including 83 correlations on support and health, Schwarzer and Leppin (1989) reported that ill health was more pronounced for those who lacked support, with support and health more closely associated for women than for men. In addition, several longitudinal studies have reported social support to predict variance in mortality or chronic disease not accounted for by traditional health and lifestyle factors (e.g., Blazer, 1982; Hanson, Isacsson, Janzon, & Lindell, 1989; Lett et al., 2005; Orth-Gomér & Johnson, 1987; Ruberman, Weinblatt, Goldberg, & Chaudhary, 1984; Sugisawa, Liang, & Liu, 1994; Welin et al., 1985). However, a complete representation must acknowledge studies which have found no benefit to health or overall mortality (e.g., Shumaker & Hill, 1991) and the fact that the underlying mechanisms by which social contact impacts on health are poorly understood (S. Cohen, 1988).

Social support and health

At first glance, compelling evidence for the benefits of support is put forward from the many epidemiological studies suggesting links between social network indices and mortality (S. Cohen, Williamson, Spacapan, & Oskamp, 1988; Holt-Lunstad & Smith, 2012; Holt-Lunstad, Smith, & Layton, 2010). Controlling for initial self-reported health status in Berkman and Syme’s (1979) seminal Alameda County study, individuals who were classified as less socially integrated (based on responses to four question categories) had higher mortality rates nine years later. Subsequent studies replicated this finding, for example, House et al. (1982) found similar results
for 2,754 men and women in Tecumseh County, Michigan, USA, at a 10-12 year follow-up, independent of objectively assessed health at baseline. In this study, the effects of intimate social relationships, formal organizational involvements outside work, and active leisure pursuits involving social contact were stronger for men than for women, with men having an adjusted mortality risk ratio of 2-3, and women 1.5-2. Studies of non-structural aspects (e.g., the perceived quality of one’s social ties, rather than the number of ties in itself) reported similar findings (Penninx et al., 1997; Rosengren, Orth-Gomer, Wedel, & Wilhelmsen, 1993).

Continuing research is consistent with early results, for example, Eng, Rimm, Fitzmaurice, and Kawachi (2002) reported that the relative risk of total mortality for men scoring low on SI was 1.19, in comparison to their more socially integrated counterparts. Croezen et al. (2010) concluded that low positive experiences of support at baseline (e.g., warmth, friendliness, esteem, and help) were associated with an increased mortality risk after an average 19 years of follow-up, while negative experiences of support (e.g., nagging an individual towards some health promoting behaviour, and in this case, incomprehension, belittlement, and avoidance) were unrelated to mortality. In a recent meta-analysis of 148 studies, Holt-Lunstad et al. (2010) found ratings of social relationships to predict a 50% increase in survival odds, comparable to well-established mortality risk factors, suggesting an important role for social relationships in mortality.

_Scrutiny of epidemiological research_

Although the overall evidence thus seems positive, a closer look at these associations reveals several anomalies. In particular, the presence of contradictory or null findings (Penninx et al., 1997; Shumaker & Hill, 1991), variation in effect sizes
Chapter 1. Introduction

(Holt-Lunstad et al., 2010) and ethnic/gender differences (Schoenbach, Kaplan, Fredman, & Kleinbaum, 1986) suggests that the social support–well-being link is less straightforward than early theorists believed. The variability in outcome measures, duration of follow-up, sample size and characteristics, and social index used also complicates interpretation. By way of example, Eng et al.’s (2002) focus on coronary endpoints reported that (a) socially isolated men had an increased risk of fatal coronary heart disease (CHD), (b) among several network indices, only number of and contact with close friends were significantly associated with fatal CHD and (c) the incidence of total CHD, nonfatal myocardial infarction (MI), and sudden cardiac death was not significantly increased in socially isolated men – as such, the findings depended on both the target outcome (even within this spectrum of cardiac events), and the social index used. Another way of phrasing these results might be to say that neither marital status nor group membership (be it church or non-religious organization) predicted any variance in mortality from any cause. In this light, the results of mortality studies are less impressive. However, rightly or wrongly they have served as the foundation for many studies examining support as a predictor of health and health-related outcomes, including adherence to medication (DiMatteo, 2004), cancer progression (Nausheen, Gidron, Peveler, & Moss-Morris, 2009) development of CHD (Barth, Schneider, & von Känel, 2010) work stress (Viswesvaran, Sanchez, & Fisher, 1999) and physiological stress responses (Thorsteinsson & James, 1999).

Theoretical assumptions

These equivocal epidemiological findings suggest that discussions of support have implicitly and prematurely adopted several critical assumptions about the nature of social relationships (Coyne & Bolger, 1990). Indeed, while theoretical work might
offer multiple ways of contemplating social support, most empirical research is based on a simple framework of correlational reasoning: namely, that quantitative indices of social support will be positively associated with quantitative indices of good health (Hughes & Creaven, 2009). In cause-and-effect terms, investigators have tended to interpret cross-sectional links between support and adaptive outcomes as evidence for the causal influence of support on outcomes, when evidence suggests that the reverse can also be true (Buunk & Hoorens, 1992). Reverting to the original hypothesis that support and well-being are linked suggests several mechanisms by which poor physical and mental health might predict concurrently lower support. Illness is likely to preclude or reduce opportunities for social contact, alienate existing supports unable or unwilling to devote resources to the individual in question, and place a burden on the sources of support that remain. Barrera (1986) encapsulates these likelihoods within his support deterioration model, which asserts that the quantity or quality of available support declines in the wake of stressful life events, and that this loss increases vulnerability to impaired health. Recent empirical studies are in agreement with this, for example, Untas et al. (2011) in a longitudinal data set spanning 12 countries reported higher mortality among patients indicating that their health interfered with social activities, locating health as the agent acting upon social contact, rather than vice versa. Researchers have also observed a threshold effect, whereby the benefits of support are only observable up to a point, after which increments in support receipt can be harmful to the recipient (Eng et al., 2002; Krause, 1995).
Support as detrimental

This latter point, where support is not only of little impact but of negative impact has been the subject of some speculation. Researchers have outlined several reasons why well-intentioned support might be destructive; it might challenge the recipient’s sense of competence or autonomy, draw attention to the problem it is intended to resolve, induce feelings of indebtedness, or heighten performance anxiety when supplied in conjunction with a performance challenge (Seidman, Shrout, & Bolger, 2006; Shrout, Herman, & Bolger, 2006). Coyne and Bolger (1990) have further posited that the absence of noxious interactions might be more pertinent than the presence of social support, though Croezen et al. (2010) at least, found no evidence for this. Still others have speculated that supportive ties co-occur with social strain (Rook, 1990a) a term encompassing social conflict, social network stressors, interpersonal obstacles, social hindrance, negative interactions, negative social support and social network upset. Even without reference to social psychology theories holding support provision above receipt, the assumption that support enhances well-being seems less reliable than early studies suggested.

Social Psychological Theories and Social Support

Social exchange theory

In this regard, several theories from social psychology provide a compelling argument against the invariant utility of social support. Social exchange theory (Kessler, McLeod, & Wethington, 1985), similar to reciprocity (Falk & Fischbacher, 2006) and equity (Pritchard, 1969) theory, posits that it is the balance between giving and receiving in personal relationships that generates satisfaction with the relationship. According to this theory, over-benefiting from a supportive relationship
violates norms of reciprocity and may lead to a state of dependency, while underbenefited people may feel angry and resentful. Research has upheld the implications of this theory, with Kawachi, Kennedy, and Glass (1999) finding that individuals \( (N = 167,259) \) who trusted that people would follow the norms of reciprocity in their close environment were more likely to have good or very good self-rated health than those who did not. In a daily diary study, Gleason, Iida, Shrout, and Bolger (2008) examined the giving and receiving of emotional support in romantic relationships, and found that receiving support was more beneficial on days when support was also provided by the recipient. Similarly, Buunk and Hoorens (1992) observed that individuals tend to report reciprocity in their relationships, and when they do not, report that they provide more support, possibly to buffer against feelings of indebtedness. Even children feel badly when they cannot help someone who has helped them (de Cooke, 1992). The type of relationship appears to moderate the importance of equity considerations, which are typically more critical to exchange (e.g., business relationships) rather than communal or intimate relationships (Buunk & Hoorens, 1992). Moreover, while being either overbenefited or underbenefited is undesirable, Uehara (1995) argues that it is being overbenefited that is particularly psychologically distressing. In this case, recipients are likely to feel obligated to repay what was given to them, and when they cannot, they begin to doubt their status and usefulness in the relationship (for a review, see Blackmon, 2008).

*Social comparison theory*

Another theory challenging the support-leads-to-health hypothesis is social comparison theory (Festinger, 1954) which proposes that the desire to evaluate oneself by comparison with others is universal, with more recent discourse identifying
self-evaluation, self-improvement, and self-enhancement as three motives for this comparison (S. E. Taylor, Wayment, & Carillo, 1995; Wood, 1989). Although earlier research suggested that comparison with others induces primarily contrast effects, with others worse off (downward comparison) generating positive feelings and those better off (upward comparisons) generating negative affect, more recently, it has been proposed and shown that exposure to descriptions of better-off others evokes a more positive and less negative mood than comparison with worse-off others (Buunk, Van der Zee, & VanYperen, 2001), with this latter finding thought to reflect the propensity to not only contrast but also identify with the comparison targets (Buunk & Ybema, 1997). Notwithstanding individual differences in the tendency to rely on comparison for information (Gibbons & Buunk, 1999), it may be suggested that in relation to social support, comparison with a better-off provider should enhance well-being. Numerous studies in a health context have found that individuals facing surgery prefer to affiliate with similar but post-operative others (Buunk, Gibbons, & Reis-Bergan, 1997; Kulik, Mahler, & Moore, 1996). Contradictorily, however, individuals with serious behavioural problems prefer that their support group include other members with similarly serious problems (Buunk et al., 1997).

S. E. Taylor and Loebel (1989) consolidate disparate viewpoints by positing that individuals under stress engage in both problem and emotion-focused coping, the former of which entails upward affiliation in order to gain clues for coping from successful others, while downward comparison is used to alleviate stress. While empirical data is lacking, this theory would submit that support receipt might comprise a double-edged sword, in the extent to which it facilitates the type of comparison useful to the recipient.
Chapter 1. Introduction

Esteem–enhancement theory

While the above theories have commented on the implications of support receipt, esteem–enhancement theory (Batson, 1998) draws attention to the need to consider provider perspectives in social support research (Hughes & Creaven, 2009). This theory proposes that giving support enhances feelings of competency and usefulness and thus is beneficial to esteem. Caring for others without the expectation of a specific or immediate reward is described as constructive and restorative. For example, based on the results of their diary study, Gleason et al. (2008) postulated that demonstrating one’s efficacy through the provision of support may allow one to accept support from one’s partner without experiencing efficacy declines. Giving support after having received it allows one to display competence, show independence or at least co-dependence, draw attention away from one’s own problems, and establish a sense of supportive equity (Gleason, Iida, Bolger, & Shrout, 2003). Although a full review lies outside the confines of the present thesis, it is notable that evidence from the literature on altruism, prosocial behaviour, and volunteering, is consonant with the premise that support provision is health-enhancing when the provider is not overburdened (Hardy & Van Vugt, 2006; Musick, Herzog, & House, 1999; Post, 2005, 2007; C. E. Schwartz, 2009).

A compelling example for this can be drawn from community epidemiological studies. In one prospective study, S. L. Brown, Nesse, Vinokur, and Smith (2003) found that received support did not predict mortality in a sample of older adults when providing support was accounted for. Lead by a different researcher of the same name, W. M. Brown, Consedine, and Magai (2005) tested this hypothesis in a large, ethnically diverse sample of community-dwelling older adults. As expected, levels of social support given were associated with lower morbidity, whereas levels of
receiving were not, even when SES, education, marital status, age, gender, ethnicity, and absolute network size and activity limitation were controlled for. Considering these findings, it is plausible that it is the likelihood of reciprocation, or the receipt of support when the possibility for subsequent provision is highlighted, might buffer stress in the manner that support receipt or availability (independent of reciprocation per se) is thought to impact on health.

Overview of social psychological implications for support research

The collective weight of these theories suggests that studies vaunting the benefits of support may in fact be assessing a proxy for support provision. Interestingly, this has been passively observed in earlier work, with Cooke, Rossmann, Hamilton, and Patterson (1988) identifying altruistic support as “information which leads you to believe that you are worthwhile because of what you have done with and for others” (p. 213; emphasis added). Affirming this notion, one spouse in this study reportedly stated “I feel good that I’m able to make her feel better” (p. 213). Notwithstanding the caveat that extreme forms of provision such as caregiving for a chronically ill individual are detrimental to physical, immunological, and mental health (Kiecolt-Glaser, Dura, Speicher, Trask, & Glaser, 1991), this hypothesis is all the more likely when one considers that the ability to provide support is more congruent with well-being than the receipt of such, which is typically indicative of stress or ill-health. Indeed, it is plausible that the purportedly beneficial effects of social support are a combined function of (a) individual difference variables confounded with support that directly affect well-being, (b) SES, a relatively objective correlate of the frequency and quality of social interaction and also of health and (c)
individual tendencies towards support provision, which in turn engender support receipt, or the expectation of such.

Mechanisms of effect in support research

Outside of social psychology the mechanisms by which support influences health are considered differently. Conventionally, social support is thought to operate on health in two ways, which are not mutually exclusive (S. Cohen & Syme, 1985). The main or direct effects model proposes that support exerts its influence on health regardless of the presence of stressors, either via changes in health behaviours (diet, exercise, smoking, alcohol intake, medication adherence; which of course, can also be for the worse) or direct influence on biological processes, including neuroendocrine, immunological, and haemodynamic activity. The diathesis stress-buffering or “stress appraisal” model (S. Cohen & Wills, 1985) proposes that support buffers against the deleterious effects of stress on health, as such, support is relevant only at elevated or potentially harmful levels of “stress”. Barrera’s support deterioration model has failed to attract much empirical attention; a search for “support” and “deterioration” on PsychInfo returns one book chapter (Jerusalem, Kaniasty, Lehman, Ritter, & Turnbull, 1995), four dissertations (Forjaz, 2002; Gjesfjeld, 2009; Kaniasty, 1991; Lauzon, 1996) and only nine relevant empirical articles (Fan, Geng, Zhang, & Zhu, 2011; Gjesfjeld, Greeno, Kim, & Anderson, 2010; Herzer, Zakowski, Flanigan, & Johnson, 2006; Kaniasty, 2012; Kaniasty & Norris, 1993; Prati & Pietrantoni, 2010; Prelow, Mosher, & Bowman, 2006; Seeds, Harkness, & Quilty, 2010), while a comparable search for “support” combined with “stress” returns 331 results. Importantly, unlike social psychological theories, neither of these primary models account for the possibility that support may be harmful. However, much empirical work has
demonstrated mixed effects for support (e.g., Gleason et al., 2008; Helgeson, 2003; Warner, Schüz, Wurm, Ziegelmann, & Tesch-Römer, 2010). One cause of these equivocal results, neither entirely consistent with social psychological theories nor with classical ideas of support, may be because measures of receipt are confounded in some instances with support provision. 

**Do provision and receipt overlap?** 

Studies directly examining the co-occurrence of provision with receipt report moderate correlations between measures. In a sample of 43 student dyads facing an exam, Knoll, Burkert, and Schwarzer (2006) noted medium to strong associations between levels of support provision and support receipt within the same person such that high levels of support receipt on a given day corresponded with high levels of support provision on that same day. In a community sample of 846 individuals, S. L. Brown et al. (2003) reported that receiving and giving were significantly and strongly correlated for measures of emotional support exchanged between spouses, though weakly correlated for measures of instrumental support exchanged with others. The authors further suggested that if the benefits of social contact are mostly associated with giving, then measures that assess receiving alone may be imprecise, producing equivocal findings. Taken together, these studies underscore the relationship between support receipt and provision, indicating the possibility that confounding these constructs has led to prematurely favourable conclusions for social support receipt.
Chapter 1. Introduction

**Issues in Support Research**

*Support measurement*

Another reason for discrepant findings may be the lack of uniformity in how support is defined. The literature has suffered from “persistent vagueness” in the operationalization of support (Coyne & Bolger, 1990, p. 149) which Thompson (1995) attributes to the intuitive and connotative meaning that support has in everyday life. Historically defined as support which is “provided by other people and arises within the context of interpersonal relationships” (Hirsh, 1981, p. 151), and as “support accessible to an individual through social ties to other individuals, groups, and the larger community” (N. Lin, Simeone, Ensel, & Kuo, 1979, p. 109), the circularity of such definitions has been commented on more frequently than it has been addressed. Perhaps as a consequence of this vagueness, investigators are plagued with myriad operational definitions which make comparisons between studies difficult. Indeed, only ten years after Cobb evoked a more general interest in social ties, investigators were producing comparative reviews of support measures in an effort to sustain clarity in a rapidly burgeoning literature (Barrera, 1986; Cooke et al., 1988; B. R. Sarason, Shearin, Pierce, & Sarason, 1987). This proliferation might also have stemmed partly from calls to replace global, undifferentiated notions of “support” with more fine-grained conceptions (Barrera, 1986; Rook, 1990a). While this call has been heeded it has not demonstrably achieved the aim of clarifying important links between social interaction and well-being. In hindsight, this volume of support measures seems symptomatic of confusion over the specific nature of support or a compensatory effort to fill gaps left by the lack of definition. For example, in the mortality studies described above, investigators count social roles, perceived social support, SI, frequency of social interaction, and perceived emotional support, among
the “unwieldy” assortment of components assessed in relation to health outcomes (Holt-Lunstad et al., 2010, p. 2). Importantly, Brummett et al. (2005) note that few mortality studies, at least in the cardiovascular arena, have employed validated support questionnaires, instead relying on study-specific assessments or simple measures of integration which raises a question regarding the comparability of these studies with those using validated measures, such as the Social Support Questionnaire (SSQ; I. G. Sarason, Levine, Basham, & Sarason, 1983) or the Interpersonal Support Evaluation List (ISEL; S. Cohen, Mermelstein, Kamarck, & Hoberman, 1985). For example, the Alameda County Study index combining marital status, church/group membership, and social contacts was relatively crude. However, the recent meta-analysis by Holt-Lunstad et al. (2010) suggested that complex measures of integration demonstrate stronger associations with mortality (OR 1.91) than do binary indices such as living alone/with someone else (OR 1.19). Therefore, it is likely that operationalization issues, in terms of the variety, specificity, and validity of measures may account in part for inconsistency in effects.

**Conceptual issues in measurement**

Alongside the operational difficulties that have challenged and at times plagued support researchers are several issues relating to support measurement, frequently achieved using self-reports. Naturalistic perceptions of support are calculated using psychometric measures to assess a number of different types of support assumed to be representative of support in everyday life. However, some argue that measurement of perceived support is a “tainted concept” (Meadows, 2009, p. 1072) as it may overlap with measures of stress or mental health; for instance, depressed individuals may believe that they are less likely to successfully mobilize
support and therefore produce lower availability scores than their non-depressed counterparts. Of course, this is notwithstanding that associations between perceived support and depression may be revealing in and of themselves. Received support measurement is also deemed problematic, as despite best efforts, what is usually being measured is “perceived receipt” (Helgeson, 2003, p. 27). Researchers also cite recall bias as a concern for received measures while others note that received support may serve as an index of need as much as a resource available to an individual (Coyne & Bolger, 1990). In addition, reporting support receipt is contingent upon observing an act in the first instance and secondly, identifying it as supportive; however, studies demonstrate that individuals often fail to notice support is being provided to them at all, and when they do, do not always classify it as useful (Gleason et al., 2008).

Finally, consistent with their notion that “support” reflects not the presence of positive but the absence of negative interactions, Coyne and Bolger (1990) have posited that questionnaire responses generally do not necessarily denote positive quantities of support, but rather, a lack of interpersonal stress within “supportive” ties. Interestingly, one study taking a novel tack reported that non-response to social support items was associated with higher mortality after acute-MI (Candido, Kurdyak, & Alter, 2011), and also with being elderly, socially disadvantaged, and of higher clinical risk, suggesting clinically significant response sets in support responding.

Given these findings, it is unclear whether naturalistic measures of support are assessing support particularly, rather than individual differences in psychological well-being, distress, social relationship quality, trait personality, or one’s own tendency to provide support. Considering this possibility within the theoretical vacuum of much support research suggests that caution is warranted in interpreting findings derived from such measures.
Validity of the premise that support is health-enhancing

Despite theoretical, operational, and measurement problems in social support research, the idea that support is invariantly useful has been difficult to dispel. Given the widespread acceptance of the “support equates to health” link, it seems prudent to identify why empirical research has classically upheld this viewpoint while ignoring, for example, the possibility of reverse causation. Hughes and Creaven (2009) delineate numerous folk-psychology perspectives potentially accountable for this hasty interpretation. Briefly, the motivation for valorizing social support might stem from a few possibilities, for example, a sympathetic thinking disposition might lead people to encourage the giving of social support because of their own positive experiences of having received social support in the past, generalizing their experiences from the individual to other people, and from the past to the future. Similarly, a simplistic utilitarian disposition might encourage an individual to consider social support as a type of universal resource, which, if produced prolifically, will contribute to the overall enhancement of the environment in which the individual lives. In essence, social support might be seen as synonymous with “doing good” and the promotion of social support as the creation of “more good in the world”.

While absent from folk psychology, the idea that support might be deleterious is more salient in empirical work, with researchers variably labeling support as unwanted, misconstrued, unhelpful, inadequate, fostering dependency, bad, and a mixed blessing (Gleason et al., 2008; Helgeson, 2003; Pal, Das, Chaudhury, Sengupta, & McConachie, 2005; Shinn, Lehmann, & Wong, 1984; Tracy, Munson, Peterson, & Floersch, 2010; Turner, 1994). As such, the folk psychology of help being universally valuable is at odds with the reality and complexity of social relationships and exchanges. Moreover, it is also possible that publication bias
reduces the likelihood of null or counter-intuitive results finding their way into mainstream literature. Indeed, when papers tend to report mixed or unexpected results, their interpretation often devolves to considering why an effect was not found when it should have been, rather than considering that the results are indicative of a true null effect (e.g., León, Nouwen, & Sheffield, 2007; Nausheen et al., 2009). For example, León et al. (2007) offer several interpretations of their counter-intuitive findings for the effects of support on cardiovascular stress recovery, such as:

The lack of any other support effects on recovery may indicate that the measure of recovery used lacked the sensitivity to portray the complex patterns of changing physiological activation during the recovery period… The failure of social support to moderate reactivity in these speech protocols may result from the high level of cognitive load produced by talking to a video camera and the associated threat of performance evaluation… One potential weakness in the present support manipulation relates to the possible failure to adequately match the support to the specific needs elicited by the experimental stressor (pp. 485-487).

Similarly, Nausheen et al. (2009) in a review of support effects on cancer progression, suggest that:

The unexpected results regarding higher perceived social support and shorter survival in breast cancer may be explained by speculating that nonexpression of negative emotions, which was positively correlated with perceived social support in the sample, might have led to the unfavorable effect of high perceived social support on cancer progression (p.411).
Christian and Stoney (2006) in a study of support effects on cardiovascular reactions to acute stress, propose that:

…it is possible that attenuating benefits of social support were not seen in the nonevaluative companion condition because the stressor did not elicit sufficient physiological stress responses to allow for effects of companion presence (p. 919).

Therefore, at least some researchers struggle to reconcile high reported support with poor physical health. Considering both the neglect of social psychological theories and the atheoretical basis for much of social support research, a more serious question is whether this paradox should be reconciled at all.

**Individual Variability in Social Support**

*Individual variability in perceived support*

Before the bulk of these studies is written off, it must be acknowledged that perceived support is consistently associated with well-being whereas received support is unrelated to or negatively associated with these outcomes (Haber, Cohen, Lucas, & Baltes, 2007; Reinhardt, Boerner, & Horowitz, 2006; Uchino, McKenzie, Birmingham, & Vaughn, 2011). Perceived support is considered to reflect an individual’s specific perception that support is available (typically measured by self-report), whereas received support denotes support actually received by that individual, which may not necessarily have been perceived by him or her, and is assessed using either provider reports of support provided to the recipient, or observational measures (e.g., Wethington & Kessler, 1986). Support, it seems, is good to have but not to use. Reinhardt et al. (2006) note that this conclusion has been made largely by comparing findings of studies that included either received or perceived support, rather than both,
while an added complication is that studies finding no benefit in received support may
be assessing populations low in support need, for which support cannot be as useful as
those needing practical help. To address this, Reinhardt et al. (2006) investigated
received and perceived emotional and instrumental support in 570 older adults
referred to a vision rehabilitation clinic, considered in need of instrumental support
owing to the difficulties attached to failing eyesight. The authors reported that
received emotional support had a small but significant positive effect on both
depressed mood and adaptation to vision loss, when perceived support was controlled
for. In contrast, received instrumental support had a negative effect on depressed
symptoms, though not adaptation. The results confirm that perceived support is more
robustly associated with adaptive outcomes. In this study, perceived emotional
support was associated with both outcomes, while perceived instrumental support was
associated with adaptation only, and, consistent with the ambiguous benefits of
instrumental help, was in fact detrimental to adaptation.

Theories of perceived social support: Stress-and-coping

Researchers have struggled to resolve this received/perceived paradox.
Traditionally, proponents of the stress-and-coping perspective have assumed that
enacted support (i.e., specific behaviours such as actual help or encouragement), is the
mechanism linking perceived support with positive outcomes. Individuals receiving
assistance from those in their environment are thought to become more likely to
perceive high support, which in turn enhances their perceptions of ability to cope with
stressors (Uchino & Garvey, 1997). However, this theory is not easily reconciled with
several divergent findings. Firstly, as noted earlier, several studies indicate that
recipients do not always benefit, and are sometimes even worse off for having
received support, a phenomenon referred to as a “reverse buffer effect” in relation to stress (Husaini, Neff, Newbrough, & Moore, 1982). In this case, perceptions of support experiences derived from receipt should perhaps entail negative consequences in themselves. Secondly, studies have shown that the benefits stemming from received support are most optimal when the recipients have not actually perceived it, that is, when they have received “invisible support” (Bolger, Zuckerman, & Kessler, 2000), asserting that “much that is helpful occurs in a routine, habitual, and therefore unnoticed fashion” (Coyne & Bolger, 1990). Thirdly, interventions designed to increase perceived support by increasing received support have failed to change perceived support levels (Lakey & Lutz, 1996). Finally, the comparatively weak correlation between support actually received and perceived (Haber et al., 2007) challenges this hypothesized association. While it is appealing to attribute this latter discrepancy to poor measurement, J. L. Cohen, Lakey, Tiell, and Neely (2005) in a sample of 100 female caregivers and their own primary support provider, demonstrated high agreement for enacted caregiving support, suggesting that enacted support is readily identifiable and recognized by others in the environment, at least for some types of support and within closely supportive relationships. As such, the correlation between received and perceived support should be statistically stronger than is generally reported. It is also possible that individuals who are dispositionally inclined to perceive support to be available to them, are more likely to seek it, and thus to receive it. Therefore, support receipt may arise from perceiving support, as much as perceiving support is thought to lead to support receipt, with perceiving support comprising a self-fulfilling prophecy for the individual in question.
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Theories of perceived social support: Social cognitive perspective

An alternative to the stress-and-coping viewpoint is the social cognitive perspective, which asserts that perceived support is based primarily on subjective and sometimes idiosyncratic evaluative processes that account for the weak association between enacted and perceived support (Kaul & Lakey, 2003; Lakey & Drew, 1997). Lakey describes this model as chiefly geared toward explaining links between perceived support and mental health, and may be relevant to physical health, insofar as mental health is important for physical health. According to the model, individuals rarely retrieve from memory the past actions of the support provider (such as enacted support) when making judgements about another’s supportiveness, but instead, retrieve the most accessible global judgement from memory, thereby producing weak associations between enacted and perceived support. Research on valenced person perceptions is relevant here, with two studies demonstrating that the amount of information required to make a negative judgement is significantly less than that required to attribute a positive trait (Rothbart & Park, 1986; Zhang & Hazan, 2002). Conversely, less disconfirmatory evidence is needed to withdraw a positive judgement than a negative one. Extending this to social support, individuals might require several instances of supportive behaviour before labelling another as “supportive”; in contrast, one failure in support provision might cause the perceiver to overturn this judgement.

In addition to Lakey and colleagues’ work, a sizeable literature testifies to the prevalence of illusion in normal human cognition which may extend to illusory beliefs about support (S. E. Taylor & Brown, 1988). In fact, illusions such as unrealistically positive self-evaluations, exaggerated perceptions of control or mastery, and unrealistic optimism, may be adaptive for mental health, with investigators noting that
these cognitive errors are absent in individuals who are depressed or low in self-esteem. For example, individuals tend to judge positive traits to be more characteristic of self than negative attributes (J. D. Brown, 1986), and recall their task performance as more positive than it actually was (Farwell & Wohlwend-Lloyd, 1998), with studies indicating that these tendencies are not a conscious effort to manage self-presentation (for reviews and critiques, see Colvin & Block, 1994; S. E. Taylor & Brown, 1988; S. E. Taylor & Brown, 1994). As such, individuals may report (a) more available support, to inflate their psychosocial resources and (b) more support provision, representative of altruism or generosity, while downplaying received support when this might be considered indicative of incompetence. In relation to support specifically, Buunk and Hoorens (1992) have described an egocentric bias in support bookkeeping, referring to individuals’ tendencies to report that they provide more support than they receive (in cases where they do not identify reciprocity in their relationships), while simultaneously claiming to be better able to rely on receiving support than their peers are. This fits well with social comparison theory, as asserting that one gives more than one takes, and that one gets more of a resource assumed to be beneficial, are both markers of an individual’s superiority.

These conflicting assertions that individuals are both providing more and potentially receiving more support suggest that individuals do not reliably translate actual received and provided support into their reports or perceptions of availability at a general level. Moreover, these errors in accounting may be psychologically adaptive, and as such, normal populations may frequently demonstrate poor correspondence between received and perceived support (recall that J. L. Cohen et al. [2005] demonstrated agreement in a caregiver–patient sample). In a diary study of 61 couples in which one partner suffered from multiple sclerosis, Kleiboer, Kuijer, Hox,
Schreurs, and Bensing (2006) found that couples agreed on reciprocity of instrumental support, consistent with the Cohen et al. findings. However, patients reported providing more emotional support than partners reported receiving and this emotional support provision was related to higher positive mood in patients but not in partners. This underscores assertions that support provision can go unnoticed (or perhaps, be ignored) to one’s advantage and suggests that within a dyad, either the support provider or recipient (or both) is likely to miscalculate at least some aspects of support receipt or provision.

*Theories of perceived social support: Attachment theory*

A third perspective implicates early childhood experiences and attachment security in our adulthood tendencies to expect support (Henderson, 1977). Attachment theory (Bowlby, 1969, 1979, 1988) proposes that regularities in our early social interactions, particularly those with the primary caregiver, influence the development of working models about our carer’s availability when needed. Over time, these relationship experiences yield general working models of self (in terms of being deserving of support) and of others, in terms of reliably providing support. Collins and Feeney (2004) propose that these working models of attachment are automatically activated in response to stressful events and act as interpretive filters through which individuals evaluate and appraise their interactions with significant others (Collins & Feeney, 2000; Pierce, Baldwin, & Lydon, 1997). As such, support recipients who have relatively secure working models should be predisposed to construe their interactions more favourably than those who have insecure models. Collins and Feeney (2004) cite several studies implying that secure adults are characterised by both higher perceived support and support satisfaction. In contrast, insecure adults
report less available support, less satisfaction with the support they receive, and a greater disparity between what they claim to need and what they receive. Models of attachment also comment on adulthood tendencies to provide support, for example, George and Solomon’s caregiving model (1996, 1999) proposes that children’s experiences with primary caregivers convey diagnostic information about what they can expect from future caregivers that influences their own supportive behaviour in adulthood. This is underscored by self-report and observational studies testifying that secure adults provide more sensitive and responsive care toward others (Collins & Feeney, 2000; Feeney & Collins, 2001; Simpson, Rholes, Oriña, & Grich, 2002; Westmaas & Silver, 2001) in addition to displaying more support seeking behaviour (Simpson, Rholes, & Nelligan, 1992; Simpson et al., 2002). In sum, the style and quality of care that individuals receive from early attachment figures affects both their expectations of support and how they provide support for significant others later in life, with evidence to suggest influences on both objective social environments and subjective construals of these. It must be acknowledged that little is known about the degree to which attachment predicts perceived support independent of differences in actually received support also attributable to attachment style. However, attachment theory strengthens the argument that perceived support is reflective of an individual difference variable rather than a consequence of support received.

Social support as an individual difference variable

The common thread in these perspectives suggests that perceived social support, that aspect most consistently implicated with health outcomes, may be conceptualized as an individual difference variable rather than a property of the environment. While unreasonable to propose that an individual’s meaningful social
environment is constructed entirely at random, or independent of one’s own preferences or behaviours, personality theories bearing on social support have been neglected. The tenacity with which support has been considered a resource is surprising. Some support researchers themselves have recognized that the perception of being supported is not primarily determined by the environmental resources that are actually available from one’s social network (Liem & Liem, 1978), with others speculating that perceived support may constitute a stable dispositional characteristic (I. G. Sarason, Sarason, & Shearin, 1986), and genetic researchers going so far as to label support a “complex human trait” (Kendler, 1997, p. 1402). This is underscored by recent research beginning to conceptualize social support and traits such as hostility as being interrelated (Smith & Gallo, 1999). Indeed, failure to account for individual differences in personality constitutes one potential explanation for why support is not invariantly beneficial. In addition, the direct import personality has for health (e.g., Lahey, 2009; Shipley, Weiss, Der, Taylor, & Deary, 2007) suggests that controlling for personality is warranted in support–health research.

Studies examining associations between support and personality have indicated that trait personality not only influences levels of enacted support, but also determines the degrees to which other individuals tend to be perceived as supportive. In this regard, Lakey and colleagues (Lakey, McCabe, Fisicaro, & Drew, 1996; Lutz & Lakey, 2001) have cited three mechanisms of effect, perceiver effects, that is, individual differences in the propensity to view others as generally supportive or unsupportive; target effects, or the extent to which perceivers agree on the supportiveness of targets, and relationship effects, reflecting processes whereby support exists only in the context of specific perceiver–target (or recipient–provider) pairings. In three studies where individuals provided ratings of supportiveness for
videotaped interactions or of those in their social environment, Lakey et al. (1996) found that relationship effects accounted for 41% of variance in support judgements, followed by target effects (20%) and perceiver effects (8%), endorsing an interpersonal rather than resource-focused view of support. Lutz and Lakey (2001) investigating the nature of relationship effects using a sample of 98 college students, reported that similarity in participant–target trait agreeableness and trait neuroticism resulted in greater ratings of target supportiveness; however, they also noted some cross-trait effects, such that high neurotics viewed high agreeables, and high agreeables viewed open individuals, as supportive. Replicating their results with a larger sample ($N = 202$); their findings revealed that perceivers differed in the extent to which they relied on extraversion, neuroticism, agreeableness, and conscientiousness to determine supportiveness, suggesting a possible mechanism for variations in support perceptions. Importantly, given perceptions of others’ supportiveness is determined in part by personality, one’s general perceptions of support availability may also be significantly influenced by personality. However, despite theoretical argument for the conceptualization of perceived social support as an individual difference variable, no published studies that the researcher is aware of have directly examined this potential overlap between personality and social support measures. Failure to do so means conclusions drawn about support–health linkages, at least in terms of naturalistic or psychometrically-assessed support, may be drawn from unreliable bases.

Overall, it appears that many of the beneficial effects of support may be attributed either to support provision as a correlate of support receipt, or to some individual difference variable underlying naturalistic support measures. The
remainder of this chapter locates this work in relation to cardiovascular markers as indicators of physical health.

**Support and Cardiovascular Health**

*Overview*

While support has been related to diverse health outcomes, studies of physical health most frequently link support with cardiovascular well-being. CVD comprises disorders of the heart and blood vessels such as CHD, cerebrovascular disease (stroke), and raised blood pressure (hypertension). CVD is the leading cause of death in industrialized nations and, owing to its rapid acceleration in developing countries, is projected to become the number one killer worldwide (Levenson, Skerrett, & Gaziano, 2002; WHO, 2011). Several studies have shown that, after accounting for factors such as age, physical inactivity, diabetes, hypertension, elevated cholesterol and triglyceride levels, and smoking, there is still unexplained variance in CHD, and while the precise amount of the residual remains unclear, it is estimated at about 25% (Beaglehole & Magnus, 2002). As such, researchers have focused on social support/isolation and personality as two major factors with a psychological component important to disease onset and progression (Rozanski, Blumenthal, & Kaplan, 1999; Strike & Steptoe, 2004). Epidemiological studies have investigated associations between basic support indices and cardiovascular-specific mortality. In the laboratory, research has examined how support and individual differences in *naturalistic* support influence cardiovascular reactions to acute stressors, or cardiovascular *reactivity* (CVR).
Cardiovascular Reactivity

What is cardiovascular reactivity?

CVR can be defined as the arithmetic difference between baseline measures of cardiovascular function and the elevation in these brought about by a stressor (Allan & Scheidt, 1996), the usual function of which is to prepare the organism to respond behaviourally to the stressor by providing nutritional supply to the major organs needed for physical action. However, as pointed out by Cannon (1929) in his description of the fight-or-flight response, such physical readiness is of less relevance when the threats in the environment require psychological responses rather than physical ones. Therefore, CVR to psychological stress involves a degree of cardiovascular responding beyond that which is metabolically necessary, with the reactivity hypothesis holding that this exaggeration can identify individuals or subgroups with an increased risk of CVD (Lovallo & Gerin, 2003). Most relevant studies have supported the implication that CVR is a stable individual characteristic, reporting moderate consistency in CVR over time and across tasks, with those examining internal consistency reliability also reporting excellent results (see Kelsey, Ornduff, & Alpert, 2007). Differences in reactivity are thought to underpin the wide variability in stress–illness associations and to reflect constitutional variation in susceptibility to stressful challenge (Boyce & Ellis, 2005). As stress is ubiquitous in the lives of most individuals (Dimsdale, 2008), CVR may have implications for physical health within both diseased and healthy populations. Moreover, several studies indicate social support to buffer CVR to a variety of challenges (e.g., K. Allen, Blascovich, & Mendes, 2002; Christian & Stoney, 2006; Phillips, Gallagher, & Carroll, 2009), signifying one potential pathway between low support and ill health.
Mechanisms of effect

Hughes (2012) summarizes several mechanisms by which heightened CVR may enhance disease risk. Due to their metabolic disproportionality to physical demands, blood pressure responses to psychological stress may disrupt physiological homeostasis in ways that lead to the gradual resetting of blood pressure (Obrist, 1981); in addition, the repeated eliciting of responses may contribute to cardiac and vascular hypertrophy (Lovallo & Gerin, 2003). Elevated levels of blood pressure reactivity may enhance disease risk by increasing serum levels of low-density lipoproteins while lowering levels of high-density lipoproteins (Raitakari et al., 1997). Further, elevated reactivity may be part of the exaggerated sympathetic responding that leads to increased blood insulin concentrations, which themselves are known to increase hypertension risk (Nazzaro et al., 2002). Finally, elevated reactivity may contribute to atherosclerosis through raising serum concentrations of proinflammatory cytokines (Georgiades, 2007). Support is thought to buffer elevated stress responses by modulating perceptions of both the stressor and the individual’s coping resources. It should be noted, however, that researchers have cautioned against extending the reactivity hypothesis to champion diminished responses (Phillips, 2011) instead proposing that biases toward very large and very small stress reaction are both indicators of poor homeostasis and possible disease risk (Lovallo, 2011). Some empirical work supports this assertion; for example, de Rooij and Roseboom (2010) reported that SBP and DBP reactivity (operationalized as the maximum measure obtained during continuous assessment) in 721 men and women from the Dutch Famine Birth Cohort was positively and linearly associated with subjective ratings of good health, and in another paper (de Rooij, Schene, Phillips, & Roseboom, 2010) inversely associated with anxiety and depression scores on a brief measure. Further,
blunted cardiac reactions to acute stress have been reported for exercise-dependent females (Heaney, Ginty, Carroll, & Phillips, 2011) and for those with disordered eating patterns (Ginty, Phillips, Higgs, Heaney, & Carroll, 2012), compared with controls. Therefore, both large and small reactions should be considered as potentially maladaptive, though the implications of blunted reactivity for future cardiovascular status remain to be established.

**Haemodynamic variables**

While stress-related increases in blood pressure and heart rate (the number of full cardiac cycles occurring within a particular timeframe) are the indices most frequently examined in published literature, the underlying haemodynamic determinants of blood pressure have also received empirical attention. These other important aspects are cardiac output (CO; the quantity of blood ejected within a certain timeframe); and total peripheral resistance (TPR; the total resistance of blood flow relating to the vascular system in its entirety). Changes in blood pressure may be the result of changes in CO, changes in TPR, or changes in both, with a large increase in one of these variables leading to an overall increase in blood pressure even when a decrease is observed for the other. Recent research has scrutinised the underlying haemodynamic pattern of profile of individuals in an effort to classify them as cardiac (characterised by increases in CO) or vascular (increases in TPR) reactors. This research is particularly valuable as available data indicate that some null changes in blood pressure patterning may be characterised by differential patterns of underlying haemodynamic functioning, with cardiac (or myocardial) responses thought to be adaptive and vascular patterns to be unhealthy (Mayet & Hughes, 2003). As such, examination of these parameters may reveal critical pathways by which social support
influences cardiovascular stress responses, with some studies indicating these variables to be sensitive to contextual dimensions of support in the laboratory (Christian & Stoney, 2006; Uno, Uchino, & Smith, 2002).

**Generalization outside the laboratory**

Of course, the notion of CVR is of little use to laboratory-based support research unless three assertions are shown to be valid, firstly, that laboratory-based CVR predicts responses in the natural environment (Dimsdale, 2008; A. R. Schwartz et al., 2003; Zanstra & Johnston, 2011), secondly, that CVR predicts disease, and finally, that video support enhances health prospects by preventing or attenuating CVR to short-term, controlled, physical, cognitive, and emotional stressors (Lepore, 1998). Kamarck, Schwartz, Janicki, Shiffman, and Raynor (2003) examined CVR to a battery of laboratory stressors (which might include, for example, mental arithmetic or the performance of a speech) for a sample of over 300 healthy participants, finding systolic and diastolic CVR to predict ambulatory responses to demanding or uncontrollable activities in daily life. Recently, Zanstra and Johnston (2011) concluded that the average cardiovascular (CV) response to a battery of laboratory stressors is related to the CV response to stress in real life when the latter is assessed by examining the response to an objective stressor. Therefore, it is likely that laboratory-based stressor responses have at least some implication for responses in everyday life, though Hughes (2012) notes that little research has examined the generalizability of variables other than blood pressure and HR.
CVR as a Predictor of Disease

Prediction of future resting levels and hypertension

Substantial empirical work has addressed the second point regarding the utility of CVR as a predictor of longer-term health. One important disease state is hypertension, clinically defined as a resting blood pressure of greater than 140/90 mmHg. Even when these somewhat arbitrary cut-offs are not attained, increased resting blood pressure comprises a major independent risk factor for the future development of essential hypertension and CHD (e.g., Franklin et al., 2001; Miura, Daviglus, et al., 2001; Miura, Dyer, et al., 2001), therefore, the processes by which exaggerated CVR are posited to contribute to essential hypertension are also important to resting blood pressure in the normotensive range (Treiber et al., 2003). Several studies have reported positive links between reactivity and subsequent blood pressure levels in children, adolescents, and adults (Matthews et al., 2004; Matthews, Woodall, & Allen, 1993; Murphy, Alpert, Walker, & Willey, 1991; Treiber et al., 2001), for example, Murphy et al. (1991) found that SBP reactivity to the video game task was related to resting SBP levels four years later among white and black children, though DBP reactivity was related to subsequent DBP for black children only. Matthews et al. (1993) assessed CVR to serial subtraction, mirror image tracing, and isometric exercise in 154 children as a predictor of resting blood pressure status 6.5 years later. After adjustment for age, resting pressure, and body mass index (BMI) at study entry, as well as length of follow-up, larger SBP and DBP responses were associated with higher subsequent resting blood pressure for boys, but not for girls.

Studies examining clinical cut-offs for hypertension in adult samples have also reported significant findings. Matthews et al. (2004) conducted a 13-year follow-up for a large sample (N = 4,100) of normotensive black and white men and women
enrolled in the CARDIA study, finding that the larger the blood pressure responses to each of three tasks (including the cold pressor task, which involves immersing the hand in ice-water for a short period of time, and which tends not to elicit the beta-adrenergically-mediated myocardial response thought to be important to early neurogenic hypertension), the earlier hypertension (defined as use of antihypertensive medication or measured blood pressure of 140/90 mm Hg) occurred. These findings held after adjustment for race, gender, and other pertinent covariates (education, BMI, age [18-30 at study entry], and resting pressure). The authors further noted that the systolic effect for the cold pressor task was apparent for women and for whites in race- and gender-specific models, whereas the DBP effect for the video game was observed for men, emphasizing moderation effects for gender and ethnicity on CVR. Moreover, in a review of the literature including over 30 studies, Treiber and colleagues (2003) found that among healthy populations, CVR in response to laboratory stress was associated with increased future blood pressure.

*Prediction of left ventricular mass*

Studies also link CVR with structural changes to the heart. Left ventricular hypertrophy (LVH) or increased left ventricular mass (LVM) is an independent predictor of risk for cardiovascular morbidity and mortality associated with most chronic diseases of the heart (Gardin & Lauer, 2004; Havranek et al., 2008; Levy, Garrison, Savage, Kannel, & Castelli, 1989). LVH is defined as an increase in the muscle mass of the heart attributed to the enlargement of the myocardial myocytes (heart muscle cells), an increase thought to preserve the systolic pumping function of the heart in the face of higher pressure or volume load in hypertensive individuals (T. R. Taylor, Kamarck, & Dianzumba, 2003). In the short term, increases in LVM allow
the heart to compensate for increased wall stress and potential haemodynamic compromise; in the long term, LVH is harmful (Artham et al., 2009; Gardin & Lauer, 2004). Few prospective studies have attempted to decrease LVM in order to lessen cardiovascular event risk; however, three trials (non-randomised in terms of baseline LVM) have shown that greater decreases in LVM are associated with greater declines in cardiovascular event rates independent of the degree of blood pressure reduction, as well as other potential confounders (Devereux et al., 2004; Okin et al., 2004; Wachtell et al., 2007). Likewise, reductions in blood pressure unaccompanied by decreased LVM are associated with worse outcomes (Okin, Hille, Kjeldsen, Dahlof, & Devereux, 2011).

Empirical evidence for a link between CVR and LVM is mixed. Rostrup et al. (1994) assessed CVR during a 5-minute mental arithmetic stressor, and during a 1-minute cold pressor test in 69 healthy men of 19 years of age, recruited from the 1st ($n = 21$), 50th ($n = 26$), and 99th ($n = 22$) percentiles in mean blood pressure. Blood pressure at screening and during mental stress and cold pressor tests were not independent explanatory variables, instead, the results suggested that resting arterial blood pressure and epinephrine may be of importance for development of LVH. In a much larger and more recent study of 876 men from four age cohorts (aged 42, 48, 58, and 64 years), Kamarck et al. (2000) reported that anticipatory pressure responses were positively associated with concurrent LVH among younger individuals ($< 50$ years) with elevated resting pressures. These findings were maintained for individuals with no history of CVD, though the cross-sectional nature of the data precludes commentary on cause-and-effect. Similarly, al’Absi et al. (2006) found mixed evidence in a community sample, with CVR unrelated to LVM, but associated with
another index of hypertrophy, relative wall thickness. Therefore, there appears to be some association between CVR and LVM though the direction of the link is unclear.

Studies in younger populations more consistently support such a link, with M. T. Allen, Matthews, and Sherman (1997) reporting positive findings in their study of children aged eight to 10 years old and adolescents 15 to 17 years old (115 in total). Across all participants, increased SBP and TPR, and decreased stroke volume (SV) and CO during a mirror tracing task were associated with higher LVM, with subgroup analyses showing that these associations were significant for males and sometimes adolescents but not for females and children. Murdison et al. (1998) and Kapuku et al. (1999) assessed CVR in samples characterised by family history of hypertension and found significant associations with LVM between 2.3 and 2.5 years later. In sum, it appears that CVR predicts LVH in at least some groups, with more consistent results for adolescents than for adults. Moreover, in a review of 21 studies, T. R. Taylor et al. (2003) concluded that there is a modestly consistent relationship between CVR and LVM, though the authors advocate that future studies utilize larger samples, prospective designs, and patently reliable measurement techniques.

*Prediction of carotid atherosclerosis*

CVR has also been assessed as a predictor of atherosclerosis, which describes the build-up of plaque in the arteries of the body, with carotid atherosclerosis referring specifically to the occurrence within the carotid arteries in the neck. A review of eight studies assessing carotid artery intima-media thickness (IMT), a non-invasive measure of atherosclerosis, concluded that carotid IMT is a strong predictor of future vascular events such as stroke and MI (Lorenz, Markus, Bots, Rosvall, & Sitzer, 2007). For each difference of 0.1 mm, the future risk of MI increases by 10% to 15%, and the
stroke risk increases by 13% to 18%, with the risk for both endpoints decreasing with the number of adjustments for risk factors. In one of these studies, Chambless et al. (1997) examined whether greater carotid IMT in asymptomatic individuals was associated prospectively with increased risk of incident CHD over a 4-7 year follow-up in four U.S. communities. Based on healthy samples of 7,289 women and 5,552 men aged 45-64 years, the results indicated that the hazard rate ratio comparing extreme mean IMT (>1 mm) to not extreme (<1 mm) was 5.07 for women and 1.85 for men. While the strength of the association was reduced by including major CHD risk factors, it remained elevated at higher IMT.

Nonhuman primate models have suggested that CVR may be associated with an increased risk for atherosclerosis in the coronary as well as the carotid arteries (Manuck, Kaplan, & Clarkson, 1983). As human studies support the co-occurrence of coronary with carotid atherosclerosis (Craven et al., 1990; Wofford et al., 1991), CVR may be particularly valuable as a predictor of these endpoints. Kamarck, Everson, and George (1997) assessed CVR to four cognitive tasks, in 901 Finnish men from four age cohorts (42 to 60 years). Diastolic responses were significantly associated with mean IMT, maximum IMT, and mean plaque height. Significant associations were also shown between stress-related SBP reactivity and mean IMT. When examined separately by age, associations were significant only in the youngest half of the sample, and remained significant after adjustment for smoking, lipid profiles, fasting glucose, and resting pressure. Results for mean IMT also remained significant in a subgroup of unmedicated younger subjects without symptomatic CVD, suggesting that CVR predicts pre-disease in healthy as well as potentially unhealthy individuals. At a 7-year follow-up, Jennings et al. (2004) reported on 756 of this sample, and indicated that systolic reactivity at study onset was positively related to mean carotid
IMT and to the progression of IMT. Similar significant relations were shown for maximal IMT and plaque height. Consistent with the trend towards stronger effects for SBP reactivity than for other parameters, DBP responses were less strongly related to carotid IMT than were systolic responses, while HR responses were unrelated. To an extent, these findings are corroborated by cross-sectional (Roemmich et al., 2009) and longitudinal (Low, Salomon, & Matthews, 2009) studies sampling children and young adults.

Summary

Recent reviews of the literature further support a role for CVR in disease. In a meta-analysis of 169 effect sizes derived from 36 prospective studies, recognisant of the potentially bidirectional association between CVR and cardiovascular ill-health, Chida and Steptoe (2010) showed that greater reactivity to stress was associated longitudinally with poor cardiovascular status, in terms of elevated blood pressure, hypertension, LVM, subclinical atherosclerosis, and clinical cardiac events. Overall, CVR appears to be at least a marker for if not a causal factor in the development and progression of CVD, with evidence for the buffering effects of support on this response reviewed below.

Social Support and CVR

Laboratory analogues of social support

Several studies have affirmed that support attenuates CVR to acute stress, though results appear to depend on the gender of both provider and recipient, the nature of the support provided, and the potential for evaluation regarding the stressor (O'Donovan & Hughes, 2008b; Reblin, Uchino, & Smith, 2010; Uchino et al., 2011).
In a meta-analysis of 22 relevant studies, Thorsteinsson and James (1999) concluded that social support (including enacted and available analogues) reliably attenuated physiological responses (including CVR) to laboratory-based stressors, with an average effect size of .61 for SBP and HR, and .51 for DBP. However, significant attenuating effects of support were only reported in 10 of 15 comparisons for SBP, seven of 15 for DBP, and 10 of 20 for HR, indicating that the effects of support are far from consistent. Additional studies have shed light on the support–CVR link since that meta-analysis, with Uno et al. (2002) reporting that the effectiveness of support depended primarily on the quality of the friendship between the support provider and recipient. Eighty-eight participants were randomly assigned to perform a speech task in one of three conditions (no–support, emotional support, instrumental support) and to bring a male or female friend, with relationship quality psychometrically assessed and categorized as being purely positive or ambivalent. Women who interacted with a female, ambivalent friend had the largest changes in DBP, TPR, and pre-ejection period (PEP) compared to the other conditions. In contrast, receiving emotional support from a purely positive friend was related to lower increases in CO, and receiving emotional support from an ambivalent friend related to larger increases in CO, when compared to individuals in the no–support condition.

Further elucidating the effects of support on CVR, Phillips, Gallagher, et al. (2009) reported a sex of supporter × intimacy with supporter interaction on women’s SBP reactivity to a mental arithmetic stressor. In a sample of 112 young healthy women, a two-way interaction was observed between friend versus stranger and the sex of the supporter, such that SBP reactivity to a serial addition task was lower when the support was from a male friend versus a female and lower when support was from a male friend versus a male stranger. In addition, a significant three-way interaction
was observed such that active (providing brief encouraging prompts) as opposed to passive (silent presence) support was associated with attenuated SBP but only when the active supporter was a male friend or female stranger. When a female friend or male stranger was actively supportive, SBP reactivity was increased. This finding highlights the uncertainty regarding support effects, with active support from a female friend exacerbating rather than attenuating CVR.

Excepting the passive condition in the Phillips, Gallagher, et al. (2009) study, these studies are notable in that the support provided to recipients largely is salient and equates to, or is at least intended to comprise received support rather than perceived support independent of actual receipt. In an early study examining perceived availability of support, Uchino and Garvey (1997) manipulated the availability of support from the experimenter. Participants (28 men and 21 women) performed a speech task in either an alone or a support condition. In the support condition, participants were informed that the experimenter was outside the door and was available to answer any queries or questions during the task. Results showed that participants in the support condition exhibited lower SBP and DBP reactivity than those in the alone condition, suggesting that simply having access to support may be sufficient to attenuate CVR to stressors, consistent with the received/perceived discrepancy discussed earlier. In sum, support or the availability of such appears to attenuate CVR (see also, K. Allen et al., 2002; Hilmert, Kulik, & Christenfeld, 2002; O'Donovan & Hughes, 2008a). However, as Rook (1990b) has hypothesized, simply feeling embedded in a network of mutual obligation may be beneficial for health, and may thus attenuate CVR. In fact, demonstrating that support receipt (or perceptions of availability) attenuates CVR relative to interactions with a friend involving support provision (i.e., embeddedness without support receipt) would substantiate claims that
it is support rather than embeddedness that reliably attenuates CVR. Moreover, given
several lines of evidence suggesting confounding between support receipt and
tendency for provision, this approach also serves to substantiate or refute claims that
support provision is more beneficial than receipt.

**Alternatives and Extensions to the Reactivity Hypothesis**

**Recovery**

While CVR has been the focus of considerable empirical work, other aspects
of physiological stress responses have also been linked with health and may be
influenced by dimensions of social support. One extension of the basic reactivity
hypothesis involves the idea that delayed recovery or return to baseline levels after
experiencing a stressor may also have deleterious effects, constituting an exaggerated
form of reactivity across the temporal dimension. In particular, it has been
hypothesized that a response pattern of elevated cardiovascular reactivity and
comparably fast recovery may reflect an adaptive response to a stressor, related to low
allostatic load; conversely, elevated peak reactivity together with delayed recovery
may be indicative of higher allostatic load (McEwen, 1998). Researchers have
reported a lack of correspondence between peak magnitude of response and
subsequent rate of return to baseline, indicating that recovery is distinct from
exaggerated reactivity (Fredrickson & Levenson, 1998).

**Empirical evidence for the utility of recovery**

A. R. Schwartz et al. (2003) concluded that the predictive utility of recovery
was weak overall, possibly owing to the ecological validity issues with laboratory
stressors. Conflictingly, Stewart and colleagues (Stewart, Janicki, & Kamarck, 2006)
proposed that recovery might constitute a predictor superior to CVR, which failed to predict subsequent blood pressure in their sample of 216 normotensive adults. Treiber et al.’s (2001) study found recovery to predict resting blood pressure at follow-up timepoints in their youth sample. More recent research affirmed limited utility with Moseley and Linden (2006) reporting that recovery was associated with ambulatory cardiovascular functioning at the 3-year timepoint, though not at ten years. Further evidence comes from the Whitehall cohort studies. Steptoe and Marmot (2005) assessed 209 healthy men and women from this group (aged 45-59 years at study entry). Increases in SBP at a 3-year follow-up were predicted by impaired post-stress recovery of SBP, DBP, and TPR, independently of baseline blood pressure, age, gender, SES, use of hypertensive medication at follow-up, BMI and smoking. The adjusted odds of an increase in SBP ≥ 5 mmHg were 3.50 for individuals with poor compared with effective post-stress recovery of SBP. Three-year increases in DBP were also predicted by impaired recovery of SBP and DBP. A subsequent Whitehall analysis indicated systolic recovery to predict carotid atherosclerosis in low SES (determined by grade of employment) but not higher SES participants in a mixed gender sample of 136 (Steptoe, Donald, O’Donnell, Marmot, & Deanfield, 2006). In 228 men, Steptoe and Marmot (2006) found that independent of reactivity, delayed systolic recovery was associated with several psychosocial variables related to poorer physical health including social isolation and poor mental health.

Based on 30 associations reported in five prospective studies, Chida and Steptoe’s (2010) meta-analysis found recovery (particularly SBP and HR recovery) to robustly predict carotid IMT and subsequent SBP and DBP levels. This is partially corroborated by several studies in the sports physiology literature implicating HR but not blood pressure recovery in physical fitness (Forcier et al., 2006). Moreover, even
where reactivity constitutes a superior predictor of disease, researchers have advised that assessment of recovery is nonetheless informative in the context of broad stress responses (A. R. Schwartz et al., 2003) and further, that the influence of social support may not generalize across all parts of the stress process (e.g., Gramer & Reitbauer, 2010). Therefore, inclusion of recovery assessments in support research may help corroborate effects observed for CVR. To date, only a few studies have examined whether support moderates recovery from acute stressors (e.g., Lache, Meyer, & Herrmann-Lingen, 2007; León et al., 2007). However, doing so may shed light on the conditions under which support is most beneficial.

Resting cardiovascular levels

With hefty tracts devoted to physiological reactivity, the baseline or resting measures of cardiovascular parameters are frequently neglected outside of their role as a constituent of the reactivity calculation. Several studies confirm elevations in resting blood pressure and heart rate to indicate higher risk for ischemic disease, stroke (Prospective Studies Collaboration, 2002), hypertension (Wolf-Maier et al., 2003), and Type-2 diabetes (Cooney et al., 2010; Nagaya, Yoshida, Takahashi, & Kawai, 2010), even in non-hypertensive individuals (Kotchen & McCarron, 1998). Others have expressed this risk in terms of prevalence of mortality, with Lewington and colleagues (Lewington, Clarke, Qizilbash, Peto, & Collins, 2003), in their analysis of 61 studies of a combined one million participants, concluding that every 1 mmHg reduction in the mean population SBP could prevent approximately 10,000 CHD deaths each year in the United States. As such, examining resting measures is both worthwhile in itself and may corroborate findings linking support to other healthful profiles of cardiovascular function (Hughes & Howard, 2009). As the gradual
resetting of resting levels is one mechanism by which CVR is thought to lead to disease, it follows that effects of support on CVR should be evident for resting levels.

Only a few studies have examined associations between support and resting levels, primarily examining naturalistic rather than laboratory-manipulated support. In a large-scale study, Nyklíček and Vingerhoets (2009) reported that although perceived support (measured using the Dutch version of the SSQ6) was associated with lower home measures of both SBP and DBP, this association disappeared when controlling for sociodemographic, biomedical, and lifestyle variables. Recently, Schwerdtfeger and Schlagert (2011) reported an interaction between naturalistic and laboratory support such that perceived available support as measured by the Berlin Social Support Scales (BSSS; Schulz & Schwarzer, 2003) was unrelated to cardiovascular activity in a no-support condition; but was accompanied by attenuated HR and increased heart rate variability (HRV) in the enacted-support condition. In a sample of 211 healthy women, Hughes and Howard (2009) reported that naturalistic support quality (measured by the SSQ6) predicted reduced resting SBP and HR measured in the laboratory. These findings are further substantiated by ambulatory data, for example, Steptoe (2000) found that high stress was associated with increased ambulatory SBP, DBP, and HR in 62 teachers, but not significantly so for those reporting high support on the ISEL. The authors concluded that high levels of perceived social support were protective, not by altering the appraisal of stressful events, but reducing the impact of these events on blood pressure in everyday life. Overall, naturalistic support appears to predict reduced cardiovascular levels. However, as alluded to earlier, whether these outcomes are independent of the links between perceived support and personality is unknown. Given the well-established public health significance of CVD, the true nature of social support effects on CVD
markers including CVR and resting levels is an important issue for behavioural medicine research. Aside from the health significance of such factors, commentators note that relating substantially subjective factors to substantially subjective outcomes is inherently problematic (Macleod & Davey Smith, 2003). As such, elucidating the nature of effects of support on well-being might more usefully be achieved for physical rather than psychological health.

**Main Conclusions and Thesis Outline**

Overall, the social support literature has been thwarted by failure to accommodate established concerns from social and personality psychology. The present thesis aims to elucidate the influence of social support on well-being within a more appropriate interpersonal and transactional context than that of much previous research. Drawing on social psychological theories, the research addresses deficiencies in transactional assessment by including support provision groups or roles within standard laboratory protocols. Objective indices of well-being, namely, cardiovascular levels, reactivity, and recovery were employed in order to (i) circumvent difficulties inherent in subjective psychological outcomes, (ii) establish the importance of support to disease markers with significance for health in the general population.

Firstly; however, the unique value of naturalistic support measures remains to be established. Perceived social support has demonstrated correlations with broad personality traits and the value of the construct over these broad models must be determined. One of the aims of the present thesis was to examine the discriminant validity of naturalistic support versus trait personality as a predictor of well-being in healthy individuals. Therefore, the first study in the present thesis employed measures
of both naturalistic social support and trait personality, facilitating the isolation of effects on well-being attributable to social support explicitly, rather than to generalized personality characteristics.

The main focus of the present research; however, was the examination of both support provision and receipt effects on CVR and recovery. While several studies have suggested that the effects of received support may be more accurately attributed to support provision or social embeddedness, little empirical research has addressed this question. A brief overview of the empirical research reported in this thesis follows.

Study 1. Are naturalistic support levels and their benefits for health accounted for by trait personality?

Study 1 (Chapter 2) examined whether significant variance in naturalistic indices of social support was predicted by trait personality. Four hundred and ten college students completed the Short-form Social Support Questionnaire and the Revised Eysenck Personality Questionnaire. Resting cardiovascular measures were also obtained for a subsample \((n = 145)\) of these participants as an objective index of well-being. The main aim of Study 1 was to examine whether differences in trait personality predicted well-being better than do naturalistic measures of social support.

Study 2. Cardiovascular responses to mental activation of social support schemas

Studies assessing support effects on CVR indicate that one’s internal representations or schemas of support can serve to moderate acute stress reactivity. Whether this effect is a function of support specifically, or of feeling embedded in a mutually supportive network is unclear. This schema activation paradigm was thus
extended to examine effects in cardiovascular recovery from an acute stressor and compared support receipt activation with support provision and neutral social contact. Seventy-two women underwent cardiovascular monitoring at rest, during acute stress, and during the mental activation of support receipt, provision, or neutral social contact. The main aim of Study 4 (Chapter 3) was to examine whether a laboratory analogue of perceived support enhanced cardiovascular recovery from an acute stressor to the same extent as the mental activation of support provision or social contact.

**Study 3. Individual- and dyad-level effects of live support provision and receipt on cardiovascular reactivity during a laboratory challenge**

Study 3 (Chapter 4) extended the traditional uni-directional laboratory protocol to assess CVR for both providers and recipients in a support interaction. 90 college students (32 men) engaged in a dyadic interaction in either a supportive condition (support provided or received to complete the stress task) or a collaborative condition (stress task completed together). The main aim of this study was to examine whether cardiovascular responses to live instrumental support provision and receipt differ, and whether patterns of dynamic *concordance* in CVR differ between supportive dyads and collaborative dyads. As the findings for individual-level CVR are mixed, it is possible that examining attunement may shed light on the meaning of social relationships at a dyadic level.
Study 4. Dyadic concordance in cardiovascular function in parent–child dyads high and low in interpersonal stress

Study 3 examined concordance in physiology between members of dyads for which the provider–recipient distinction was experimentally-manipulated. Chapter 5 examines dynamic concordance in an ecologically-valid provider–recipient context by utilizing a sample of 104 parent–child dyads was used. Fifty-two dyads were characterised by child maltreatment (CM) with the remainder being control dyads. The main aim was to examine differences in concordance in cardiovascular arousal in naturally inequitable relationships as a function of interpersonal stress.

Study 5. Do perceptions of child characteristics moderate the degree to which parents find interactions with their children stressful compared with cognitive stress?

Dyadic concordance in cardiovascular arousal was assessed in Study 3 (Chapter 4), as well as the differences in the nature of this concordance between high and low stress relationships (Chapter 5). Study 5 (Chapter 6) aims to examine CVR during a dyadic interaction between parents and their children. Using a sample of 21 parents and their children, parental CVR was monitored during an acute stressor and during dyadic interaction. The main research aim of Study 5 was to determine whether perceptions of one’s dyadic partner influence the difference between CVR in response to social interaction and the typical CVR response to acute stress. In doing so, it may be possible to establish whether stress responses to dyadic interaction are similar or qualitatively different to the stress reactivity displayed in response to cognitive stressors.
Chapter 2: STUDY 1

ARE NATURALISTIC SUPPORT LEVELS AND THEIR BENEFITS FOR HEALTH ACCOUNTED FOR BY TRAIT PERSONALITY?²

INTRODUCTION

Some researchers have assumed that perceiving support is dependent on actually receiving support, and that it is this actual support receipt that links perceived support with positive outcomes (S. Cohen, 1988). However, an alternative theory is that variability in perceived support is not related to variations in support receipt, but in fact is a function, at least in part, of differences in trait personality (I. G. Sarason et al., 1986). As both variables are typically measured by self-report, invoking a level of shared method variance (Brannick, Chan, Conway, Lance, & Spector, 2010), it is even more likely that measures purportedly assessing support are proxies for personality. Moreover, as perceived (rather than received) support is so widely studied and exalted as a predictor of well-being, the extent to which it is (a) independent of broad personality traits and (b) a better predictor of well-being than trait personality warrant attention.

The idea that a narrow psychosocial construct might reflect a constellation of higher-order traits is not unfamiliar. Using factor analytic techniques, Marshall, Wortman, Vickers, Kusulas, and Hervig (1994) examined several health-relevant personality instruments including measures of optimism and self-esteem, and found

² Elements of this chapter have been published with minor editorial modifications: Creaven, A-M., Howard, S., & Hughes, B. M. (in press). Social support and trait personality are independently associated with resting cardiovascular function in women. British Journal of Health Psychology.
that these appeared to tap into the higher-order traits of neuroticism, extraversion, and agreeableness (along with conscientiousness and openness to experience) contained in Costa and McCrae’s (1992) five-factor or “Big Five” model. Judge, Erez, Bono, and Thoresen (2002) measured self-esteem, neuroticism, locus of control, and generalized self-efficacy, finding that these too were represented by a common core, described by the authors as neuroticism. Further, Judge, Heller, and Mount (2002) conducted a meta-analysis of 163 independent samples examining personality and job satisfaction, and found that the Big Five demonstrated an average correlation of .41 with job satisfaction, with extraversion and neuroticism consistently predicting satisfaction across studies. Taken together, these studies indicate that narrow psychosocial constructs might be well represented by higher-order trait models. However, despite evidence suggesting a dispositional basis for perceived or self-reported naturalistic support, the overlap between this and personality has yet to be investigated.

Eysenck’s (1967) three-factor model provides a useful framework to address this question. This contains three factors (extraversion, neuroticism, and psychoticism) and a lie scale, and as such might provide a more parsimonious investigation than would the five-factor model. While there is divided opinion as to which of models can be considered the most valid representation of the main higher order traits (Aziz & Jackson, 2001; Draycott & Kline, 1995; Saggino, 2000), the regularly cited support correlates of extraversion and neuroticism are common to both models. The third main factor in this model, psychoticism, is also under-researched regarding its potential overlap with social support. This framework also includes a lie scale as a measure of socially desirable responding (SDR), conceptualized as the tendency to respond to self-report items in a manner that makes the respondent look good rather than to respond in an accurate and truthful manner (Holtgraves, 2004). Therefore, the
Eysenckian model provides an opportunity to assess the relevance of both personality and SDR to social support within a single personality framework. Moreover, elements of this model have been utilized in several prior studies examining various health-relevant indices of physiological arousal (Hughes, Howard, James, & Higgins, 2011; Phillips, Carroll, Burns, & Drayson, 2005) that are thought to be influenced by support.

As noted in Chapter 1, social support may have both positive and negative connotations. When such implications are salient self-reports may be influenced by perceptions of whether or not reporting support reflects favourably on an individual. For example, depending on the context, respondents may consider that indicating a high level of support characterises an agreeable, popular individual, or alternatively, someone who frequently requires assistance to cope with life stressors. Heitzmann and Kaplan (1988) reviewed several support instruments and reported no associations with various SDR measures, while Evans and Steptoe (2001) found no association between scores on the 10-item version of the Marlowe-Crowne Social Desirability Scale (MCSDS; Strahan & Gerbasi, 1972) and work support in their occupational sample. In contrast, Vandervoort (2000), reported that both network size and adequacy based on their adaption of Syme’s unpublished measure (see Vandervoort, 1999) were highly correlated with Marlowe-Crowne scores, while Cramer (2000) reported the subscales of the full MCSDS (referred to as the Crowne-Marlowe Social Desirability Scale; Crowne & Marlowe, 1960) to be positively associated with two scores derived from the Interview Schedule of Social Interaction (Henderson, Byrne, & Duncan-Jones, 1981) of in a sample of 225 middle-aged individuals. Although these links are inconsistent overall, there is also evidence to suggest SDR may moderate associations between support and personality. Stokes (1985) in a study of
personality and psychosocial variables, noted that failing to control for SDR “does not change the results except for inflating the variance in loneliness attributable to the individual difference variables by about 8%” (p. 986, emphasis added). In the same vein, it is possible that SDR moderates links between personality and other psychosocial measures such as social support, even when direct SDR–support associations are not observed. To adequately examine overlap between personality traits and support reports, it may be prudent to control for social desirability bias.

The first aim of the present study is to examine the extent to which variance in naturalistic support, purportedly a reflection of an environmental resource, is predicted by trait personality and social desirability bias. The second aim is to examine whether the associations between support and well-being are accounted for by trait personality. Resting cardiovascular levels were selected as an objective index of well-being for this purpose. Prior work has reported links between high social support and reduced resting blood pressure and HR in normal samples (e.g., Hughes & Howard, 2009; Schwerdtfeger & Schlagert, 2011), and as discussed in Chapter 1, resting levels are important risk factors for the development of CVD (World Health Organization, 2008). As several studies implicate support with CVD morbidity and mortality (e.g., Lett et al., 2008; Lett et al., 2005), it is particularly important to establish the independence of support effects on cardiovascular function as a risk factor for CVD.
Our hypotheses were as follows:

1. that extraversion would be positively associated with network size
2. that neuroticism would be inversely associated with support satisfaction
3. that high lie scale scores would predict low network support
4. that high lie scales scores would predict high support satisfaction

In summary, we expected to replicate established bivariate associations between extraversion and network size, and neuroticism and support satisfaction. In addition, we considered that reporting a large support (rather than social) network might be perceived to indicate poor coping ability, while reporting dissatisfaction or inadequacy in one’s social network might be seen to indicate low quality support networks. Therefore, we predicted a positive association between SDR and network size, and an inverse association between SDR and satisfaction.

Regarding our cardiovascular indices, we first hypothesized that support would predict lower resting cardiovascular levels. Second, based on the documented positive link between support and extraversion, and the inverse link between support and neuroticism, we hypothesized that support would predict extraversion and neuroticism. Third, we hypothesized that personality (i.e., extraversion and neuroticism) would mediate the links between support and reduced cardiovascular levels. Finally, we analysed psychoticism on an exploratory basis, as this component of Eysenck’s model has been under-researched.

**METHODS**

**Participants**

The sample comprised 410 undergraduate students (162 men) participating in four separate trials examining aspects of psychological influences on well-being. Data
from 211 participants were collected by the present author, with the remainder collected by another researcher as part of an on-going programme of cardiovascular data gathering at the present author’s laboratory. Participation was voluntary and rewarded with course credit. Men ranged in age from 17 to 63 years \( (M = 21.50, SD = 6.16) \), while women ranged in age from 17 to 52 years \( (M = 20.05, SD = 4.26) \). Men were significantly older than women, \( t(260.71) = 2.62, p < .001 \). Chi-squared analysis indicated that there was an uneven distribution of gender by trial group, \( \chi^2 = 166.70, p < .001 \), with men predictably under-represented in one trial recruiting a sample of women. Age also differed across groups, \( \chi^2 = 175.65, p < .001 \).

A subsample of these participants was employed in the cardiovascular analyses. In part owing to gender differences in both support (Neff & Karney, 2005) and resting cardiovascular levels (Hart, Joyner, Wallin, & Charkoudian, 2012), with men tending to score lower for support and higher for resting blood pressure than women, only women were included in the analyses. In addition, the smaller sample of men for whom cardiovascular data were gathered \( (n = 48) \) precluded an adequately-powered analysis of these data. The subsample therefore comprised 145 healthy normotensive non-smoking women of age range 17 to 27 years \( (M = 19.17, SD = 1.41) \), with BMI ranging from 17.44 to 33.43 kg/m\(^2\) \( (M = 22.89, SD = 3.36) \).

**Psychometric assessments**

**Short-form Social Support Questionnaire.** Perceived social support was measured using the Short-form Social Support Questionnaire (SSQ6; I. G. Sarason, Sarason, Shearin, & Pierce, 1987). This contains six 2-part items such as “Whom can you count on to console you when you are very upset?” followed by a satisfaction rating, yielding separate scores for perceived number of supports (SSQ-N) and
support satisfaction (SSQ-S). Individuals list up to nine target persons who they feel are likely to provide support in a given situation, and rate their satisfaction with each number on a 6-point Likert scale. Unlike measures of received or enacted support, this measure does not require the respondent to list specific support acts within a specified time frame, thereby assessing perceived available support. Standardization studies have reported high internal consistency and test-retest reliability for both measures, and strong factorial validity (I. G. Sarason et al., 1987). Internal reliability estimates (Cronbach’s α) were excellent; for SSQ-N, α = .93 and for SSQ-S, α = .85.

Revised Eysenck Personality Questionnaire. The Revised Eysenck Personality Questionnaire (EPQ-R; Eysenck & Eysenck, 1991) was used to assess personality and SDR. The scale involves a yes–no format in response to 100 items assessing psychoticism, extraversion, neuroticism, and SDR. The extraversion and neuroticism subscales have adequate reliability (Caruso, Witkiewitz, Belcourt-Ditloff, & Gottlieb, 2001), with generally lower reliabilities reported for psychoticism (Caruso et al., 2001). Cronbach’s α for all subscales was satisfactory: .82 for extraversion, .83 for neuroticism, .74 for psychoticism, and .80 for the lie scale.

Hospital and Anxiety Depression Scale. The Hospital Anxiety and Depression Scales (HADS; Zigmond & Snaith, 1983) consists of two 7-item subscales assessing anxiety (HADS-A) and depression (HADS-D) with items uncontaminated by reports of physical symptomology. Participants respond to items on a 4-point Likert scale, with different response options for each item. Prior research has reported Cronbach’s α of over .90 for both subscales (Moorey et al., 1991), which are very widely used (for a review, see Herrmann, 1997). In the present study, these data were considered only for the cardiovascular analyses as potential confounds of resting levels (Hildrum et
al., 2007; Lechin et al., 1995). Cronbach’s α for the HADS-A was .80 and for the HADS-D was .70.

**Procedure**

Each participant was met in the laboratory by a researcher and asked to complete a number of psychometric scales including the SSQ6 and the EPQ-R. All participants read and signed a consent form prior to participation. Cardiovascular measures were obtained from those participants who elected to take part in one of the cardiovascular protocols. For these participants, height (to the nearest mm) and weight (to the nearest 0.1kg) were obtained using a digital balance (Seca, model 707; Seca, Hamburg, Germany). Measures were taken in a small psychophysiology laboratory at the participants’ university. Participants were seated in a comfortable chair and provided with reading material to facilitate genuine relaxation prior to measurement (Jennings, Kamarck, Stewart, Eddy, & Johnson, 1992). The researcher was present in the room but separated from the participant via an opaque screen. This served to ensure the participant adhered to procedural instructions, while minimizing social contact between the researcher and participant. Resting cardiovascular measures were computed differentially by trial, but were derived similarly as the mean beat-to-beat readings obtained from a sample within a 10-minute resting period for each participant.

**Cardiovascular assessment**

Measures were taken using a Finometer haemodynamic monitor (Finapres Medical Systems BV, BT Arnhem, The Netherlands). The Finometer is the successor to the TNO Finapres-model-5 and of the Ohmeda Finapres 2300e which have been
used in previous research (Beckham, Flood, Dennis, & Calhoun, 2009; Gregg, Matyas, & James, 2005; Philippsen et al., 2007; van Rooyen et al., 2004). Based on the volume-clamp method first developed by Penáz (1973), the Finometer makes use of an appropriate-sized finger cuff placed on the middle finger of the non-dominant hand to non-invasively assess cardiovascular variables. It also corrects for the hydrostatic height of the finger with respect to the heart level. The finger cuff inflates to keep the arterial walls at a set diameter. Built into the cuff is an infrared photoplethysmograph which detects changes in the diameter of the arterial wall. When the intra-arterial pressure increases, thereby expanding the diameter of the arterial wall, a dynamic servo-controller causes the finger cuff to inflate, maintaining the diameter of the artery at a constant position. When the volume clamp is active at the proper unloaded diameter, intra-arterial pressure equals that of the finger cuff pressure.

The Finometer uses Physiocal (Finapres Medical Systems, Amsterdam) to determine and maintain the pressure at which the finger artery is clamped (Wesseling, De Wit, Van der Hoeven, Van der Goudoever, & Settels, 1995). Physiocal is an algorithm that establishes a setpoint level and provides for the periodic setpoint adjustment by a computer, accounting for changes in smooth muscle tone that would lead to errors in blood pressure measurement if a fixed setpoint was used. The Physiocal criteria allow for correction of errors without interrupting continuous measurements (Wesseling et al., 1995). Measures of arterial pressure CO are provided based on the validated Modelflow modelling method (Wesseling et al., 1995; Wesseling, Jansen, Settels, & Schreuder, 1993). This simulates the inflow of blood into the arterial system caused by left ventricular contraction and opposed by arterial counter pressure and aortic and peripheral arterial input impedance. The computation of flow from pressure by Modelflow is based on the three major properties of the
aorta and arterial system: aortic characteristic impedance, a dynamic property of the aorta that impedes pulsatory outflow from the ventricle; windkessel or buffer compliance, the ability of the aorta and arterial system to store elastically the cardiac stroke output from the left ventricle; and peripheral resistance, the Poiseuille resistance of all vascular beds together. Age, sex, height and weight for each participant are entered into the unit prior to testing, and these parameters were used to determine the individual aortic pressure–area relationship. Aortic pressure is estimated for each heart beat from the integral of the finger arterial pressure wave. Flow is then computed by simulation of the behavior of the model under the applied arterial pressure pulsation. Finally, TPR is computed as the ratio of mean arterial pressure (MAP) to CO, assuming zero venous pressure at the right atrium. The Finometer has been shown to accurately assess absolute blood pressure in young participants (Harrington, Kirjavainen, Teng, & Sullivan, 2001, 2003; Schutte, Huisman, Van Rooyen, Oosthuizen, & Jerling, 2003), and in cardiac patients (Guelen et al., 2003), to a standard meeting the validation criteria of the Association for the Advancement of Medical Instrumentation. Based on these studies, it is recommended for use in clinical settings and for research.

Data analysis

Kolmogorov-Smirnov tests were performed to examine the distribution of continuous variables, with natural log transformations applied to positively skewed, and square root transformations applied to negatively skewed variables. All analyses were carried out using hierarchical multiple regression with demographic variables (age and gender) entered at Step 1, the three-factor main effects (SDR, psychoticism, extraversion, and neuroticism) at Step 2, and support (either network size or
satisfaction) as the criterion variable. As can be seen from comparing Table 3 and Table 4, the inclusion of SDR in the model did not appreciably alter the strength or significance of the other effects; therefore, the model inclusive of SDR is reported in detail. To test interactive effects, the demographic variables were entered at Step 1, with the independent variables at Step 2, and the interaction terms at Step 3. A significant interaction term (i.e., standardized regression coefficient: $\beta$, as well as $R^2$ change) indicates a moderator effect. Effect sizes are presented as adjusted $R^2$, with values indicating the percentage of variance in the criterion variable explained by the predictor(s). Gender was dummy-coded as men = 0, and women = 1. Data were means-centred prior to computing interaction terms. Slight differences in degrees of freedom are as a result of missing data (one woman supplied SSQ-N but not SSQ-S scores).
RESULTS

Descriptive statistics

Table 1 reports the descriptive statistics for psychometric measures, with cross-correlations in Table 2.

Table 1

**Mean scores (with SDs) for personality and social support subscales by gender**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Men (n = 162)</th>
<th>Women (n = 248)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived network size***a</td>
<td>15.22 ± 11.38</td>
<td>28.09 ± 11.28</td>
</tr>
<tr>
<td>Support satisfactionb</td>
<td>30.17 ± 5.00</td>
<td>30.68 ± 4.86</td>
</tr>
<tr>
<td>Extraversion***c</td>
<td>13.26 ± 4.59</td>
<td>15.20 ± 4.67</td>
</tr>
<tr>
<td>Neuroticismd</td>
<td>12.93 ± 5.12</td>
<td>13.66 ± 5.17</td>
</tr>
<tr>
<td>Psychoticism***e</td>
<td>10.11 ± 4.54</td>
<td>6.99 ± 3.62</td>
</tr>
<tr>
<td>Lie score***f (SDR)</td>
<td>8.71 ± 4.70</td>
<td>6.45 ± 3.82</td>
</tr>
</tbody>
</table>

Note: ***p < .001 denotes significant gender differences in scores

a Measured using the N subscale of the SSQ6 (Sarason et al., 1987) with items responses summed to produce a scale ranging from 0 (minimum) to 54 (maximum).
b Measured using the S subscale of the SSQ6 with items responses summed to produce a scale ranging from 6 (minimum) to 36 (maximum).
c Measured using the appropriate subscale of the EPQ-R, with scores ranging from 0 (minimum) to 23 (maximum).
d Measured using the appropriate subscale of the EPQ-R, with scores ranging from 0 (minimum) to 24 (maximum).
e Measured using the appropriate subscale of the EPQ-R, with scores ranging from 0 (minimum) to 32 (maximum).
f Measured using the appropriate subscale of the EPQ-R, with scores ranging from 0 (minimum) to 21 (maximum).
Table 2

Cross-correlations among psychometric variables

<table>
<thead>
<tr>
<th>Measure</th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Perceived network size</td>
<td>-</td>
<td>.16**</td>
<td>.31**</td>
<td>-08</td>
<td>-.28**</td>
<td>-.32**</td>
</tr>
<tr>
<td>2. Support satisfaction</td>
<td>.15**</td>
<td>-.22**</td>
<td>-.05</td>
<td>.10*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Extraversion</td>
<td>-.15**</td>
<td>-.07</td>
<td>-.16**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Neuroticism</td>
<td>.03</td>
<td>-.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Psychoticism</td>
<td>.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Lie score (SDR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

Notes: *p < .05, **p < .01, denote significant correlations between variables

Predictors of perceived network size and support satisfaction

With perceived network size as the criterion variable, age and gender were entered at Step 1, with SDR, extraversion, psychoticism, and neuroticism at Step 2. The model was significant at Step 1, $F(2, 409) = 63.26, p < .001$ accounting for 23% of variance in network size. Gender predicted support such that women reported a larger network size ($\beta = .49, p < .001$). Age was not a significant predictor ($\beta = .02, p = .70$). The model was also significant at Step 2, $F(5, 409) = 33.72, p < .001$, accounting for an additional 9% of variance in network size ($p < .001$) and 32% in total. As shown in Table 4, high extraversion, low psychoticism, and low SDR predicted greater network size; however, the variance explained by these factors was comparatively little. In addition, scrutiny of the beta-weights suggested that SDR in this instance is as strong a predictor of network size as extraversion.
With support satisfaction as the criterion variable, the model was not significant at Step 1, $F(2, 408) = 2.44, p = .09$, with no significant predictors ($\beta = .10, p = .05$ for age; $\beta = .06, p = .20$ for gender). However, the model was significant at Step 2, $F(5, 408) = 6.53, p < .001$, accounting for approximately 8% of the variance in support satisfaction. As shown in Table 4, low neuroticism and high extraversion predicted greater satisfaction. As predicted, high SDR also predicted greater satisfaction.

**Interaction effects**

To test interaction effects between significant predictors, all pertinent two-way interactions (i.e., all two-way interactions between gender, extraversion, psychoticism, and SDR) were added into the final step of the model predicting perceived network size. A significant interaction between gender and SDR was observed at Step 3 ($\beta = .29, p < .001$) indicating that the effect of gender on perceived network size was moderated by SDR. No other significant interactions were observed ($\beta = .01, p = .76$ for psychoticism $[P] \times$ extraversion $[E]$; $\beta = -.24, p = .09$ for SDR $\times$ E; $\beta = .01, p = .92$ for SDR $\times$ P; $\beta = .04, p = .84$ for gender $\times$ E, and $\beta = -.05, p = .70$ for gender $\times$ P).

To determine the nature of this interaction, a graph was plotted, and the analysis was re-run separately by gender. Age was entered at Step 1, with the main effects of extraversion, neuroticism, psychoticism, and SDR at Step 2. Breaking down the analysis by gender revealed that this effect was significant for men ($\beta = -.48, p < .001$), accounting for 30% of variance, but not for women ($\beta = .006, p = .93$). Figure 1 indicates that for men, high SDR was associated with smaller network size, while there was no difference in network size for women high and low on SDR.
For support satisfaction, we chose not to examine moderating effects of SDR on age for several reasons. Firstly, age did not independently predict satisfaction when SDR was included in the model as an independent predictor, and secondly, notwithstanding the significant age difference between men and women, the majority of the sample fell within a restricted age range making any effects observed difficult to interpret. This strategy further reduced the number of statistical tests performed on the data. Therefore, the final step included SDR × E and SDR × neuroticism (N) interaction terms. Neither term was significant ($\beta = -.02, p = .67$ for SDR × E, and $\beta = .03, p = .60$ for SDR × N), indicating that SDR did not moderate the effect of personality on support satisfaction.

*Figure 1.* Graph of perceived network size for men and women high/low in SDR (based on median split of SDR data for illustration purposes only [for males, $n = 73$ low; $n = 89$ high; for females, $n = 155$ low; $n = 93$ high]; error bars denote standard error of the mean)
Table 3

*Summary of regression analyses predicting support variables (N = 410)*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Perceived network size</th>
<th>Support satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>SE</td>
</tr>
<tr>
<td>(Constant)</td>
<td>16.38</td>
<td>.91</td>
</tr>
<tr>
<td>Age</td>
<td>.11</td>
<td>.11</td>
</tr>
<tr>
<td>Gender</td>
<td>10.96</td>
<td>1.21</td>
</tr>
<tr>
<td>Extraversion</td>
<td>.58</td>
<td>.12</td>
</tr>
<tr>
<td>Psychoticism</td>
<td>-.34</td>
<td>.14</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>-.17</td>
<td>.11</td>
</tr>
</tbody>
</table>

Notes: $\Delta R^2 = 30\%$ for perceived network size; $\Delta R^2 = 8\%$ for support satisfaction
Table 4

Summary of regression analyses including SDR as a predictor of support variables (N = 410)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Perceived network size</th>
<th>Support satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>SE</td>
</tr>
<tr>
<td>(Constant)</td>
<td>17.13</td>
<td>.90</td>
</tr>
<tr>
<td>Age</td>
<td>.17</td>
<td>.11</td>
</tr>
<tr>
<td>Gender</td>
<td>9.71</td>
<td>1.22</td>
</tr>
<tr>
<td>SDR</td>
<td>-.57</td>
<td>.13</td>
</tr>
<tr>
<td>Extraversion</td>
<td>.53</td>
<td>.12</td>
</tr>
<tr>
<td>Psychoticism</td>
<td>-.39</td>
<td>.13</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>-.18</td>
<td>.10</td>
</tr>
</tbody>
</table>

Notes: $\Delta R^2 = 33\%$ for perceived network size; $\Delta R^2 = 9\%$ for support satisfaction
Follow-up analyses

Finally, we conducted analyses to determine whether individual traits remained predictive of support when the other personality variables were not controlled for. We ran a series of regressions for men and for women, with age entered at Step 1, the predictor trait (e.g., extraversion) at Step 2, and perceived network size/support satisfaction as criterion variables. The findings (summarized in Table 5) indicated that all predictors maintained significance in these analyses, with the exception of psychoticism, which was not a predictor of network size for either men or women when the effects of extraversion, neuroticism, and SDR were not accounted for.

Resting cardiovascular levels

The next analyses aimed to determine whether the effects of support on physical health might be accounted for by links between support and personality utilizing the subsample of 145 women for whom cardiovascular data were obtained. Cronbach’s α values were generally reliable for this subsample; α = .89 for SSQ-N, .84 for SSQ-S, .84 for extraversion, .84 for neuroticism, and .69 for psychoticism. Mean scores and cross-correlations are reported in Table 6 and Table 7. Neither age (all ps ≥ .09) nor BMI (all ps ≥ .64) were correlated with any cardiovascular measure. Data checks indicated that one participant completed the SSQ-N but not the SSQ-S items of the SSQ6. This participant was removed leaving a final sample of 144 participants. To compare the variance explained by support and personality, social support (i.e., SSQ-N and SSQ-S) or personality (i.e., psychoticism, extraversion, and neuroticism) was entered into the second step of the respective analyses, producing
Table 5

*Summary of regression analyses predicting social support variables for men (n = 162) and women (n = 248)*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Perceived network size</th>
<th>Support satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>SE</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>B</strong></td>
<td>SE</td>
</tr>
<tr>
<td>(1) Age</td>
<td>.14</td>
<td>.14</td>
</tr>
<tr>
<td>E</td>
<td>.60</td>
<td>.19</td>
</tr>
<tr>
<td>(2) Age</td>
<td>.11</td>
<td>.15</td>
</tr>
<tr>
<td>N</td>
<td>-.21</td>
<td>.18</td>
</tr>
<tr>
<td>(3) Age</td>
<td>.14</td>
<td>.15</td>
</tr>
<tr>
<td>P</td>
<td>-.35</td>
<td>.20</td>
</tr>
<tr>
<td>(4) Age</td>
<td>.20</td>
<td>.13</td>
</tr>
<tr>
<td>SDR</td>
<td>-1.19</td>
<td>.17</td>
</tr>
</tbody>
</table>

Notes: *p < .05, **p < .01, ***p < .001, for network size, and for men; ΔR² = 5% for extraversion and 23% for SDR; for women, ΔR² = 6% for extraversion and 1% for neuroticism. For support satisfaction, and for men; ΔR² = 7% for neuroticism and 4% for SDR; for women, ΔR² = 3% for extraversion and 3% for neuroticism.
two sets of regressions. Additional regressions were performed to determine whether support predicted unique variance in cardiovascular levels when personality was controlled for. For these, control variables were entered into the first step, personality in the second step, and support in the final step. Following the procedure by Baron and Kenny (1986), formal tests of mediation were then performed to determine whether links between support and cardiovascular levels were mediated by personality.

Multicollinearity of the predictors was analysed here using tolerance statistics and the variance inflation factor (VIF). Tolerance statistics less than .20 and/or VIF of 5 and above indicate a multicollinearity problem (O’Brien, 2007). In the present study, the tolerance statistics for the psychometric variables ranged from .48 to .93, with the VIF ranging from 1.08 to 2.11, indicating that there were no problems with multicollinearity. Controlling for SDR in cardiovascular analyses did not alter the magnitude or direction of the findings; as such, these are reported exclusive of SDR.

**Systolic blood pressure**

For the first series of multiple regressions, control variables (as outlined above) were entered into the first step, followed by the personality variables entered into the second step. For SBP, the overall model accounted for only 2% of variance and was not significant at Step 1, $F(4, 143) = 0.60, p = .67$, showing that the control variables did not influence SBP ($\beta = .11, p = .22$ for age; $\beta = -.02, p = .81$ for BMI; $\beta = .06, p = .57$ for anxiety, and $\beta = -.08, p = .44$ for depression). After entering the personality variables of neuroticism, extraversion and psychoticism at Step 2, the overall model was not significant, $F(7, 143) = 1.63, p = .13$. The addition of Step 2 itself was significant ($p = .03$), accounting for an additional 6% of variance.
Table 6

*Means (with SDs) for cardiovascular and psychometric variables (n = 144 women)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP (mmHg)</td>
<td>118.26</td>
<td>11.24</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>71.24</td>
<td>8.51</td>
</tr>
<tr>
<td>HR (bpm)</td>
<td>81.13</td>
<td>11.35</td>
</tr>
<tr>
<td>Anxiety&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.82</td>
<td>3.50</td>
</tr>
<tr>
<td>Depression&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.09</td>
<td>2.50</td>
</tr>
<tr>
<td>Extraversion&lt;sup&gt;b&lt;/sup&gt;</td>
<td>15.97</td>
<td>4.45</td>
</tr>
<tr>
<td>Neuroticism&lt;sup&gt;c&lt;/sup&gt;</td>
<td>13.51</td>
<td>5.30</td>
</tr>
<tr>
<td>Psychoticism&lt;sup&gt;d&lt;/sup&gt;</td>
<td>6.22</td>
<td>3.37</td>
</tr>
<tr>
<td>Number of supports&lt;sup&gt;e&lt;/sup&gt;</td>
<td>29.55</td>
<td>11.20</td>
</tr>
<tr>
<td>Satisfaction with support&lt;sup&gt;f&lt;/sup&gt;</td>
<td>30.29</td>
<td>5.28</td>
</tr>
</tbody>
</table>

<sup>a</sup>Measured using the appropriate subscale of the HADS, with scores ranging from 0 (minimum) to 21 (maximum).

<sup>b</sup>Measured using the appropriate subscale of the EPQ-R, with scores ranging from 0 (minimum) to 23 (maximum).

<sup>c</sup>Measured using the appropriate subscale of the EPQ-R, with scores ranging from 0 (minimum) to 24 (maximum).

<sup>d</sup>Measured using the appropriate subscale of the EPQ-R, with scores ranging from 0 (minimum) to 32 (maximum).

<sup>e</sup>Measured using the N subscale of the SSQ6 (Sarason et al., 1987) with items responses summed to produce a scale ranging from 0 (minimum) to 54 (maximum).

<sup>f</sup>Measured using the S subscale of the SSQ6 with items responses summed to produce a scale ranging from 6 (minimum) to 36 (maximum).
Table 7

*Cross-correlations among age and psychometric variables (n = 144 women)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
<th>7.</th>
<th>8.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Age</td>
<td>-</td>
<td>-</td>
<td>-.36**</td>
<td>+.19*</td>
<td>-.08</td>
<td>+.24**</td>
<td>+.15**</td>
<td>-.002</td>
</tr>
<tr>
<td>2. Extraversion</td>
<td>-</td>
<td>-</td>
<td></td>
<td>+.09</td>
<td>-.19*</td>
<td>-.28**</td>
<td>+.24**</td>
<td>+.15</td>
</tr>
<tr>
<td>3. Neuroticism</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+.09</td>
<td>+.66**</td>
<td>+.42**</td>
<td>-.17*</td>
<td>-.21*</td>
</tr>
<tr>
<td>4. Psychoticism</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+.15</td>
<td>+.29**</td>
<td>-.19*</td>
<td>-.01</td>
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<tr>
<td>5. Anxiety</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+.51**</td>
<td>-.23**</td>
<td>-.18*</td>
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<tr>
<td>6. Depression</td>
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<td>-</td>
<td>-</td>
<td>-.32**</td>
<td>-.26**</td>
</tr>
<tr>
<td>7. Number of supports</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+.27**</td>
</tr>
<tr>
<td>8. Satisfaction with support</td>
<td>-</td>
<td>-</td>
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<td>-</td>
<td>-</td>
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</tr>
</tbody>
</table>

Notes: * p < .05, ** p < .01, denote significant inter-correlations between variables
Extraversion was a significant predictor at this step ($\beta = -.25, p = .008$); neither neuroticism ($\beta = -.04, p = .71$) nor psychoticism ($\beta = .14, p = .11$) were predictors, and no control variables were significant at this step ($\beta = .04, p = .63$ for age; $\beta = -.04, p = .60$ for BMI; $\beta = .08, p = .48$ for anxiety, and $\beta = -.18, p = .09$ for depression). As such, our hypothesis that personality would predict resting SBP was confirmed for extraversion.

For the second series of multiple regressions, the same control variables as outlined above were entered in the first step, with social support variables entered in the second step. Step 2 was not significant ($p = .10$), accounting for an additional 3% of variance over the control variables; nor was the overall model significant at Step 2, $F(6, 143) = 1.20, p = .31$. Scrutiny of the individual predictors indicated that high support satisfaction predicting reduced resting SBP ($\beta = -.19, p = .03$) while number of supports did not ($\beta = .02, p = .85$). None of the control variables were significant at this step ($\beta = .14, p = .12$ for age; $\beta = -.02, p = .86$ for BMI; $\beta = .04, p = .70$ for anxiety, and $\beta = -.12, p = .26$ for depression).

For the final series of regressions, the control variables were entered in the first step as before, with personality entered into the second step, and social support variables at the third step. The model for SBP was not significant at Step 1, $F(4, 143) = 0.60, p = .67$, at Step 2, $F(7, 143) = 1.63, p = .13$, or at Step 3, $F(9, 143) = 1.85, p = .07$. Step 3 was not significant ($p = .09$) accounting for an additional 3% of variance. Scrutiny of the overall model at Step 3 indicated that support satisfaction significantly predicted SBP when personality was accounted for ($\beta = -.90, p = .03$), while extraversion remained a robust predictor at the final step ($\beta = -.24, p = .01$). Therefore, the support–SBP link was not explained by the association between SBP and personality. None of the other variables were significant at Step 3 ($\beta = .08, p =$
Chapter 2. Support, personality, and resting cardiovascular levels

.40 for age; β = -.04, p = .62 for BMI; β = .09, p = .47 for anxiety; β = -.20, p = .06 for depression; β = .17, p = .06 for psychoticism; β = -.07, p = .59 for neuroticism; and β = .08, p = .39 for number of supports).

Diastolic blood pressure

For DBP, control variables were entered into the first step, followed by the personality variables entered into the second step. The overall model was not significant at Step 1, \( F(4, 143) = 1.01, p = .40 \), or at Step 2, \( F(7, 143) = 1.29, p = .26 \). No significant predictors were observed at Step 1 (β = .14, p = .12 for age; β = -.04, p = .61 for BMI; β = .07, p = .48 for anxiety, and β = -.10, p = .33 for depression), with 3% of variance accounted for. However, psychoticism emerged as a significant predictor within the model such that individuals high in trait psychoticism had elevated resting DBP (β = .20, p = .03), with this non-significant step (\( p = .18 \)) accounting for an additional 3% of variance. No other significant predictors were observed at this step (β = .15, p = .11 for age; β = -.04, p = .63 for BMI; β = .04, p = .74 for anxiety; β = -.17, p = .11 for depression; β = -.05, p = .63 for extraversion; and β = .04, p = .72 for neuroticism).

For the second regression, the same control variables were entered in the first step, with social support variables entered in the second step. The overall model was not significant at Step 2, \( F(6, 143) = 0.83, p = .55 \); nor was the addition of Step 2 significant (\( p = .63 \)) accounting for less than 1% of additional variance. There were no significant predictors of DBP (β = .15, p = .09 for age; β = -.04, p = .64 for BMI; β = .06, p = .54 for anxiety; β = -.12, p = .26 for depression; β = -.001, p = .99 for SSQ-N; and β = -.09, p = .35 for SSQ-S).
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For the final DBP regression, the control variables were entered in the first step as before, with personality entered into the second step. Social support variables were entered in the third step. The model was not significant at Step 1, $F(4, 143) = 1.01, p = .40$, at Step 2, $F(7, 143) = 1.29, p = .26$, or at Step 3, $F(9, 143) = 1.15, p = .34$. Scrutiny of the overall model indicated that psychoticism remained a robust predictor at the final step ($\beta = -.21, p = .02$), while no other variables predicted DBP ($\beta = .17, p = .08$ for age; $\beta = -.04, p = .65$ for BMI; $\beta = .04, p = .75$ for anxiety; $\beta = -.18, p = .09$ for depression; $\beta = -.04, p = .70$ for extraversion; $\beta = .03, p = .80$ for neuroticism; $\beta = .03, p = .76$ for number of supports, and $\beta = -.10, p = .25$ for support satisfaction).

Heart rate

For HR, again, the first series of multiple regressions included control variables in the first step, followed by the personality variables entered into the second step. The overall model was not significant at Step 1, $F(4, 143) = 1.30, p = .27$, with 4% of variance explained. Anxiety significantly predicted lower HR ($\beta = -.20, p = .046$). No other variables were significant at this step ($\beta = -.02, p = .81$ for age; $\beta = .04, p = .67$ for BMI; and $\beta = .04, p = .67$. After entering the personality variables at Step 2, the overall model did not predict resting HR, $F(7, 143) = 0.76, p = .63$. Contrary to our prediction, no significant predictors were observed at this step ($\beta = -.03, p = .75$ for age; $\beta = .03, p = .72$ for BMI; $\beta = -.17, p = .16$ for anxiety; $\beta = -.05, p = .67$ for depression; $\beta = -.02, p = .83$ for extraversion; $\beta = -.02, p = .86$ for psychoticism, and $\beta = -.04, p = .72$ for neuroticism).

For the second regression, the control variables were entered into the first step, with the social support variables entered into the second step. Neither Step 2 ($p = .05$)
nor the overall model at Step 2 was significant, $F(6, 143) = 1.91, p = .08$. Anxiety was a significant predictor at this step ($\beta = -.22, p = .03$); no other control variables were significant ($\beta = -.02, p = .85$ for age; $\beta = -.04, p = .60$ for BMI; and $\beta = -.01, p = .96$ for depression). At Step 2, number of supports predicted resting HR, ($\beta = -.22, p = .02$), such that high number of supports was associated with lower resting HR. Support satisfaction did not predict HR ($\beta = .06, p = .52$). This was not entirely consistent with the findings of Hughes and Howard (2009) that support satisfaction, not number of supports, predicted resting HR, but was consistent with the general hypothesis that support would predict lower resting HR.

The final regression included control variables in the first step, personality in the second step, and social support variables in the third step. The model was not significant at Step 1, $F(4, 143) = 1.30, p = .27$, Step 2, $F(7, 143) = 0.76, p = .63$, or at Step 3, $F(9, 143) = 1.29, p = .25$, however, number of supports predicted resting HR at Step 3, ($\beta = -.23, p = .02$), with this step ($p = .05$) accounting for approximately 4% of variance. Therefore, controlling for trait personality did not account for the association between number of supports and lower resting HR. No other variables predicted HR ($\beta = -.01, p = .88$ for age; $\beta = .04, p = .61$ for BMI; $\beta = -.20, p = .10$ for anxiety; $\beta = .02, p = .89$ for depression; $\beta = .02, p = .82$ for extraversion; $\beta = -.05, p = .59$ for psychoticism; $\beta = -.03, p = .80$ for neuroticism, and $\beta = .06, p = .52$ for support satisfaction). A summary of the final models for SBP, DBP, and HR is outlined in Table 8. These associations held regardless of whether or not anxiety and depression were controlled for.

Formal mediation analyses were then conducted to confirm that these associations were not mediated by personality. In order to demonstrate mediation, a number of conditions must be met; (1) the predictor variable must affect the mediator;
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(2) the predictor variable must affect the criterion variable; (3) the mediator affects the criterion variables when the predictor variable is controlled for, and (4) full mediation is confirmed when the association between the predictor variable and the criterion variable is reduced to non-significance after the effect of the mediator is controlled for (Baron & Kenny, 1986).

Social support as a predictor of personality

First, we formally tested the condition that social support would predict personality for this subsample. Extraversion was regressed onto number of supports and support satisfaction. The overall model was significant, $F(1, 143) = 4.74, p = .01$, accounting for 6% of variance. Consistent with the bivariate associations in Table 2, number of supports was a significant predictor ($\beta = .21, p = .01$); support satisfaction was not ($\beta = .09, p = .28$). Next, neuroticism was regressed onto number of supports and support satisfaction. The overall model was significant, $F(1, 143) = 4.15, p = .02$, accounting for 4% of variance. Support satisfaction was a significant predictor ($\beta = -.17, p = .04$); network support was not ($\beta = -.12, p = .16$). Finally, psychoticism was regressed onto number of supports and support satisfaction. The overall model was not significant, $F(1, 143) = 2.65, p = .07$, accounting for 4% of variance. Number of supports was a significant predictor ($\beta = -.06, p = .02$); network support was not ($\beta = .30, p = .59$). As such, condition 1 was met for number of supports and extraversion, number of supports and psychoticism, and support satisfaction and neuroticism. Therefore, neuroticism was tested as a mediator of the satisfaction–SBP link, and extraversion and psychoticism tested as mediators of the number of supports–HR link. The beta weight for support predictors was not reduced in any of the three analyses. Therefore, neither full nor partial mediation was indicated.
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Tests of interaction effects

Finally, an equivalent set of regression analyses was conducted including the control variables, the individual predictors and also all two-way interactions between predictor variables, (namely, number of supports, support satisfaction, extraversion, neuroticism, and psychoticism); however, no significant effects were observed for any of the cardiovascular measures.

Other cardiovascular variables

Corresponding analyses for CO and TPR revealed no significant psychosocial or personality predictors of these variables.

DISCUSSION

The present study examined the extent to which naturalistic social support is reflective of trait personality using Eysenck’s three–factor model of extraversion, neuroticism, psychoticism, and the lie scale. Contrary to expectations, only a small proportion of variance in naturalistic support was accounted for by trait personality. Extraversion predicted network support while neuroticism predicted support satisfaction as expected. However, the relatively small proportion of variance explained suggests that naturalistic support measures are not substantially reflective of a dispositional characteristic, or at least, not one captured well by the three–factor model. This is consistent with Marshall et al.’s (1994) assertion that broad and narrow measures provide complementary frames of references and validates the use of perceived social support instruments over broad measures of personality. Notably, the
Table 8

Summary of hierarchical multiple regression models (control variables, personality, and social support) predicting resting SBP, DBP, and HR

(n = 144 women)

<table>
<thead>
<tr>
<th></th>
<th>Systolic blood pressure</th>
<th>Diastolic blood pressure</th>
<th>Heart rate</th>
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<tbody>
<tr>
<td></td>
<td>B</td>
<td>SE B</td>
<td>β</td>
</tr>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>.62</td>
<td>.73</td>
<td>.08</td>
</tr>
<tr>
<td>BMI</td>
<td>-.14</td>
<td>.28</td>
<td>-.04</td>
</tr>
<tr>
<td>Anxiety</td>
<td>.27</td>
<td>.38</td>
<td>.09</td>
</tr>
<tr>
<td>Depression</td>
<td>-.90</td>
<td>.47</td>
<td>-.20</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extraversion</td>
<td>-.61</td>
<td>.24</td>
<td>-.24</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>-.14</td>
<td>.24</td>
<td>-.07</td>
</tr>
<tr>
<td>Psychoticism</td>
<td>.56</td>
<td>.29</td>
<td>.17</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Number supports</td>
<td>.08</td>
<td>.09</td>
<td>.08</td>
</tr>
<tr>
<td>Support satisfaction</td>
<td>-.41</td>
<td>.19</td>
<td>-.19</td>
</tr>
</tbody>
</table>
findings are not inconsistent with the stress-and-coping perspective on perceived social support.

Nonetheless, the findings highlighted some concerns in the overlap between personality and naturalistic support. For men, SDR revealed main effects on network size and support satisfaction such that those high in SDR reported smaller networks and higher satisfaction. The idea that smaller social networks are desirable might seem counter-intuitive given that having a large network might indicate positive characteristics such as popularity or sociability. However, the SSQ items tap into support for incidences of distress, for example, being “down in the dumps”, that might be considered particularly susceptible to impression management concerns. In essence the items reflect not only general support availability, but admissions of distress. Consistent with the notion that reporting high support can indicate need for support and by implication, high stress, over one-fifth of the variance in men’s network size accounted for by SDR. This suggests, but does not unambiguously imply that men may have responded to the SSQ items in this context. It may also be true that men high in impression management depict themselves as independent, competent, successful, and un-need of support, reflecting the stereotypical male preference for autonomy, and therefore find themselves with smaller support networks. Importantly, women did not demonstrate this variation in network size contingent on impression management, perhaps reflecting tendencies to observe support as normative or neutral rather than especially positive or negative. However, there were no gender differences in SDR effects on satisfaction, with SDR related to higher satisfaction for both men and women.

Notably, the relatively strong and robust effect of SDR on network size suggests that theories linking well-studied traits such as extraversion to social
interaction might be better placed to examine the extent to which various types of social contact are perceived as desirable. Nonetheless, controlling for SDR in this instance did not alter the contribution of personality to social support. This concurs with theories suggesting that SDR or impression management specifically is not so much reflective of a response style that must be partialled out but a personality characteristic in itself. This also confirms that trait personality, in the traditional sense, is relevant to individual variability in perceived support. While it is also possible that these associations reflect differences in actual support levels attributable to personality, the fact remains that should a given social support measure be found to overlap substantially with broad personality traits, that measure might be redundant regardless of the mechanisms by which the broad and narrow instruments are linked.

The present study also corroborates work implicating social support with reduced resting cardiovascular levels and suggests that these links are independent of individual differences in personality. Consistent with many studies reporting effects for cardiac rather than vascular aspects of cardiovascular arousal (e.g., Kamarck, Manuck, & Jennings, 1990), effects for SBP and HR, but not for DBP, were identified. Satisfaction with social support predicted lower resting SBP while network size predicted lower HR. Prior work has associated support satisfaction rather than network size with resting SBP and HR in women. However, the different confounds included in this and the Hughes and Howard (2009) study mean that these are not strictly comparable, which may partly explain the varying effects. Previous reviews of cross-sectional data have revealed no differences in structural and functional links with cardiovascular regulation (Uchino et al., 1996) and the distinct pathways by which these might lead to well-being are unclear. One possibility is that demographic differences between cohorts moderate the importance of structural and functional
indices for health; for example, network size may be more important to younger compared with older cohorts (Carstensen, 1992; Wrzus, Hanel, Wagner, & Neyer, 2012). Notwithstanding this complexity, the data confirm that social support generally demonstrated significant associations with SBP and HR in the expected direction, even in a relatively small sample. It is also notable that for the most part, anxiety and depression failed to demonstrate significant associations with cardiovascular measures in this study. However, as the sample was relatively homogenous in terms of age and BMI, and displayed non-clinical levels of anxiety and depression, associations between these and cardiovascular variables might be more difficult to detect. It is further worth noting that the support effects observed remained when the data were re-analyzed excluding anxiety and depression as control variables. However, the analyses for CO and TPR revealed no links with either perceived network size or support satisfaction.

As well as corroborating previous research, the current findings indicate that the support–SBP and support–HR links were not mediated by personality. As the personality model, or more specifically, extraversion, also explained variance in SBP, it appears that support and personality have unique pathways to health. However, in the current sample, network support, the support index considered to overlap with extraversion, did not predict resting SBP. Therefore, it is perhaps unsurprising that controlling for extraversion did not eliminate the link observed between support satisfaction and SBP. The likelihood remains that extraversion may underlie support–well-being associations where network or structural support are predictors. Of course, these findings also indicate that extraversion predicts SBP independent of both network and functional support. Previous work has linked extraversion with decreased mortality risk (Shipley et al., 2007; Wilson et al., 2005) and has suggested that
extraversion is related to lower sympathetic nervous system activity (Miller, Cohen, Rabin, Skoner, & Doyle, 1999), although the mechanisms underlying this link remain uncertain. Nonetheless, it is notable that extraversion accounted for greater variance in SBP than either gender or social support did in prior work (Hughes & Howard, 2009), signifying that personality has an important role in physiological functioning.

The findings of the current study also implicate psychoticism in well-being, with individuals high in psychoticism displaying elevated resting DBP. Previous work has suggested a complex role of psychoticism in CVD. For example, in a population-based study of over 4,000 participants, Stürmer, Hasselbach, and Amelang (2006) reported that high and low psychoticism, that is, extreme scores on this trait, predicted incidence of MI at an 8.5 year follow-up, while high psychoticism was associated with reduced risk of stroke. Individuals high in psychoticism are also thought to experience greater number of negative life events (Pickering et al., 2003), which may result in elevated physiological function in comparison to individuals experiencing low stress, or alternatively, lower arousal levels owing to habituation to recurring stress. Studies examining resting blood pressure specifically are equivocal, with one study sampling a Japanese cohort (using a Japanese version of the EPQ) indicating that psychoticism is unrelated to self-measured resting blood pressure (Hozawa et al., 2002), while Coelho et al. (1999) reported that lower psychoticism was related to lower ambulatory blood pressure in white-coat hypertensives. As such, methodological differences may account for the mixed links between psychoticism and blood pressure. While the present findings suggest that psychoticism warrants further empirical attention, the relatively low reliability of the P subscale indicates that the results must be interpreted with caution.
Chapter 2. Support, personality, and resting cardiovascular levels

Following previous studies of resting levels, the present study evaluated psychometrically-assessed rather than laboratory-manipulated social support. In one study to manipulate support, Grewen, Girdler, Amico, and Light (2005) measured resting levels before and after warm contact with one’s spouse, however, their statistical analyses focused on the link between psychometrically-assessed support and resting levels post-contact. Although data on laboratory-manipulated support effects on resting levels is somewhat scant, psychometric assessments are more closely aligned with the measures employed in epidemiological studies reporting links between support and CVD, and in this sense are particularly useful. Nonetheless, additional work addressing manipulated effects on resting levels might shed further light on the implications of support for cardiovascular function.

A limitation of the present study is its cross-sectional nature, which impedes cause-and-effect conclusions about the findings. Further limitations include the caveats applied to measures of SDR in general (Uziel, 2010), including the fact that measures of SDR are not uniquely sensitive to changes in the demand for self-presentation, with other personality traits also susceptible to bias. Moreover, the sample comprised undergraduate students; therefore the findings may not be generalizable to other populations. Particularly, the use of a healthy, non-smoking, non-hypertensive subsample for cardiovascular analyses precludes the extension of these findings to less healthy groups, such as individuals exhibiting clinically-elevated blood pressure. Given the well-documented gender differences in both social support (e.g., Neff & Karney, 2005; Turner, 1994) and personality (e.g., Feingold, 1994), we are prohibited from generalizing the present findings to men. However, the use of the student sample ensures that the findings are applicable to the many studies which use
psychometric assessments of support in such samples (e.g., Allgower, Wardle, & Steptoe, 2001; Haden, Scarpa, Jones, & Ollendick, 2007).

In conclusion, the present study indicates that only moderate variance in a measure of naturalistic support is accounted for by broad personality traits, and that naturalistic support predicts resting cardiovascular levels when personality is controlled for. Thus, as naturalistic support appears not to reflect trait personality, it seems that considering naturalistic support as individual differences in personality may not be a valid conceptualization. Substantial literature indicates that receiving support can be disadvantageous, but it as yet remains unclear what aspects of naturalistic support are or are not constructive. A possibility outlined in Chapter 1 is that the benefits of reporting support are confounded with the perception of embeddedness in a network of mutual obligation. To test this hypothesis, the next chapter aims to investigate whether support provision, support receipt, and neutral social contact differentially influence a key aspect of the cardiovascular stress responses, namely, cardiovascular recovery from an acute stressor. By comparing support receipt and support provision effects, we can compare support receipt with embeddedness, and by comparing these groups with the control group, we can determine whether receipt is more beneficial than non-supportive social contact.
Chapter 3: STUDY 2

CARDIOVASCULAR RESPONSES TO MENTAL ACTIVATION OF SOCIAL SUPPORT SCHEMAS

INTRODUCTION

Most early studies examining the impact of support assessed the effects of actual support provided by a confederate or friend, with only one study manipulating availability of support by modifying the instructions supplied by the experimenter (Uchino & Garvey, 1997). This manipulation might have depended on numerous contextual characteristics such as the perceived supportiveness of a stranger rather than a typical relationship tie relied on for support in everyday life. As a result, even this paradigm may have failed to capture the internal representations of support, or support schemas, which might be considered analogous to the aspect of support that enhances health in naturalistic settings. While extensive research has described individual differences in support schemas (e.g., Lakey et al., 1996) much less has attempted to invoke these cognitive structures to examine their effects on cardiovascular responses. However, to do so might provide a more ecologically valid approximation of naturalistic support than does manipulating support from a stranger or confederate. Moreover, thoughts of support provision may be similarly activated, thereby facilitating comparisons between internal representations of support provision and receipt.

Using structured writing tasks (whereby an individual responds to questions designed to activate thoughts of a supportive tie), three studies have found that activating thoughts of a supportive tie prior to laboratory stress attenuates CVR to that stressor, in comparison to the activation of a control schema (Gramer & Reitbauer, 2010; Ratnasingam & Bishop, 2007; Smith, Ruiz, & Uchino, 2004). Smith et al. (2004) also found that this advantage was confined to individuals low in hostility, while Gramer and Reitbauer (2010) found it restricted to stressor CVR with no effects for recovery, though it is possible that the effects of the intervention dissipated by the time the stressor was completed. The collective work indicates that the mental activation of support may have beneficial effects in the absence of actually received support. However, these studies have compared the activation of support receipt with the activation of non-supportive social contact. As such, it is not clear whether CVR is influenced by the activation of support receipt specifically, or the activation of thoughts of embeddedness, hypothesized by Rook (1990b) to be more critical than specific support acts. In addition, the potential for mentally–activated support to assist post-stressor recovery is unclear. Finally, despite theoretical and empirical work describing support provision as beneficial, the possibility that mentally–activated support provision influences cardiovascular responsivity has not been explored.

Studies examining cardiovascular responses to live support provision have yielded positive results. In an ambulatory study, Piferi and Lawler (2006) reported that the tendency to give social support was a significant predictor of lower ambulatory SBP, DBP, and HR, while received support was a significant predictor of lower SBP only. Consistent with esteem–enhancement theory (Batson, 1998), the authors postulated that support provision might increase self-efficacy, thereby decreasing stress and resulting in lower, more healthful levels cardiovascular function.
In a laboratory study, Nealey, Smith, and Uchino (2002) found that providing support evoked larger increases in cardiac sympathetic activation and reduced vascular resistance. Of course, these results must be contextualized within the literature suggesting beneficial effects primarily for individuals who are not undergoing stress themselves (Capistrant, Moon, & Glymour, 2012; Haley, Roth, Howard, & Safford, 2010; Pinquart & Sörensen, 2007).

Examination of support provision and receipt must also account for an important individual difference variable relevant to both. Hostility involves a core emotional component of anger, in addition to behavioural (e.g., aggression) and cognitive (e.g., cynicism, mistrust, suspiciousness) components (Williams, 2010), and has been established as an important risk factor for CVD (Everson et al., 1997). Several studies indicate that hostile persons display low levels of social support and high levels of social conflict (Houston & Kelly, 1989; Scherwitz, Perkins, Chesney, & Hughes, 1991; Smith & Frohm, 1985), with others reporting that high hostiles do not derive the usual cardiovascular benefits from laboratory-based support (Chen, Gilligan, Coups, & Contrada, 2005), displaying exaggerated CVR to self-disclosure (Christensen & Smith, 1993), support provision, and receipt (Holt-Lunstad, Smith, & Uchino, 2008). These findings may be attributable to a mismatch between hostile personality and situational demands, posited to result in exaggerated cardiovascular responsivity (Davis & Matthews, 1996).

The present study sought to examine whether mentally–activated support might enhance cardiovascular recovery from acute stress. A number of methodological refinements on previous studies were incorporated. In addition to the support receipt and social contact groups, a support provision group was included. This facilitated the segregation of support receipt specifically from involvement in a
network of mutual obligation, while enabling the verification of support provision as physiologically taxing or beneficial. As previous work has generally focused on how support schemas affect cardiovascular arousal during the experience of mental stress, the extent to which the effects of support schemas persist after stress is unclear. As such, we focus on cardiovascular arousal during the recovery period immediately following stress. By doing so, we sought to ascertain whether support schema activation would be successful in enhancing an individual’s well-being after a stressful event, thereby more closely approximating the temporal sequence of everyday support–provision (in which supporters typically offer social support in response to witnessing the individual’s exposure to stress).

We hypothesized that participants exposed to the support provision manipulation would display elevated post-stressor responses in comparison to support recipients or control participants, consistent with theories describing support provision as detrimental when the provider is already burdened. We predicted that recipient and control groups would display decreasing responses, with no additional advantage for recipients, consistent with the hypothesis and findings of Gramer and Reitbauer (2010) that the benefits of mentally–activated support are confined to CVR to stressors. Based on the task–personality mismatch between support and hostility, we predicted that high hostile participants in the support groups would display particularly exaggerated responses, while hostility would be unrelated to responses in the control group. Finally, as post-stressor CVR is considered vascular in nature (Gregg, James, Matyas, & Thorsteinsson, 1999) and as schema-based support is likely to elicit coping of a passive (rather than active) nature (Sherwood & Turner, 1992), we expected that changes in gross cardiovascular responses would be largely driven by underlying changes in TPR. If substantiated, such mechanisms may help explain
why support provision under stress appears to elevate the risk of adverse health outcomes (Capistrant, Moon, Berkman, & Glymour, 2011; Capistrant et al., 2012). Moreover, should support provision and receipt show comparable effects on recovery, this may validate Rook’s (1990b) hypothesis that embeddedness rather than support is critical for well-being.

**METHODS**

*Participants*

Participants were 72 healthy women aged 17 to 27.17 years ($M = 19.96, SD = 1.98$) underwent laboratory-based cardiovascular monitoring. All were free from personal history of hypertension or heart disease, with BMI ranging between 16.73 and 38.67 ($M = 23.19, SD = 3.71$). Smokers were included ($n = 15$) as were oral contraceptive (OC) users ($n = 3$, none of whom were also smokers). While debate persists over the influence of smoking and OC use on CVR (Davis, 1999; Hughes & Higgins, 2010; Phillips, Der, Hunt, & Carroll, 2009; Schallmayer & Hughes, 2010; Ward, Swan, Jack, & Javitz, 1994), there were no differences in CVR between OC users and non-users, or smokers and non-smokers, in the present sample.

Participants were recruited via announcements placed on an online participant pool management system to which relevant undergraduate students (i.e., those for whom research participation is a Psychology course component) have access. Each signed up to attend a briefing session during which the protocol was outlined and demographic data collected. In addition, participants completed a battery of questionnaire measures including an assessment of trait hostility. Participation was voluntary and all participants provided informed consent.
To ensure randomization, participants were assigned to groups by providing each with a sealed envelope. This contained task instructions for one of the three groups, and was randomly drawn from a pre-arranged supply. As such, the experimenter was blinded to the group assignment until the experimental session had been completed.

**Hostility assessment**

Hostility was measured using the Cook-Medley Hostility Scale (CMHS; W. W. Cook & Medley, 1954), a 50-item true–false instrument assessing the cognitive-experiential dimensions of hostility, which has good internal consistency (Cronbach’s $\alpha = .84$ for the current sample) and test-retest reliability (Smith & Frohm, 1985). The mean score for this sample was 12.68 ($SD = 5.45$).

**Cardiovascular assessment**

Beat-to-beat cardiovascular measures were recorded using a Finometer haemodynamic monitor, the specifications and validity of which are described in Chapter 2 (p. 89; *Cardiovascular assessment*). Throughout the procedure, participants were seated in a comfortable chair at a desk with a personal computer and some writing space. The researcher was present in the room throughout the procedure and separated from the participant via an opaque screen. As in Chapter 2, this served to ensure the participant adhered to procedural instructions, while minimizing social contact between the researcher and participant.
Stressor task

The laboratory challenge used to elicit reactivity was a standardized mental arithmetic task. Subtraction problems were presented on a computer screen alongside a count-down bar, to increase the sense of pressure involved in the task. Participants pressed the space bar to enter their response to each problem, and, to control for mathematical ability, were presented with problems of varying difficulty according to their performance. A correct answer produced a more difficult subtraction, while an incorrect answer produced a simpler subtraction. Difficulty was indexed by length of numbers to be subtracted; those responding correctly were required to subtract a 4-digit number from another 4-digit number, while those answering incorrectly might subtract a single-digit number from another single-digit number. Mental arithmetic tasks have been shown to reliably induce elevated CVR, are used widely in laboratory research (Edens, Larkin, & Abel, 1992; Kamarck et al., 1990), and avoid the possible influence of speech artefacts on CVR implicit in speech task stressors.

Schema task

As noted above, participants were randomly assigned to groups and until task commencement were blind as to the specific aims of the paradigm, having been informed that it involved writing and that task responses were not analysed by the researcher, to avoid task-related evaluation anxiety. The experimenter was also blinded to the task condition until the experiment had concluded. Support group participants were asked to recall and write about a specific person in their lives to whom they either provide or from whom they receive support, while the control group wrote about a casual acquaintance. This exercise was modelled on the original
structured writing task (Ratnasingam & Bishop, 2007; Smith et al., 2004), adapted to explicitly evoke thoughts of either support provision or receipt.

The support provision group was asked to write on the following questions:

- Describe what you do or have done for this person that is supportive and helpful.
- Describe how you feel when you are helpful to this person.
- Describe how this person depends on you.
- Describe how it feels for you to have this person be dependent on you and receive support from you.

These were rephrased for the support receipt group:

- Describe what this person does or has done for you that is supportive and helpful.
- Describe how you feel when this person is helpful to you.
- Describe how you depend on this person.
- Describe how it feels to be dependent on this person and receive support from them.

Finally, those assigned to the acquaintance group responded to the following questions:

- Describe what you know about this person and what you think they are like.
- Describe the places and times at which you usually see them.
- Describe what this person does when you see them and what they usually talk about.
- Describe how you feel when you are in the presence of this person.

Procedure

All testing took place in a quiet haemodynamic laboratory at the university. Upon arrival, height (to the nearest mm) and weight (to the nearest 0.1kg) were obtained using a digital balance (Seca, model 707; Seca, Hamburg, Germany). The participant was then seated and the blood pressure cuff attached to the middle finger.
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of the non-dominant arm. The participant completed some individual difference questionnaires while habituating to the laboratory setting.

Following this, the formal experiment was initiated. For the first phase, participants relaxed reading a magazine for a 10-minute “vanilla” baseline period (Jennings et al., 1992). Participants were verbally prompted by the experimenter when the 5-minute mental arithmetic task was about to commence, and prompted to progress to the 9-minute schema activation task upon completion. Following this, participants relaxed for an additional 10-minute extended recovery period, comprising recovery from both the stressor and activation task. Finally, participants were disconnected from the apparatus, thanked, debriefed, and left the laboratory.

Overview of analyses

Baseline levels were computed as the average over minutes 4 to 8 of the baseline period, to allow time for participants to habituate to the monitoring and to avoid contamination in relation to anticipatory stress. Stressor and extended recovery CVR were calculated as the arithmetic mean of all readings for each phase. To test the hypothesis that groups would display differential response patterns during support schema activation, mean values were computed from the first and second halves of this period to represent “start” and “end” values. A series of mixed factorial analyses of covariance (ANCOVAs) were used to assess cardiovascular patterns during this phase. These analyses comprised of a separate time (within-subjects, two levels: time 1 and time 2) by group (between subjects, three levels: support provision, support receipt, and acquaintance control) ANCOVA for each dependent variable (SBP, DBP, HR, CO, and TPR). The inclusion of confounds such as age, smoking status, BMI, and OC use as covariates did not alter the findings. As such, only baseline values (to
control for the likely association between baseline levels and subsequent changes in cardiovascular parameters; Benjamin, 1967), and stressor values, were included as covariates. Multiple regression analyses were used to examine the associations between hostility, support, and cardiovascular responses for each group.

Effect sizes are presented as partial $\eta^2$ for ANOVA effects, with values of .04, .25, and .64, being taken as representing small, medium, and large effect sizes, respectively (J. L. Cohen, 1988, 1992). Partial $\eta^2$, rather than simple $\eta^2$, is recommended for ANOVA designs with multiple independent variables, as simple $\eta^2$ contains systematic variance attributable to other effects and interactions (Tabachnick & Fidell, 2007). For correlation analyses, effect sizes are presented as $r$, with values of .10, .25, and .37 taken as representing small, medium, and large effect sizes respectively (J. L. Cohen, 1988, 1992). As in Chapter 2, effect sizes for regression analyses are presented as adjusted $R^2$.

**RESULTS**

*Demographics*

Data from five participants were excluded owing to equipment failure ($n = 2$), or as outliers in terms of age ($n = 2$), or BMI ($n = 1$). The remaining 67 comprised 20 participants in the support provider group, 22 in the support recipient group, and 25 in the control group. This final sample size was nonetheless sufficient to detect medium-to-large effects sizes with 93% power (Faul, Erdfelder, Lang, & Buchner, 2007). One-way ANOVAs confirmed that groups did not differ on biometric or psychometric variables. One-way ANOVAs also confirmed that providers, recipients, and controls did not differ on lines of text ($M = 19.71, SD = 5.48$ for providers; $M = 23.64, SD = 7.19$ for recipients; $M = 24.22, SD = 6.19$ for controls; $p = .16$) or number of words...
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(M = 144.64, SD = 42.40 for providers; M = 159.29, SD = 41.67 for recipients; M = 166.67, SD = 32.22 for controls; p = .37) written during the activation task.

Descriptive statistics

Mean resting and stressor CVR values are shown in Table 9, and within-phase measures for schema activation in Table 10. Internal reliability estimates for resting and stressor measures were excellent; all αs ≥ .98. One-way ANOVAs revealed no significant or near-significant group differences for resting and stressor SBP, HR, CO, or TPR, (all ps > .12); however, groups differed for resting, F(2, 66) = 3.82, p = .03, partial η² = .11, and stressor DBP, F(2, 66) = 4.31, p = .02, partial η² = .12, with post-hoc Bonferroni tests indicating that providers had slightly elevated values in comparison to controls, necessitating the inclusion of stressor CVR as a covariate.

Occurrence of reactivity

2 × 1 repeated-measures ANOVAs confirmed that the mental arithmetic stressor successfully elicited SBP, DBP, HR, and CO reactivity, with main effects for time on SBP, F(1, 66) = 33.40, p < .001, partial η² = .34; DBP, F(1, 66) = 18.35, p < .001, partial η² = .22; HR, F(1, 66) = 8.28, p = .005, partial η² = .11; CO, F(1, 66) = 8.99, p = .004, partial η² = .12, with no change for TPR, F(1, 66) = 0.06, p = .78, partial η² = .001, consistent with a cardiac response.
### Table 9

*Mean (with SDs) resting and reactivity levels for cardiovascular parameters (n = 67)*

<table>
<thead>
<tr>
<th></th>
<th>SBP (mmHg)***</th>
<th>DBP (mmHg)***</th>
<th>HR (bpm)**</th>
<th>CO (l/min)**</th>
<th>TPR (pru)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>121.79 ± 18.75</td>
<td>77.33 ± 14.26</td>
<td>83.05 ± 12.64</td>
<td>5.29 ± 1.42</td>
<td>1.23 ± 0.62</td>
</tr>
<tr>
<td>Stressor</td>
<td>130.32 ± 19.13</td>
<td>82.23 ± 13.58</td>
<td>85.83 ± 14.11</td>
<td>5.69 ± 1.86</td>
<td>1.21 ± 0.52</td>
</tr>
</tbody>
</table>

Notes: **p < .01, ***p < .001, denoting significant differences between phases (i.e., elicitation of reactivity)
### Table 10

*Unadjusted mean (with SDs) cardiovascular parameters during the schema activation phase*

<table>
<thead>
<tr>
<th></th>
<th>Providers (n = 20)</th>
<th>Recipients (n = 22)</th>
<th>Controls (n = 25)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time 1</td>
<td>Time 2</td>
<td>Time 1</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>137.94 ± 24.89</td>
<td>139.16 ± 23.69</td>
<td>126.67 ± 19.18</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>90.04 ± 16.41</td>
<td>91.15 ± 15.75</td>
<td>82.67 ± 13.13</td>
</tr>
<tr>
<td>HR (bpm)</td>
<td>89.67 ± 10.95</td>
<td>89.11 ± 11.59</td>
<td>83.75 ± 10.78</td>
</tr>
<tr>
<td>CO (l/min)</td>
<td>5.17 ± 1.45</td>
<td>5.30 ± 1.48</td>
<td>5.08 ± 1.29</td>
</tr>
<tr>
<td>TPR (pru)</td>
<td>1.39 ± 0.60</td>
<td>1.47 ± 0.67</td>
<td>1.32 ± 0.42</td>
</tr>
</tbody>
</table>
Cardiovascular response patterns during support activation

For SBP, the ANCOVA revealed a main effect for time, $F(1, 62) = 8.24, p = .006$, partial $\eta^2 = .12$, no main effect for group, $F(2, 62) = 0.55, p = .58$, partial $\eta^2 = .02$, and a significant time × group interaction, $F(2, 62) = 3.59, p = .03$, partial $\eta^2 = .10$. Visual scrutiny confirmed that groups differed in cardiovascular patterning, with support receipt and control groups exhibiting a decrease in SBP, while providers displayed an increase as depicted in Figure 2. Overall, it is evident that recipients did not gain from support activation any more than the controls, with both groups exhibiting cardiovascular adaptation from start to end. However, rather than adapting to support activation, providers were physiologically disadvantaged by the intervention.

![SBP during schema activation](image)

*Figure 2.* SBP during the schema phase for support providers, recipients, and controls (based on change scores from stressor reactivity)
Similar patterning was evident for DBP as shown in Figure 3, with a main effect for time, $F(1, 62) = 9.92, p = .003$, partial $\eta^2 = .14$, no main effect for group $F(2, 62) = 0.59, p = .56$, partial $\eta^2 = .02$, and a significant time × group interaction on DBP, $F(2, 62) = 6.18, p = .004$, partial $\eta^2 = .17$.

![DBP during schema activation](image)

**Figure 3.** DBP during schema period for support providers, recipients, and controls (based on change scores from stressor reactivity)

Corresponding analyses for HR and CO revealed no significant results. The ANCOVA for TPR revealed no main effect for time, $F(1, 62) = 1.30, p = .26$, partial $\eta^2 = .02$ or group, $F(2, 62) = 2.07, p = .14$, partial $\eta^2 = .06$, with a near-significant time × group interaction congruent with the patterning for SBP and DBP, $F(2, 62) = 2.99, p = .06$, partial $\eta^2 = .09$, such that providers displayed an increase in TPR while recipients and controls showed a decrease as displayed in Figure 4, indicative of a vascular profile as predicted. The finding that support recipients and support providers displayed differential response patterns suggests that individuals respond to the directional element of the support activation rather than the non-specific activation of
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a supportive tie, thereby validating previous research utilizing support and acquaintance groups. Although no differences were observed between support recipients and controls, this is congruent with the limited data reporting only stressor but not post-stressor group effects on CVR (Gramer & Reitbauer, 2010).

![TPR during schema activation](image)

**Figure 4.** TPR during schema period for support providers, recipients, and controls (based on change scores from stressor reactivity)

**Hostility and cardiovascular response patterns**

Pearson’s correlations revealed that hostility was positively correlated with both start and end schema SBP ($r = +.27, p = .03; r = +.26, p = .03$, respectively). Starting SBP was entered as the criterion variable in a hierarchical regression. Resting SBP was controlled for in Step 1, with group and hostility as independent variables at Step 2, and the group $\times$ hostility interaction term at Step 3.

The overall model was significant at Step 1, $F(5, 66) = 25.06, p < .001$, Step 2, $F(7, 66) = 19.15, p < .001$, and Step 3, $F(8, 66) = 18.23, p < .001$. At Step 1, the model accounted for 65% of variance in SBP, with resting SBP the only predictor ($\beta =$
.81, p < .001). At Step 2, resting SBP (β = .80, p < .001) and hostility (β = .15, p < .05) predicted CVR. However, Step 2 did not improve the model, adjusted $R^2 = .66$, $\Delta R^2 = .02$, $p = .13$, but Step 3 did, adjusted $R^2 = .68$, $\Delta R^2 = .02$, $p = .04$, revealing a significant group × hostility interaction on CVR, $\beta = .29$, $p = .04$, in addition to a main effect for hostility, $\beta = .19$, $p = .01$, with high hostiles displaying elevated CVR.

For end-phase SBP, the overall model was significant at Step 1, $F(5, 66) = 21.98$, $p < .001$; Step 2, $F(7, 66) = 16.99$, $p < .001$; and Step 3, $F(8, 66) = 16.48; p < .001$. Again, Step 2 did not improve the model, adjusted $R^2 = .63$, $\Delta R^2 = .03$, $p = .11$, but Step 3 did, adjusted $R^2 = .65$, $\Delta R^2 = .03$, $p = .03$. In this instance, hostility did not predict CVR at Step 2, with resting SBP, hostility, and group × hostility predicting CVR at Step 3 ($\beta = .74$, $p < .001$ for resting SBP; $\beta = .19$, $p = .02$ for hostility; $\beta = .32$, $p = .03$ for group × hostility).

**Hostility and responses by group**

Following the advice of Aiken and West (1991), separate regression analyses were conducted for each group as follow-up tests omitting non-significant biometric variables. While the sample sizes for these analyses are reduced, they allow us to determine the nature of the group × hostility interaction.

The regression for providers’ starting SBP revealed that the overall model was significant, $F(2, 19) = 41.42$, $p < .001$. For this group, hostility significantly predicted SBP to support activation, $\beta = .25$, $p = .03$, accounting for 5% of variance explained, adjusted $R^2 = .81$, $\Delta R^2 = .05$. For provider’s end-phase SBP, there was a significant overall model, $F(2, 19) = 21.17$, $p < .001$; however, hostility was not a predictor of SBP, $\beta = .22$, $p = .14$, suggesting that individuals high in hostility may be particularly
disadvantaged only in the short-term, or might habituate to the demands of a support transaction.

Though uncorrelated with DBP, hostility also predicted starting DBP when resting CVR was controlled for; $\beta = .25$, $p = .04$, with this step improving the model, $F(2, 19) = 34.81$, $p < .001$ and accounting for 6% of variance, adjusted $R^2 = .78$, $\Delta R^2 = .06$. Partial correlations confirmed that for providers, hostility was associated with starting DBP when resting DBP was controlled for, $r = .48$, $p = .04$. As per the model for SBP, the analysis for end-phase DBP revealed that hostility was not a predictor, $F(2, 19) = 22.75$, $p < .001$, $\beta = .20$, $p = .15$. Hostility was not predictive of CVR for recipients or controls, nor was it related to providers’ HR, CO, or TPR patterning during schema activation or extended recovery.

To confirm that hostility influenced support providers’ reactivity to the support activation specifically rather than in response to challenge generally, we substituted stressor CVR as the criterion variable. Hostility failed to predict either stressor SBP, $F(2, 19) = 38.52$, $p < .001$, $\beta = .16$, $p = .16$, or DBP, $F(2, 19) = 28.73$, $p < .001$, $\beta = .16$, $p = .19$, confirming that the effects of hostility on support provision activation could not be attributed to generalized enhanced reactivity to cognitive stress.

*Extended cardiovascular recovery responses*

Mixed ANOVAs revealed no group effects on CVR from baseline to extended recovery, bar an effect for elevated providers’ DBP that proved attributable to elevated baseline DBP for this group. Main effects for time were observed, such that post-activation SBP, DBP, and TPR were significantly elevated above baseline levels, $F(1, 64) = 31.57$, $p < .001$, partial $\eta^2 = .33$ for SBP; $F(1, 64) = 22.02$, $p < .001$, partial
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η^2 = .27 for DBP; \( F(1, 64) = 4.86, p = .03 \), partial η^2 = .07 for TPR, while HR and CO were lower, \( F(1, 64) = 28.05, p < .001 \), partial η^2 = .31 for HR; \( F(1, 64) = 4.44, p = .04 \), partial η^2 = .07 for CO. The results suggested the effects of support activation did not extend beyond the activation itself, though HR and CO were lower for all groups following the task. As such, providers were only disadvantaged during the activation of provision. Nor did ANCOVAs examining within-phase patterns of CVR during extended recovery reveal any group effects.

**DISCUSSION**

The present study affirms that support provision and receipt are associated with unique profiles of cardiovascular responding and extends this to patterning observed during the mental activation of cognitive structures of support. Rather than compromising two facets of social embeddedness (Rook, 1990b), support provision and receipt appear to exert qualitatively distinct effects on cardiovascular recovery. The results also reveal that trait hostility affects post-stressor responses to support provision, such that consideration of support provision induced exaggerated elevations in blood pressure for individuals high in trait hostility. These results held after controlling for a number of confounds of cardiovascular function such as smoking status and BMI. Moreover, the current data corroborate the findings of Gramer and Reitbauer (2010) pertaining to recovery, in that activation of received support failed to enhance cardiovascular recovery even when timed to occur after the cognitive stressor, indicating that the benefits of perceived support may be stress phase-specific.

The absence of a significant difference between recipients’ and controls’ responses contrasts with some previous studies observing differences between these
groups in stressor responses (e.g., Ratnasingam & Bishop, 2007; Smith et al., 2004). The activation of support availability when the stressor is no longer a threat may be less relevant to well-being and thus less pertinent to CVR for support recipients, resulting in no significant differences in patterning for recipients and controls. However, it is also possible that significant group differences might be detected in a larger sample. Regarding the lack of significant effects in the extended recovery period, it is also possible that there were chance group differences in participants’ ability to recover from cognitive stress that interacted with random group assignation to obscure group effects. However, as Gramer and Reitbauer (2010) found no effects for recovery, it seems more likely that the effects of support do not generalize across the stress process. It is also possible that the schema effects here are attributable to some other aspect of the manipulation other than the support element. However, as groups did not differ either on words written, or in HR responses which would have indicated differential psychomotor activity during the task, this seems unlikely.

In comparison with support receipt or social contact, the generation of thoughts of support provision might be considered a more effortful process. Researchers have hypothesized that active coping in response to challenge results in heightened CVR (Gramer & Reitbauer, 2010); therefore, the heightened CVR displayed by providers described here may be a function of effort required to mentally provide support over that of support receipt or social contact. However, the trend towards a vascular profile indexed by elevated TPR for providers during schema activation does not necessarily attest to this, according to Sherwood, Dolan, and Light’s (1990) assertion that such a profile is indicative of passive coping, or a reduction in task engagement. The results are more consistent with Blascovich and colleagues’ (Blascovich & Tomaka, 1996; Tomaka, Blascovich, Kibler, & Ernst,
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1997), biopsychosocial model of arousal regulation in which a predominantly vascular response pattern is thought to characterize threat. In this instance, support provision may constitute a threat to resources to individuals whose resources are already depleted. Contextualizing this research within social psychology theories advocating benefits for support provision suggests that such theories should be considered in relation to the stress that the individual is currently undergoing themselves.

The present study also complements existing literature associating hostility with maladaptive responses to mentally–activated support, by extending this to activation of support provision. This finding raises the possibility that high hostiles are more aggravated when confronted with support provision in everyday life than when they are bestowed with support themselves, consistent with the Holt-Lunstad et al. (2008) results. Hostile individuals may have coping mechanisms to deal with unwanted support, minimizing its negative impact by ignoring or reframing support receipt, or by circumventing receipt entirely by avoiding support seeking behaviour or social contact. In contrast, being asked to generate thoughts of an active role in support provision may constitute a greater personality–situation mismatch as such individuals are less likely to initiate support provision in real life, and thus less accustomed to managing this aspect of a support transaction. Unlike the original study (Smith et al., 2004), hostility was unrelated to CVR for the support receipt group. Given the wide literature implicating hostility with CVR to traditional support, this suggests potential response-phase specificity in the association between hostility and physiological stress. Hostile individuals may be less discomforted by support receipt when they are not anticipating a stressor for which support might be needed, or when they have successfully completed a stressful task. However, it is also possible that
sampling participants with particularly high or low scores on hostility from a larger sample would reveal effects here.

A limitation of the present study is the relatively small sample size of undergraduate women, nonetheless comparable with previous research in the area (e.g., Gramer & Reitbauer, 2010). Much cross-sectional social support research typically relies on this cohort, given age-related changes (Uchino, Holt-Lunstad, Uno, Betancourt, & Garvey, 1999; Uchino, Uno, Holt-Lunstad, & Flinders, 1999) and sex differences (Farag et al., 2006; Girdler, Turner, Sherwood, & Light, 1990) in physiological stress responses. Interestingly, the Smith et al. (2004) study suggests that gender differences in this type of manipulation may not be particularly conspicuous, reporting non-significant trends for men consistent with some significant effects for women, specifically in terms of the influence of hostility on CVR to stressors. Indeed, participants recalling their own mental representations of support may produce schemas that are functionally more congruent with their support needs than a generic support manipulation, reducing gender-specific differences in physiological responses.

In conclusion, the present study indicates that activating thoughts of support provision (but not receipt) subsequent to stress exposure exacerbates rather than enhances cardiovascular recovery from the stressor. What the present study did not address is whether actual support provision and receipt differ in their effects on cardiovascular responsivity. The next chapter utilizes a live support manipulation to investigate whether direct involvement in a supportive transaction is beneficial at the level of the individual and of the dyad, in comparison with dyadic completion of a stress task in a manner that is not explicitly supportive.
Chapter 4: STUDY 3

INDIVIDUAL AND DYAD-LEVEL EFFECTS OF LIVE SUPPORT PROVISION AND RECEIPT ON CARDIOVASCULAR REACTIVITY DURING A LABORATORY CHALLENGE

INTRODUCTION

Studies examining social support effects on physiological stress responses tend to employ either structured manipulations of support from a confederate or friend or psychometric assessments such as the SSQ6 utilized in Chapter 2. Notably, the former method assesses actually received support or the manipulation of available support (rather than the participant’s own perception of the manipulation), while the latter uses a questionnaire assessment of that aspect of support that enhances well-being in naturalistic settings. A divergence is therefore observed between these manipulations; with neither actually assessing the effects of one’s perception of live support on CVR (except in those few cases where participant perceptions of the support manipulation serve as an independent variable). Moreover, as noted in previous chapters, studies seldom examine both support provision and receipt within a single framework despite theoretical arguments for conceptualizing both aspects as part of a unitary process.

One key limitation in studies of either support provision or receipt is that these can only inform us about reactivity at the level of the individual rather than the dyad. Examining both recipient and provider reactivity enables us to apply dyadic rather than individualistic perspectives to cardiovascular function during social interactions, an approach that has only rarely been employed despite theoretical frameworks suggesting some value to this approach. Particularly, researchers examining dyadic interactions have considered synchrony as a key indicator of high quality interactions
or relationships, with some examining synchrony in physiological measures including reactivity.

Synchrony has been conceptualized as an overarching process that coordinates the on-going exchanges of sensory, hormonal, and physiological stimuli between individuals during dyadic social interactions (Feldman, 2007a, 2007b; Harrist & Waugh, 2002). Some studies have examined matching or correspondence in physiology, or physiological concordance, as one such manifestation of synchrony in dyadic relationships. Several dyadic studies of family and spousal relationships have investigated concordance in measures of cardiovascular, immunological, and hormonal function between members of relational dyads, with most asserting this to designate various facets of high quality relationships such as attunement with the dyadic partner’s emotional states. Although the majority of studies have examined caregiver–child interactions, others have observed physiological concordance in mother-adolescent dyads (Papp, Pendry, & Adam, 2009), and in romantic partners (Helm, Sbarra, & Ferrer, 2011). Despite this, studies have not examined such concordance in social support exchanges. However, it is this concordance (rather than individual-level CVR) that is hypothesized in some cases to signify optimal dyadic interactions. As actual social support (as opposed to one’s individualized perceptions of support) is inherently at minimum a dyadic, rather than uni-directional concept, to examine concordance might shed light on the role of support for cardiovascular responsivity within the actual dyadic contexts in which support occurs. It may be that in cases where no individual-level benefits to CVR are observed, dyad-level concordance between recipient and provider might be evident.

Although few studies to date have examined physiological concordance in interactions between adults, some have assessed cardiovascular responses from both
members of a dyad. Examining CVR to both provision and receipt, Holt-Lunstad et al. (2008) reported that support role (provider vs. recipient) during a problem disclosure task did not moderate CVR during the interaction. However, they also found that that discussing negative events was associated with higher SBP reactivity than discussing positive experiences for support recipients, with no differences for support providers, suggesting distinct cardiovascular patterning in some contexts. As their study examined only blood pressure and HR, whether the underlying determinants of blood pressure are similarly influenced by support role is unclear. Moreover, although cardiovascular measures were obtained for both recipients and providers, no assessment of dyad-level concordance was reported.

To address this limitation, the present study sought to test the effects of giving and receiving support (and perceptions of this) on CVR during a novel instrumental challenge task. Just as reporting support receipt might hinge on undergoing a stressor for which support is required, the ecological validity of emotional support provision in response to problem disclosure is reliant on one having a problem to disclose, a likelihood which may vary markedly across individuals. Therefore, a laboratory stressor was devised for the present study to facilitate instrumental support provision and receipt in the context of a tangible and novel challenge. In addition, the novelty of the instrumental task over that inherent in tasks such as problem disclosure offered a purer test of social exchange theories. Again, particular attention was paid to the primary indices of cardiovascular function that have previously been implicated in the relationship between social support variables and CVR (e.g., Hughes, 2007; Uchino, Uno, Holt-Lunstad, & Flinders, 1999), namely SBP, DBP, and HR, in addition to the haemodynamic variables of CO and TPR.
For individual-level CVR, we predicted that support providers would demonstrate lower CVR than either recipients or collaborators (consistent with social psychological theories of exchange when the individual is not undergoing stress themselves). Based on the mixed findings for individual-level analyses of CVR, we hypothesized that the benefits of support may be seen at a dyadic level, and therefore predicted that supportive dyads would demonstrate greater dynamic concordance (i.e., concurrent concordance at each epoch from epoch to epoch) in cardiovascular indices than collaborative dyads. Drawing on social exchange theories, we predicted that reporting support receipt would be associated with buffered CVR for individuals assigned to the role of support provider. Conversely, we predicted that reporting provision would be associated with buffered CVR for individuals assigned the role of support recipient. Finally, we expected equity and reciprocity in perceived support provision and receipt to be positively associated with concordance in CVR.

METHODS

Recruitment and screening

Participants were recruited from the undergraduate Psychology participant pool at the present author’s university. The study was advertised as an investigation of cardiovascular responses to stressful tasks to be completed in pairs on the online participant management system described in Chapter 2 (p. 83, Participants). Individuals selected a timeslot to attend a screening and briefing session, where the dyadic nature of the study was outlined and demographic data collected. Interested participants referred a social tie (i.e., a person known to the participant whom the participant considered willing to participate in the study, from the Psychology pool or otherwise) to the researcher for screening and briefing. As friendship or romantic
relationship qualities per se were not the focus of the present study, no restrictions pertaining to the nature of the relationship between participants were imposed. Partners who were not members of the Psychology pool contacted the researcher directly by email. Eligible dyads were then scheduled to attend laboratory sessions together. Ineligible dyads (e.g., ones in which the recruited partner did not meet the inclusion criteria) were supplied with details of appropriate alternative ongoing research projects, or invited to recruit an alternative partner. Exclusion criteria were self-reported history of cardiovascular problems, and current or recent consumption of medication impacting on CVR (other than OC use). Women reporting OC use were included as personality differences impinging on social support have been noted between users and non-users (e.g., users report higher internal locus of control than non-users; Morrison, 1985). Smokers were included, and asked to refrain from nicotine consumption for two hours prior to the session. This timeframe allowed for the subsidence of acute cardiovascular effects of smoking prior to testing (Domino et al., 2004; Monfrecola, Riccio, Savarese, Posteraro, & Procaccini, 1998; Silvestrini, Troisi, Matteis, Cupini, & Bernardi, 1996; Terborg, Bramer, Weiller, & Rother, 2002) while avoiding the cardiovascular effects of prolonged smoking abstinence (Primatesta, Falaschetti, Gupta, Marmot, & Poulter, 2001; Tsuda, Steptoe, West, Fieldman, & Kirschbaum, 1996). Psychology participants were rewarded with partial course credit; others were not rewarded.

Participants

Participants were 90 healthy adults (including 32 men) ranging in age from 17 to 53 years ($M = 19.97$, $SD = 5.68$), with BMI ranging from 17.36 to 38.30 kg/m$^2$ ($M = 23.51$, $SD = 3.11$). None reported a history of cardiovascular problems or
medication use. Dyad composition included 26 dyads comprised of women only, 13 comprised of men only, and six mixed-sex dyads. Based on self-report data obtained following the experiment it was noted that of the mixed-sex dyads, 2 constituted romantic dyads; no same-sex dyads were romantic couples, and no dyads were family relationships. Data from five participants (each a member of a separate dyad) were excluded on the basis of technical difficulties with the cardiovascular monitoring equipment, resulting in a final sample of 85 participants. One woman with a BMI $\geq 35$ kg/m$^2$ was retained as excluding this individual did not alter the findings.

**Design**

The present study employed a two-group design. In the first group, dyad members completed an experimental task together (therefore, each member of the dyad held the same experimental role within the dyad). In the second group, members were randomly assigned to the role of task completer (i.e., support recipient) or assistant (i.e., support provider; therefore, each member of the dyad held a different role to their partner). While the first group comprises a control group in the sense that individuals are not manipulated to explicit provide or receive support, to refer to members of this group as “controls” might imply not only that they completed the task without explicit support but that they worked alone on the task. Equally, to describe this group as a “non-supportive” group implies that the presence of a friend is non-supportive, when it might be supportive, evaluative, socially facilitative or irrelevant. For these reasons the first group is referred to as the collaborative group. The dependent variables were SBP, DBP, HR, CO, and TPR.
Chapter 4. Dyadic social support

Laboratory task

The laboratory task devised for this study was a novel pegboard task. Dyads were supplied with five pegboards, coloured pegs, and five copies of board designs, and were instructed to mimic these designs within the allotted time. Dyads were also provided with a stopwatch, and instructed to start the stopwatch when prompted by the researcher. The task was constructed so that it was difficult, if not impossible, to complete during the allotted 10-minute timeframe, thereby engendering a stress response for the duration of the interaction. This time pressure was imposed by supplying dyads with a larger number of designs than could reasonably be completed within the allotted timeframe (indeed, no dyads successfully completed the task). Further, the task was selected so as to be sufficiently novel as to discount any practice or experience effects that might bear on cardiovascular function.

Cardiovascular assessment

Beat-to-beat cardiovascular measures were recorded using two Finometer haemodynamic monitors, the specifications and measurement validity of which are outlined in Chapter 2 (p. 89; Cardiovascular assessment). Following a comparable protocol to Study 1 and Study 2, both Finometers were located out of the participants’ view behind an opaque screen. The Finometer cuffs were drawn around either side of this screen to facilitate the connection of the cuff to the participants. As in Study 1 and Study 2, the researcher was present in the room throughout the procedure and separated from the participants via the opaque screen. The Finometers were operated simultaneously by the researcher from behind the opaque screen.
**Procedure**

Upon arrival at the laboratory, participants’ height (to the nearest mm) and weight (to the nearest 0.1kg) were obtained using a digital balance (Seca, model 707; Seca, Hamburg, Germany). The scales were zero balanced before each participant was weighed, and were situated in a separate cubicle next to the laboratory, in order to obtain measurements privately for each participant. Participants then returned to the laboratory and were seated in comfortable chairs facing each other at a table and connected to the Finometers. Dyads were randomly assigned to the collaborative or supportive group, and for those in the supportive group, members were randomly assigned to the role of task completer (i.e., support recipient) or assistant (i.e., support provider). A trial reading was taken to facilitate habituation to the laboratory setting and monitoring equipment. At this point, task instructions were supplied, and clarification provided if necessary.

For the collaborative group, the task instructions were as follows:

This task involves placing coloured pegs on a board in a particular formation. It is a variation of a task commonly used to test manual dexterity. There are pegs, pegboards, and pictures of the formation you have to copy on the table also. When you have completed one board, move it to one side and start the next one. You may communicate as you please while working on the task. When the experimenter tells you time is up, please stop working on the task and rest quietly for another ten minutes, till the experimenter ends the session.

For the supportive group, the task instructions were directed to the task completer (i.e., support recipient) as follows:

This task involves placing coloured pegs on a board in a particular formation. It is a variation of a task commonly used to test manual dexterity. There are pegs, pegboards, and pictures of the formation you
have to copy on the table also. When you have completed one board, move it to one side and start the next one. You may communicate as you please while working on the task. Your partner may assist you but you must place the pegs on each board yourself. When the experimenter tells you time is up, please stop working on the task and rest quietly for another ten minutes, till the experimenter ends the session.

For the baseline period, participants were provided with reading materials and asked to read quietly until prompted by the researcher. Seven minutes into the baseline period, participants completed the first administration of a mood questionnaire. When the baseline period was over, the experimenter prompted participants to begin the task by starting a stopwatch timer. When the time allotted to the task had finished, participants ceased the task and a second mood assessment was administered, along with the interaction ratings scale. Participants were then supplied with their reading material and asked to read quietly for the remainder of the 10-minute recovery period. When the monitoring period had concluded, the apparatus was disconnected. Participants were provided with a debriefing sheet, and a take-home questionnaire pack containing individual difference measures.

**Psychometric assessments**

*Short-form Social Support Questionnaire.* Perceived social support was measured using the SSQ6 as described in Chapter 2 (p. 54, Psychometric assessments). Cronbach’s α for the present sample was excellent; for SSQ-N, α = 91 and for SSQ-S, α = 86.

*Positive and Negative Affect Schedule.* Pre- and post-interaction mood was assessed using Positive and Negative Affect Schedule (PANAS; Watson, Clark, &
Tellegen, 1988), a 20-item measure of positive affect (PA) and negative affect (NA), with 10 items assessing each dimension. Participants respond to items on 5-point Likert scales from 1 (very slightly or not at all) to 5 (extremely) to indicate their present mood. Previous work has established the PANAS as a reliable and valid measure (Crawford & Henry, 2004; Ostir, Smith, Smith, & Ottenbacher, 2005) and it is widely used in psychological research (e.g., Dickerson & Kemeny, 2004; Flynn & James, 2009). Reliability coefficients were good in the current sample; for baseline affect, $\alpha = .82$ for PA and $\alpha = .85$ for NA, while for post-task affect, $\alpha = .89$ for PA and $\alpha = .75$ for NA.

**Interaction Ratings Scale.** A novel 4-point Likert scale was used to assess perceptions of task stressfulness, difficulty, enjoyment, and support. Participants rated statements such as *I found this task stressful* and *I received as much actual help as I needed from my partner* on a scale from 1 (Strongly Agree) to 4 (Strongly Disagree). Cronbach’s $\alpha$ for the five items assessing perceptions of supportiveness was .82 (help, encouragement, satisfaction with help, satisfaction with encouragement, and overall satisfaction). Cronbach’s $\alpha$ for the 2-item provided support scale was .85 (help provided and encouragement provided), and for the task stressfulness scale was .74 (including 2 items rating stressfulness and difficulty). In analyses of support perceptions, we utilized the perceived support and perceived support provision items (i.e., perceived support combined help and encouragement received; provided support combined help and encouragement provided). In addition, *equity* was operationalized as the discrepancy between support received and provided at the individual level (i.e., the difference between an individual’s own reports of provision and receipt). *Reciprocity*, which implies a level of between-individual supportiveness, was operationalized as the association between dyad members on support provided and
received (i.e., the association between one member’s perceptions of receipt and their partner’s perceptions of provision, and vice versa).

*Relationship data.* Finally, participants selected the nature of their relationship from a list of options including friend, close friend, best friend, girlfriend/boyfriend, and other.

**Analytic strategy**

Data were collected simultaneously and longitudinally nested within dyads. Multilevel modelling (MLM), estimated using the Linear Mixed Facility of SPSS 18, was used to account for the non-independence of data within dyads. Several papers provide detailed discussions of multilevel modelling techniques (Liu, Rovine, & Molenaar, 2012; Llabre, Spitzer, Siegel, Saab, & Schneiderman, 2004). To summarize, multilevel approaches are preferred over ANOVA designs to account for the non-independence of data nested within groups such as dyads. For example, within a dyad, a support recipient’s physiological response is likely to be associated with, or to be *non-independent* of, a support provider’s response. Multilevel models are unaffected by unequal sample sizes at each level (e.g., participant level; dyad level) and are robust to missing data. MLM permits prediction of individual scores adjusted for group differences as well as group scores adjusted for individual differences within groups. MLM also allows the testing of cross-level interactions (for example, does dyad type [a Level 2 variable] interact with participant ratings of social support [a Level 1 variable] to influence change in SBP over time [a dependent variable]?). Multilevel models are widely used in dyadic support research (e.g., Gleason et al., 2008; Holt-Lunstad et al., 2008). The primary limitations of MLM are pertinent to most modelling techniques (Greenland, 2000) and are reviewed in detail.
elsewhere (Tabachnick & Fidell, 2007). A key limitation is that correlated predictors are particularly problematic in MLM, as equations at multiple levels are solved and correlations among predictors at all levels are taken into account simultaneously. Because effects of correlated predictors are all adjusted for each other, it becomes increasingly likely that none of their regression coefficients will be statistically significant. It is therefore recommended to choose a very small number of relatively uncorrelated predictors.

Baseline measures, age, BMI, gender, role, and dyad type were centred at their grand mean before inclusion in the models as covariates. Maximum likelihood method (ML) was selected over restricted maximum likelihood method (REML) as ML produces more accurate estimate of fixed effects, the focus of interest in this study, whereas REML produces more accurate estimates of random variances (Field, 2009). The results are reported in unstandardized regression coefficients. Goodness of fit was determined by referring to the -2 log likelihood (-2LL), the Akaike Information Criterion (AIC), and the Bayesian Information Criterion (BIC; for these, a smaller number indicates a better fit).

**RESULTS**

*Outline of analyses*

Mean levels of SBP, DBP, HR, CO and TPR were computed for baseline and task phases. In addition, to examine dynamic concordance (i.e., concordance over time), CVR was averaged over two-minute epochs to produce five measures for the task phase. For each cardiovascular parameter (SBP, DBP, HR, CO, and TPR), a multi-level model was constructed. Firstly, to investigate the impact of support role on overall mean CVR (i.e., the overall average of the five epochs), this was entered as the
dependent variable, with age, gender, resting level, and BMI as control predictors, and support role as the independent variable. This model was conducted for each dependent variable (i.e., for SBP, DBP, HR, CO and TPR). Secondly, to examine dynamic concordance in measures, the dependent variable was means-centred CVR at each epoch (i.e., epoch-by-epoch CVR). The predictor variables were resting measures, and partner epoch-by-epoch CVR. To examine whether perceptions of supportiveness influenced individual- and dyad-level CVR, the variable of perceived receipt was added to the original models, which were then conducted for perceived provision.

Several data checks were conducted prior to this hypothesis-testing. Specifically, these examined baseline equivalence of groups, occurrence of reactivity, changes in affect, and agreement on partner supportiveness. Following these, we conducted the key analyses. These had four primary objectives; firstly, to examine individual-level CVR across three groups; secondly, to compare dynamic concordance in CVR between collaborative and supportive dyads; thirdly, to determine whether perceptions of supportiveness influenced individual- and dyad-level CVR and fourthly; to determine whether equity and reciprocity in these perceptions influenced individual- and dyad-level CVR.

**Descriptive statistics**

Cardiovascular and psychometric variables are reported in Table 11. Neither age nor BMI were correlated with resting cardiovascular levels (all $p_s \geq .31$ for age; all $p_s \geq .20$ for BMI) or with CVR (all $p_s \geq .14$ for age; all $p_s \geq .11$). Chi-squared analysis indicated that gender was evenly distributed across experimental groups, $\chi^2 = .45, p = .80$. The collaborative group included 18 men and 26 women (2 mixed
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dyads); the supportive group included 14 men (8 support providers) and 32 women (15 support providers); four dyads were of mixed gender.

One association was observed between psychometric variables and cardiovascular function; pre-task NA was correlated with higher TPR at rest ($r = +.42$, $p < .001$). Gender differences were observed such that men displayed higher resting DBP than did women ($M = 83.56$ vs. $M = 76.68$; $t[83] = 2.12, p = .04$) and higher overall DBP during the interaction ($M = 92.30$ vs. $M = 83.34$; $t[83] = 2.77, p = .007$). There was no significant difference in DBP change score by gender ($t[83] = 1.51, p = .14$); all other cardiovascular and affective variables were comparable.

**Baseline equivalence of groups**

Univariate ANOVA was used to examine baseline equivalency of variables. There were no significant differences between support roles at baseline for any of the five physiological indices, $F(2, 84) = 1.79, p = .17$, partial $\eta^2 = .04$ for SBP, $F(2, 84) = 1.28, p = .28$, partial $\eta^2 = .03$ for DBP, $F(2, 84) = 0.19, p = .83$, partial $\eta^2 = .005$ for HR, $F(2, 84) = 0.63, p = .54$, partial $\eta^2 = .02$ for CO, $F(2, 84) = 1.59, p = .21$, partial $\eta^2 = .04$ for TPR; for baseline PA, $F(2, 84) = 0.54, p = .58$, partial $\eta^2 = .01$, or NA, $F(2, 84) = 0.54, p = .59$, partial $\eta^2 = .01$. Age did not differ by role assignment, $F(2, 84) = 1.96, p = .15$, partial $\eta^2 = .05$; nor did BMI, $F(2,84) = 0.02, p = .98$, partial $\eta^2 = .001$. Finally, psychometric variables did not differ by role assignment (all $ps \geq .25$).

**Confirmation of reactivity**

$2 \times 1$ repeated-measures ANOVA complemented by scrutiny of the means indicated that there were significant changes between baseline and mean CVR during the interaction, $F(1, 84) = 42.57, p < .001$, partial $\eta^2 = .34$ for SBP; $F(1, 84) = 27.47,
Table 11

Means (with SDs) for participant characteristics and baseline values by gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting SBP (mmHg)</td>
<td>125.97 ± 15.43</td>
<td>123.24 ± 21.90</td>
</tr>
<tr>
<td>Resting DBP (mmHg)*</td>
<td>83.56 ± 12.06</td>
<td>76.68 ± 15.47</td>
</tr>
<tr>
<td>Resting HR (bpm)</td>
<td>79.68 ± 15.64</td>
<td>79.07 ± 14.61</td>
</tr>
<tr>
<td>Resting CO (l/min)</td>
<td>5.66 ± 1.47</td>
<td>5.15 ± 1.41</td>
</tr>
<tr>
<td>Resting TPR (pru)</td>
<td>1.17 ± 0.36</td>
<td>1.36 ± 1.27</td>
</tr>
<tr>
<td>Baseline PA</td>
<td>3.00 ± 0.55</td>
<td>2.82 ± 0.58</td>
</tr>
<tr>
<td>Baseline NA</td>
<td>1.36 ± 0.33</td>
<td>1.57 ± 0.60</td>
</tr>
<tr>
<td>Hostility</td>
<td>23.90 ± 6.47</td>
<td>24.21 ± 5.54</td>
</tr>
<tr>
<td>SSQ-N</td>
<td>4.15 ± 2.28</td>
<td>4.65 ± 1.81</td>
</tr>
<tr>
<td>SSQ-S*</td>
<td>4.87 ± 0.66</td>
<td>5.25 ± 0.64</td>
</tr>
</tbody>
</table>

Note: *p < .05 denotes significant gender difference in scores

$p < .001$, partial $\eta^2 = .25$ for DBP; $F(1, 84) = 21.72$, $p < .001$, partial $\eta^2 = .21$ for HR. and $F(1, 84) = 4.75$, $p = .03$, partial $\eta^2 = .05$ for CO. There was no significant change for TPR, $F(1, 84) = 0.03$, $p = .86$, partial $\eta^2 < .001$. As such, the task successfully elicited SBP, DBP, HR, and CO reactivity, but not TPR reactivity, revealing a comparable reactivity profile (indicative of active coping) to that elicited by the mental arithmetic stressor described in Chapter 3. Unadjusted reactivity values are reported in Table 13 with change scores from baseline to overall reactivity illustrated in Figure 6. Notably, providers exhibited a decrease in TPR from baseline to interaction; however, as referenced above, this downward shift was not significant using ANOVA. One-way ANOVAs conducted on change scores revealed no significant group differences in CVR.
Change in affect

Prior to examining the physiological indices, we used paired-samples $t$-tests to detect change in affect by support role from pre- to post-interaction. There was no significant change in PA or NA for support providers or collaborators (all $p_s \geq .37$). For support recipients, there was no change in PA, but a significant reduction in NA from pre to post-interaction, $t(23) = 2.62, p = .02$ ($M = 1.45, SD = 0.37$ vs. $M = 1.25, SD = 0.28$). Recipients’ PA was marginally correlated with PA post-interaction ($r = +.41, p = .05$), with a similar effect for NA ($r = +.45, p = .003$). Providers’ PA measures were not inter-correlated ($r = +.26, p = .24$), but their NA measures were ($r = +.59, p = .003$). Finally, collaborators pre and post-interaction PA measures were significantly inter-correlated ($r = +.65, p < .001$), while their NA measures were not ($r = +.13, p = .42$). Recipient measures were not correlated with provider measures; collaborator measures were not correlated with partner measures. Mean scores are shown in Table 12.

Table 12

Means (with SDs) for affect variables by support role

<table>
<thead>
<tr>
<th>Variable</th>
<th>Providers ($n = 23$)</th>
<th>Recipients ($n = 23$)</th>
<th>Controls ($n = 44$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>PA$^a$</td>
<td>2.80</td>
<td>0.60</td>
<td>2.97</td>
</tr>
<tr>
<td>NA$^a$</td>
<td>1.59</td>
<td>0.81</td>
<td>1.45</td>
</tr>
<tr>
<td>PA$^b$</td>
<td>2.89</td>
<td>0.66</td>
<td>2.95</td>
</tr>
<tr>
<td>NA$^b$</td>
<td>1.47</td>
<td>0.59</td>
<td>1.25</td>
</tr>
</tbody>
</table>

Note: $^a$Pre-interaction; $^b$Post-interaction
Ratings of and agreement on support

Pearson’s correlations indicated that collaborators agreed that they received instrumental support when it was provided ($r = +.88$, $p < .001$) and also agreed on encouragement ($r = +.53$, $p = .004$). Their ratings of stressfulness were not significantly inter-correlated ($r = -.14$, $p = .47$); nor was their satisfaction with their partner’s behaviour ($r = -.17$, $p = .40$). Ratings of stress were unrelated to partner perceptions of support receipt. However, support recipients and providers did not agree on received help ($r = -.16$, $p = .51$) or encouragement ($r = -.005$, $p = .98$). Provider perceived stress was inversely correlated with recipient reports of encouragement receipt ($r = -.47$, $p < .05$). Providers and recipients did not rate the interaction as similarly stressful ($r = +.08$, $p = .75$) nor did they rate their partner’s behaviour as similarly satisfactory ($r = +.17$, $p = .15$).

Interestingly, groups did not differ significantly in terms of the support they reporting receiving or providing (all $p$s > .20), which might initially suggest that the manipulation was unsuccessful. However, providers reported more support provision than they did receipt, while recipients and collaborators reported more receipt than provision, consistent with their assigned support role as shown in Figure 5. Collaborators reported lower receipt and provision than both recipients and providers.

Support role effects on gross reactivity

Having completed the preliminary analyses, the focal analyses tested the study hypotheses. Firstly, we examined individual-level CVR to test our prediction that providers would display lower CVR than either recipients or collaborators. Baseline levels, age, gender and BMI (all means-centred around the grand mean) were entered as covariates along with role (also centred around the grand mean of collaborator = 0,
provider = -1, recipient = 1) as a predictor of overall mean CVR during the interaction. To account for variability between dyads, slopes were allowed to vary by selecting the random effects intercept option for each dyad. This analysis was conducted for each parameter, SBP, DBP, HR, CO, and TPR.

Figure 5. Support ratings by group (support received reflects sum of help and encouragement received; support provided reflects sum of help and encouragement provided; error bars denote standard errors of the mean)
### Table 13

**Means (with SDs) for cardiovascular parameters during dyadic interaction (n = 85)**

<table>
<thead>
<tr>
<th>Measure</th>
<th>SBP&lt;sup&gt;a&lt;/sup&gt;</th>
<th>DBP&lt;sup&gt;a&lt;/sup&gt;</th>
<th>HR&lt;sup&gt;b&lt;/sup&gt;</th>
<th>CO&lt;sup&gt;c&lt;/sup&gt;</th>
<th>TPR&lt;sup&gt;d&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoch 1</td>
<td>132.70 ± 17.34</td>
<td>84.30 ± 12.77</td>
<td>82.98 ± 13.96</td>
<td>5.52 ± 1.42</td>
<td>1.37 ± 1.16</td>
</tr>
<tr>
<td>Epoch 2</td>
<td>135.14 ± 19.64</td>
<td>86.60 ± 14.14</td>
<td>83.66 ± 13.61</td>
<td>5.47 ± 1.42</td>
<td>1.33 ± 0.64</td>
</tr>
<tr>
<td>Epoch 3</td>
<td>136.15 ± 19.57</td>
<td>86.57 ± 16.78</td>
<td>83.62 ± 16.44</td>
<td>5.49 ± 1.43</td>
<td>1.28 ± 0.49</td>
</tr>
<tr>
<td>Epoch 4</td>
<td>137.08 ± 20.84</td>
<td>87.26 ± 17.76</td>
<td>83.90 ± 16.16</td>
<td>5.54 ± 1.46</td>
<td>1.25 ± 0.46</td>
</tr>
<tr>
<td>Epoch 5</td>
<td>138.48 ± 20.98</td>
<td>88.66 ± 16.72</td>
<td>84.61 ± 14.55</td>
<td>5.53 ± 1.43</td>
<td>1.30 ± 0.50</td>
</tr>
</tbody>
</table>

**Notes:**<br>  
<sup>a</sup> measured in mmHg; <sup>b</sup> measured in bpm; <sup>c</sup> measured in l/min; <sup>d</sup> measured in pru
Chapter 4. Dyadic social support

Figure 6. Reactivity scores for cardiovascular parameters for providers, recipients, and collaborators (changes scores from baseline levels; error bars denote standard errors of the mean).

Note: ** $p < .01$, *** $p < .001$ denote significant differences between recipient and provider groups only, in the multilevel analyses controlling for age, gender, and BMI.
Blood pressure. For SBP\(^4\), there were a significant effect for gender such that men displayed greater reactivity ($\beta = -7.25$, $p < .001$), with age positively related to SBP ($\beta = 0.73$, $p < .001$), and baseline SBP negatively related to SBP during the interaction ($\beta = -1.00$, $p < .001$). There was no effect of role on SBP ($\beta = 0.64$, $p = .22$). However, analyses for the support dyads only indicated that recipients displayed elevated SBP in comparison with providers ($\beta = 1.08$, $p = .007$), as expected.

For DBP across roles, main effects for age ($\beta = 0.28$, $p = .02$) and baseline DBP were observed ($\beta = -1.04$, $p < .001$; in addition to a near-significant effect for gender ($\beta = -2.19$, $p = .065$)). Importantly, a main effect for role was also noted ($\beta = 0.89$, $p = .004$). Follow-up analyses revealed support recipients displayed elevated DBP in contrast with providers ($\beta = 0.89$, $p < .001$), while there were no significant differences between providers and collaborators ($\beta = 6.48$, $p = .10$). Nor was the difference between recipients and collaborators DBP statistically significant ($\beta = -0.99$, $p = .52$).\(^5\)

Heart rate. Similar findings were observed for HR\(^6\). Significant effects were noted for baseline HR ($\beta = -0.96$, $p < .001$) and BMI ($\beta = 0.15$, $p = .002$). A main effect for gender was also observed; however, this time, women demonstrated elevated HR in comparison to men ($\beta = 2.86$, $p < .001$). Finally, a significant effect

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\(^4\) With role as the only predictor of CVR, the model was significant ($\beta = -2.42$, $p = .005$). With resting SBP controlled for ($\beta = -1.02$, $p < .001$), role was not a significant predictor ($\beta = 0.53$, $p = .34$). For the support dyads only, role was a significant predictor of CVR ($\beta = 0.94$, $p = .02$) when resting SBP was controlled for ($\beta = 1.19$, $p < .001$), and when it was not ($\beta = -2.49$, $p = .01$). Including the baseline value indicates that recipients have elevated SBP in comparison to providers. Excluding it indicates that providers have elevated SBP in response to recipients.

\(^5\) With role as the only predictor of CVR, the model was not significant ($\beta = -1.24$, $p = .066$). With resting DBP as a control variable ($\beta = -1.06$, $p < .001$) role was a significant predictor ($\beta = 0.88$, $p = .004$).

\(^6\) With role as the only predictor of HR CVR, a significant effect was observed ($\beta = 1.30$, $p = .02$). With resting HR included ($\beta = -0.95$, $p < .001$) the association appears to become more highly significant ($\beta = .54$, $p = .001$).
for role was noted ($\beta = 0.42, p = .007$). Recipients displayed elevated HR in comparison to providers ($\beta = 0.44, p < .001$), with no difference between recipients and collaborators ($\beta = 0.72, p = .63$), or providers and collaborators ($\beta = 1.32, p = .56$).

_Haemodynamic variables._ For CO\(^7\), effects were observed for baseline CO ($\beta = -0.86, p < .001$), gender ($\beta = 0.15, p = .03$), age ($\beta = 0.03, p < .001$), and BMI ($\beta = 0.02, p < .001$). As for SBP, no effects were observed for role ($\beta = 0.02, p = .30$). However, analyses for the support dyads only indicated that recipients displayed elevated CO in comparison with providers ($\beta = 1.01, p < .001$).

Finally, for TPR\(^8\), significant effects were observed for baseline TPR ($\beta = 1.12, p < .001$) and BMI ($\beta = -0.01, p = .04$), with a trend towards an effect for age ($\beta = -0.01, p = .087$) and a significant effect for role ($\beta = 0.02, p = .005$), suggesting that role effects on DBP were driven by effects on TPR. There were no significant differences between providers and collaborators ($\beta = 0.21, p = .45$), or recipients and collaborators ($\beta = 0.07, p = .26$), and similar to the results for DBP, recipients displayed elevated TPR in comparison to providers ($\beta = 0.02, p = .005$).

Conducting these analyses with resting levels as the only covariate revealed no change in the effects for role as a predictor of CVR, indicating that these were not contingent on controlling for gender or biometric characteristics. Therefore, support recipients demonstrated elevated CVR in comparison to providers across all

---

\(^7\) With role as the only predictor of CO CVR, a significant effect was observed ($\beta = .11, p = .04$). With resting CO included ($\beta = -.86, p < .001$) the association is non-significant ($\beta = .03, p = .15$).

\(^8\) With role as the only predictor of TPR CVR, a significant effect was observed ($\beta = -.06, p = .003$). With rest included in the model ($\beta = -.12, p < .001$), this remained significant ($\beta = .01, p = .01$). Therefore, the effects of role on CVR for any parameter do not appear to be contingent on controlling for gender.
parameters. While this contrasts with the findings of Holt-Lunstad et al. (2008), who observed no differences in CVR between support providers and recipients, their study involved emotional support provision and receipt in a situation where the recipient was not undergoing stress. In the context of stress, one might expect the support recipient to demonstrate elevated CVR in comparison to support providers, who, as highlighted in Chapter 3, may be stressed by support provision but not by the task itself. These effects are summarized in Table 14, Table 15, Table 16, Table 17, and Table 18.

**Testing within-dyad concordance**

Secondly, we tested our hypothesis regarding dyad-level CVR (i.e., that a significant difference in dynamic concordance in CVR would be observed between supportive and collaborative dyads, such that supportive dyads would demonstrate higher levels of epoch-by-epoch concordance in CVR). To do so, means-centred partner change scores for each epoch were entered as the dependent variable, with participant change scores for each epoch (grand mean-centred) entered as the predictor variable. Dyad type and the 2-way interaction between participant CVR and dyad type were also included. No additional covariates were included. First, the model excluding BD variance was conducted, then, the BD variance was added and the models compared by referring to the -2LL values. This model was conducted for each of the dependent variables, SBP, DBP, HR, CO, and TPR. Dyad type effects reflect effects observed above; therefore, the two-way interaction between participant CVR and dyad type was of primary interest. In summary, the model included partner
change score as the dependent variable, with participant change score, dyad type, and the change score × dyad type interaction term as predictor variables.
### Table 14

**Summary of multilevel model for effects of support role on SBP**

<table>
<thead>
<tr>
<th></th>
<th>Recipients vs. Providers</th>
<th>Collaborators vs. Recipients</th>
<th>Collaborators vs. Providers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Effect</strong></td>
<td><strong>SE</strong></td>
<td><strong>t</strong></td>
<td><strong>p</strong></td>
</tr>
<tr>
<td>Baseline</td>
<td>-1.169</td>
<td>0.035</td>
<td>-32.828</td>
</tr>
<tr>
<td>Age</td>
<td>.145</td>
<td>0.160</td>
<td>0.905</td>
</tr>
<tr>
<td>Gender</td>
<td>-5.098</td>
<td>1.696</td>
<td>-3.006</td>
</tr>
<tr>
<td>BMI</td>
<td>-.126</td>
<td>0.160</td>
<td>-0.784</td>
</tr>
<tr>
<td>Support Role</td>
<td>1.091</td>
<td>0.392</td>
<td>2.778</td>
</tr>
</tbody>
</table>

### Table 15

**Summary of multilevel model for effects of support role on DBP**

<table>
<thead>
<tr>
<th></th>
<th>Recipients vs. Providers</th>
<th>Collaborators vs. Recipients</th>
<th>Collaborators vs. Providers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Effect</strong></td>
<td><strong>SE</strong></td>
<td><strong>t</strong></td>
<td><strong>p</strong></td>
</tr>
<tr>
<td>Baseline</td>
<td>-1.151</td>
<td>0.026</td>
<td>-44.368</td>
</tr>
<tr>
<td>Age</td>
<td>-0.072</td>
<td>0.094</td>
<td>-0.769</td>
</tr>
<tr>
<td>BMI</td>
<td>-.069</td>
<td>0.087</td>
<td>-0.795</td>
</tr>
<tr>
<td>Support Role</td>
<td>0.890</td>
<td>0.206</td>
<td>4.312</td>
</tr>
</tbody>
</table>
## Table 16
**Summary of multilevel model for effects of support role on HR**

<table>
<thead>
<tr>
<th></th>
<th>Recipients vs. Providers</th>
<th>Collaborators vs. Recipients</th>
<th>Collaborators vs. Providers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Effect</strong></td>
<td><strong>SE</strong></td>
<td><strong>t</strong></td>
<td><strong>p</strong></td>
</tr>
<tr>
<td>Baseline</td>
<td>-1.055</td>
<td>0.015</td>
<td>-66.993</td>
</tr>
<tr>
<td>Age</td>
<td>0.156</td>
<td>0.047</td>
<td>3.364</td>
</tr>
<tr>
<td>Gender</td>
<td>0.419</td>
<td>0.476</td>
<td>0.879</td>
</tr>
<tr>
<td>BMI</td>
<td>0.427</td>
<td>0.042</td>
<td>10.047</td>
</tr>
<tr>
<td>Support Role</td>
<td>0.445</td>
<td>0.100</td>
<td>4.443</td>
</tr>
</tbody>
</table>

## Table 17
**Summary of multilevel model for effects of support role on CO**

<table>
<thead>
<tr>
<th></th>
<th>Recipients vs. Providers</th>
<th>Collaborators vs. Recipients</th>
<th>Collaborators vs. Providers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Effect</strong></td>
<td><strong>SE</strong></td>
<td><strong>t</strong></td>
<td><strong>p</strong></td>
</tr>
<tr>
<td>Baseline</td>
<td>-1.016</td>
<td>.026</td>
<td>-38.203</td>
</tr>
<tr>
<td>Age</td>
<td>0.034</td>
<td>.006</td>
<td>5.188</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.028</td>
<td>.066</td>
<td>-0.420</td>
</tr>
<tr>
<td>BMI</td>
<td>0.007</td>
<td>.006</td>
<td>1.127</td>
</tr>
<tr>
<td>Support Role</td>
<td>0.012</td>
<td>.015</td>
<td>0.855</td>
</tr>
</tbody>
</table>
Table 18

Summary of multilevel model for effects of support role on TPR

<table>
<thead>
<tr>
<th></th>
<th>Recipients vs. Providers</th>
<th>Collaborators vs. Recipients</th>
<th>Collaborators vs. Providers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>-1.376 0.029 -47.970 &lt; .001</td>
<td>-.985 0.020 -47.632 &lt; .001</td>
<td>-0.961 0.021 -45.175 &lt; .001</td>
</tr>
<tr>
<td>Age</td>
<td>-0.010 0.002 -4.192 &lt; .001</td>
<td>.003 0.004 0.643 .521</td>
<td>0.002 0.005 0.390 .697</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.007 0.025 -0.298 .766</td>
<td>-0.16 0.031 -5.316 &lt; .001</td>
<td>-0.219 0.035 -6.268 &lt; .001</td>
</tr>
<tr>
<td>BMI</td>
<td>0.002 0.002 1.042 .299</td>
<td>-0.004 0.002 -1.490 .137</td>
<td>-0.002 0.002 -0.653 .514</td>
</tr>
<tr>
<td>Support Role</td>
<td>0.037 0.005 6.377 &lt; .001</td>
<td>0.071 0.061 1.152 .256</td>
<td>0.216 0.281 0.771 .445</td>
</tr>
</tbody>
</table>
Blood pressure. For SBP, CVR was not associated with partner CVR, as there was no main dynamic concordance effect as shown in Table 19. Importantly, there was a significant dyad type × CVR interaction on partner CVR. For DBP, similar results were observed. There was no main dynamic concordance effect for DBP, but importantly, there was again a dyad type × CVR interaction on partner CVR, indicative of a moderation effect for dyad type on dynamic concordance.

Follow-up analyses by dyad type revealed that dynamic concordance was observed in support dyads for SBP ($\beta = .37, p < .001$) and for DBP ($\beta = .45, p < .001$), but not for collaborative dyads (for SBP, $\beta = .06, p = .38$; for DBP, $\beta = .04, p = .51$). Pearson’s correlations were used to corroborate MLM results, and indicated that SBP was correlated in support dyads ($r = +.24, p = .02$) as was DBP ($r = +.33, p = .001$), but not for collaborative dyads ($r = -.13, p = .24$ for SBP; $r = -.05, p = .66$ for DBP).

Other cardiovascular variables. For HR, CO, and TPR, no concordance in CVR was observed. These findings for SBP and DBP are illustrated in Figure 7.

Support perceptions and CVR within supportive dyads

Thirdly, we tested whether perceptions of supportiveness during the interaction affected individual- and dyad-level CVR for recipients and providers (i.e., for support dyads only). Perceived support receipt (sum of perceived help and perceived encouragement) was entered as a variable into the model with resting level and role as additional predictors. In addition, the interaction term of role × received support was entered into the model predicting overall mean CVR.

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9 The model for DBP also revealed a main effect of dyad type on CVR, such that support dyads had higher DBP than collaborative dyads, when BMI, gender, and age were not controlled for. Essentially, this means that recipients had higher DBP than collaborators, as it is recipients’ CVR that is included within the criterion variable of partner CVR.
Support receipt and cardiovascular variables. For SBP, there were significant effects of role ($\beta = 6.32, p < .001$) and support receipt ($\beta = 2.63, p < .001$) on CVR, and a role × support receipt interaction ($\beta = -2.10, p < .001$) as illustrated in Figure 8 and Figure 9. For DBP, there was no significant main effect of support receipt ($\beta = 0.02, p = .97$), but a significant role × support receipt interaction ($\beta = -1.23, p = .01$). Therefore, perceiving support receipt was associated with elevated SBP for all groups, partially consistent with social psychological theories of support exchange. Moreover, for DBP, support receipt was taxing for recipients and collaborators, but not for providers, also partially consistent with social exchange theory. This effect is illustrated in Figure 10. There were no main or interactive effects of receipt on HR, CO, or TPR.

Support provision and cardiovascular variables. Next, the analyses were repeated using support provision rather than receipt. For SBP, there was no significant effects of support provision ($\beta = -0.33, p = .51$) on CVR, and no role × support provision interaction ($\beta = -0.49, p = .43$). For DBP, there was a significant effect of support provision ($\beta = -1.08, p = .02$), but no significant role × support provision interaction ($\beta = -0.38, p = .47$).

There were no main or interactive effects of provision on HR. There was a main effect of support provision on CO ($\beta = 0.07, p = .002$) but no role × provision interaction. Likewise, there was a main effect of provision on TPR ($\beta = -0.10, p = .004$) but no role × provision interaction. These effects were such that support provision was associated with buffered CVR during the interaction, for DBP, CO, and TPR.
Table 19

*Summary of multilevel models predicting concordance over time for SBP and DBP*

<table>
<thead>
<tr>
<th></th>
<th>Partner SBP</th>
<th></th>
<th></th>
<th></th>
<th>Partner DBP</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Effect</td>
<td>SE</td>
<td>t</td>
<td>p</td>
<td>Effect</td>
<td>SE</td>
<td>t</td>
<td>p</td>
</tr>
<tr>
<td>Participant CVR</td>
<td>-1.299</td>
<td>1.411</td>
<td>-.921</td>
<td>.358</td>
<td>-1.203</td>
<td>.944</td>
<td>-1.275</td>
<td>.204</td>
</tr>
<tr>
<td>Dyad type</td>
<td>.079</td>
<td>.055</td>
<td>1.423</td>
<td>.156</td>
<td>.193</td>
<td>.067</td>
<td>2.864</td>
<td><strong>.005</strong></td>
</tr>
<tr>
<td>P. CVR × Dyad type</td>
<td>.301</td>
<td>.110</td>
<td>2.756</td>
<td><strong>.006</strong></td>
<td>.438</td>
<td>.133</td>
<td>3.289</td>
<td><strong>.001</strong></td>
</tr>
<tr>
<td>Including random slopes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participant CVR</td>
<td>.223</td>
<td>.055</td>
<td>4.104</td>
<td>.000</td>
<td>-1.559</td>
<td>1.815</td>
<td>-.859</td>
<td>.395</td>
</tr>
<tr>
<td>Dyad type</td>
<td>-1.883</td>
<td>2.787</td>
<td>-.676</td>
<td>.503</td>
<td>.254</td>
<td>.055</td>
<td>4.569</td>
<td><strong>.000</strong></td>
</tr>
<tr>
<td>P. CVR × Dyad type</td>
<td>.32</td>
<td>.1086</td>
<td>2.962</td>
<td><strong>.003</strong></td>
<td>.421</td>
<td>.110</td>
<td>3.825</td>
<td><strong>.000</strong></td>
</tr>
</tbody>
</table>

Notes: Measures are means-centred around the grand mean. Excluding random slopes: For SBP model, -2LL = 1404.33, AIC = 1414.33, BIC = 1430.59. For DBP model, -2LL = 1247.51, AIC = 1257.51, BIC = 1273.77. Including random slopes: For SBP model, -2LL = 1257.41, AIC = 1269.41, BIC = 1288.92. For DBP model, -2LL = 1105.46, AIC = 1117.46, BIC = 1288.92. Comparing the -2LL values reveals both models including random slopes are a better fit; ps = .001. As modelling provider–recipient and recipient–provider associations would essentially mean analyzing data twice over (and likewise for collaborative dyads) the models are constructed such that provider CVR is predicting recipient CVR in the support dyads.
Figure 7. Concordance in SBP and DBP (solid lines denote supportive dyads) using absolute difference in changes scores for dyad members at each epoch.
Support perceptions and dynamic concordance in CVR

Finally, we tested whether support perceptions or equity and reciprocity in these influenced the observed concordance in SBP and DBP during the interaction. Equity was operationalized from the perspective of each individual (i.e., the discrepancy in support they reported providing and receiving) with reciprocity operationalized from the perspective of the dyad (i.e., average agreement on support received and provided).

Including perceptions of support, equity in support receipt (operationalized as the absolute difference between partners’ perceived receipt) and equity in support provision (likewise) revealed no significant effects on concordance for either SBP or DBP; nor did reciprocity influence concordance in either measure. Therefore, while supportive dyads demonstrated greater concordance in blood pressure throughout the interaction, this appeared not to be a function of specific perceptions of support receipt, provision, or equity or reciprocity in receipt and provision.

Figure 8. Scattergram reflecting main effect of perceived support on SBP reactivity during the interaction.
Figure 9. Scattergrams of SBP × perceived support receipt for each group illustrating role × perceived support interaction for SBP.
Figure 10. Scattergrams of DBP × perceived support receipt for each group illustrating role × perceived support interaction for DB
DISCUSSION

The present study sought to investigate cardiovascular responses to live social support provision and receipt, and further, to examine dynamic concordance in CVR during the interaction. Consistent in part with social psychological theories of support, the perception of having provided support to another person was associated with buffered DBP, CO, and TPR during the interaction for all groups, with no effects of provision on SBP or HR. Further, concordance in SBP and DBP was observed only for supportive and not for collaborative dyads. The findings diverge from those studies demonstrating effects on cardiac elements of the stress response, suggesting that support provision and receipt exert qualitatively different influences on cardiovascular stress responses. Moreover, the findings indicate that physiological concordance may be observed in supportive interactions, suggesting concordance as one means by which support may influence individual–level physiological responsivity.

Although several studies suggest that concordance in physiology may be important to the quality of interactions in developmental and marital contexts, this study is unique in its examination of concordance during dyadic support interactions. As such, the present study affirms that concordance in physiology is not present only in marital or family dyads, but extends to support interactions between friends. Although limited research has examined support provision and receipt effects on CVR in a dyadic context (e.g., Holt-Lunstad et al., 2008), these studies have applied analytical approaches that do not offer much more than do separate studies of support provision and receipt. In the present study, while support providers demonstrated significantly lower overall CVR in comparison with both recipients and collaborators,
the epoch-by-epoch blood pressure measures of providers and their recipient partners were more similar than were those of the collaborative dyads.

Importantly, individuals engaged in a supportive transaction demonstrated more highly correlated SBP and DBP reactivity than those completing the task in a non-supportive context. Much prior work describes the effects of support on cardiac indices in particular, with less reporting vascular effects. In the present study, no such concordance for the other parameters, HR, CO, and TPR was noted, meaning that it is difficult to clarify the nature of the effects at the haemodynamic level. However, these effects for blood pressure indicate that individuals engaged in a supportive interaction are more attuned to each other’s physiological arousal, a finding that most studies have considered indicative of positive relationship qualities, though consensus is far from complete.

In the present study, equity was operationalized as the difference in support provision and receipt for each individual, while reciprocity was operationalized as the agreement between dyad members on support received and provided. Previous studies have varied in their definition of reciprocity; for example, Gleason et al. (2003) defined perceived reciprocity from the perspective of the individual. In their study, perceived reciprocity is present when support is perceived to be both received and given by an individual. Similarly, Knoll et al. (2006) presumed reciprocity in support provision to occur when individuals’ received support two days prior to an exam stressor predicted change in their provision of support from two days to one day prior to the exam. To distinguish between individual perceptions and dyad members’ agreement on equity, we calculated equity and reciprocity as distinct measures. However, neither of these constructs moderated individual CVR or dynamic concordance in CVR. The failure to observe significant effects here suggests that
equity and reciprocity, as operationalized in the present study, were not buffers of CVR in response to a laboratory challenge, though effects may have been detected in a larger sample size. However, the significant differences in concordance between supportive dyads and collaborative dyads suggest that some element of the support interaction is likely to influence CVR at the level of the dyad.

In the present study, surprisingly, reports of support receipt and provision did not differ significantly across groups. However, recipients demonstrated greater CVR during the interaction than did providers or collaborators, suggesting that CVR was sensitive to the experimental manipulation employed. One reason for this discrepancy is that the 4-point Likert-format ratings scale was too restricted to capture variations in perceptions of the interaction. Some other studies have successfully employed a 7-point (Glynn, Christenfeld, & Gerin, 1999; Phillips, Gallagher, et al., 2009; Steptoe, Owen, Kunz-Ebrecht, & Brydon, 2004; Westmaas & Jamner, 2006) or even a 9-point format (Van Well & Kolk, 2008) that may be considered for additional research. However, it is also worth noting that many of these studies use confederates or structured support from friends, and therefore had greater control over the degree of supportiveness provided. In addition, the balance of support provision and receipt was consistent with the provider/recipient role distinction, with providers reporting more provision than receipt, and recipients reporting more receipt than provision. It is also notable that ratings of interactions do not always predict consistent cardiovascular effects; for example, in Phillips, Gallagher, et al. (2009), participants in the active condition felt closer to and more supported by their supporter, but active support from a female friend increased SBP reactivity while active support from a male friend decreased SBP reactivity. Nonetheless, perceptions of support provision and receipt predicted variations in CVR according to role. For recipients and collaborators,
perceived receipt was associated with elevated CVR, with no effect for support providers. This is partially consistent with social exchange theories in that receipt was detrimental, and only for those groups who reported greater receipt than provision. For providers, receipt had no effect on CVR, while provision generally buffered CVR across all three groups. As such, the effects of being in a support provider role were not enhanced by perceiving receipt in return. While this coheres more with esteem–enhancement rather than equity or reciprocity theories, it is plausible that individuals in a chronic or long-term provider role might benefit from perceiving receipt in turn.

Of course, a limitation of this study is that participants completing the task individually (that is, those in the recipient role) were all subject to support provision. Therefore, the current design precludes comparisons between support receipt, and individual task completion without support receipt. While the study was not intended to explicitly compare support receipt with mere presence of a supporter, or other contextual support variables, to do so might shed further light on the conditions under which support is useful for both recipient and provider.

Other limitations of the study pertain to the sample size and characteristics. Utilizing a primarily homogenous sample of healthy undergraduate students precludes generalization of the findings to other cohorts, such as older individuals or those with clinical disease. Moreover, the current paradigm invited participants to recruit their study partner rather than assigning them to a specific partner or confederate. As such, it is likely that individuals selected a friend they felt comfortable participating with in the study, which may have produced a sample higher on characteristics such as friendliness or sociability in comparison to the general population. Their decision to participate may reflect patterns of gregariousness absent from nonparticipants. This requirement may also have excluded individuals low in social support who may have
felt unable to ask a friend to participate; indeed, examining SSQ-N and SSQ-S scores for this sample indicates that the men scored an average of 24.90 for SSQ-N, in comparison to the 15.22 observed for men in Study 1, though SSQ-S scores are comparable (27.90 in the present study versus 30.17 for Study 1) as are scores for women on both measures (28.09 vs. 27.90 for network size, and 30.68 vs. 31.50 for satisfaction, in Study 1 and the present study, respectively). While the sampling of real-life friendship dyads reduces the experimental control afforded by the use of a confederate, it also facilitates the extension of prior work to real-life friendships, with researchers suggesting that this method actually enhances rather than undermines the ecological validity of support provided during the interaction (Schwerdtfeger & Schlagert, 2011). Maintaining a degree of experimental control necessitated the random assignation of participants to dyad type and to role within the support-specific dyad, and this perhaps has the disadvantage of soliciting uncharacteristic behaviour of some participants. However, participants did not differ by support role on social network measures or on trait personality. A final issue is that friendliness *per se* was not assessed in the current protocol – instead, ratings of the interaction were sampled in terms of support perceptions, enjoyment, and stressfulness.

In conclusion, the present study suggests that supportive interactions may be characterized by concordance in physiology between two members of the interactive dyad. As some studies have upheld physiological concordance as adaptive and as connotative of optimal relationships, this suggests that supportive interactions may be advantageous at the dyadic level in terms of influences on physiology. Moreover, the findings also highlight that the benefits of supportive interactions may be derived from the experience of concordance in physiological arousal, rather than from buffered arousal in particular. However, it should be noted that a few inconsistent
results have been observed, with physiological concordance also reported as arising in such negative contexts as marital conflict (R. W. Levenson & Gottman, 1983) and parent–child relationships characterised by conflict (Hibel, Granger, Blair, & Cox, 2009). It is possible that rather than denoting sensitivity to the partner’s emotional and physiological arousal, concordance indicates stress contagion between partners where one or both partners are faced with a stressful task. Accordingly, to shed further light on whether concordance in physiology might be indicative of high quality or low quality relationships, the next study examines two forms of concordance in parent–child dyadic relationships characterised by high and low interpersonal stress, during a resting condition as opposed to in a stressful or emotional context.
Chapter 5: STUDY 4

--BRIEF REPORT—

DYADIC CONCORDANCE IN CARDIOVASCULAR FUNCTION IN PARENT–CHILD DYADS HIGH AND LOW IN INTERPERSONAL STRESS

INTRODUCTION

The previous chapters examined the influence of naturalistic and laboratory analogues of social support on individual measures of cardiovascular function, extending to an investigation of dyadic concordance in cardiovascular responsivity. Significant concordance in SBP and DBP was observed only among supportive (in comparison to collaborative) dyads. However, in Study 3, the provider–recipient role within these supportive dyads was experimentally manipulated rather than naturalistic. It is unlikely that this type of distinction accurately reflects the real-world relationships between those dyad members. To examine a more ecologically-valid provider–recipient distinction, Study 4 utilized a sample of mother–child dyads, with mothers being considered to have a persistent support provider role, and children viewed as regular support recipients. To clarify whether concordance is observed in optimal or disrupted dyadic relationships, we examined concordance between 2 groups of these dyads characterised by high or low interpersonal stress. Child maltreatment is used as an index of dyadic stress, with half the sample being characterised by CM, and half confirmed as non-CM by relevant Child Protective Services (CPS). Two operationalizations of concordance are employed; that is,

10 A manuscript based on this chapter has been accepted for publication in Developmental Psychobiology.
between-dyad (BD) where an individual’s average arousal is related to her/his partner’s average arousal level, and within-dyad (WD, or dynamic) concordance (where shifts in an individual’s arousal correspond to shifts in their partner’s arousal).

*Synchrony and concordance*

As noted in Chapter 4, outside of animal studies, synchrony has most often been studied within the context of caregiver–child relationships. Recent studies examining concordance in maternal–child physiology suggest that this may be moderated by various caregiving qualities such as maternal sensitivity, empathy, or depression, lending support to the idea that physiological concordance might be relevant to synchronous relationships. However, family systems theorists have described a process of being enmeshed or overinvolved in family relationships (Bowen, 1978; Minuchin, 1974) that might also be indicated by concordance rather than independence in emotional and physiological arousal. The implications of physiological concordance are further obscured by wide variation in how concordance is operationalized. To shed light on this in the present study, we examined two forms of concordance in autonomic function between mother–child dyads during a shared resting condition.

*Developmental perspectives on regulation*

Developmental psychologists conceptualize self-regulation as a child’s capacity to deliberately control affect and behaviour (Kochanska, Philibert, & Barry, 2009), which accounts for their emerging ability to voluntarily uncouple their behavioural response from the immediate emotional impulse. From a developmental perspective, socialization is the process by which children internalize external
regulation from parents and other caregivers to become self-regulating even in the absence of external monitoring (Kochanska, Coy, & Murray, 2001). Researchers have also posited that synchrony in interactions between child and caregiver fosters the development of self-regulatory skills (Feldman, Greenbaum, & Yirmiya, 1999), with a few studies examining concordance in physiology as potentially facilitative of or indicative of deficits in self-regulatory capacity. Concordance in physiology has received particular attention owing to the proposed physiological basis for emotional arousal and functioning (Kreibig, 2010; Porges, 2011).

*Studies of autonomic concordance*

Empirical studies of mother-child physiological concordance in autonomic measures have produced equivocal findings. Several have confirmed patterns of BD associations in mother–child responses to challenge, while none observed WD concordance. In a prospective study of 76 mother-infant dyads, Bornstein and Suess (2000) found no associations between mothers and children at two months or at five years in either resting HR or vagal tone (an index of heart rate regulation via the vagus nerve), though vagal withdrawal in response to challenge (that is, a withdrawal of vagal tone to effect an increase in heart rate to support increased metabolic demands) showed positive BD associations by age 5. Hill-Soderlund et al. (2008) found no dynamic concordance in autonomic functioning (as measured by salivary α-amylase and vagal withdrawal) during the Strange Situation Paradigm, but HR concordance during the Strange Situation in mother-infant dyads has been reported (Donovan & Leavitt, 1985). Paradoxically, some dynamic concordance has been observed in mother and infant HPA axis functioning (indexed via cortisol reactivity in response to challenge), both in mother-infant dyads exposed to domestic violence and
in dyads headed by more hostile and controlling mothers (Hibel et al., 2009), as well as among more sensitive mothers and their infants (van Bakel & Riksen-Walraven, 2008) and toddlers (Sethre-Hofstad, Stansbury, & Rice, 2002). In summary, whether or not physiological concordance is considered adaptive appears to depend on how it is operationalized (as BD or WD), the type of sample (i.e., normative or at-risk), the specific neurobiological process and parameter (e.g., autonomic, including HR and vagal tone) and the context in which it is assessed (i.e., at rest or in response to challenge). As such, it is unclear whether concordance in physiology reflects that type of synchrony thought to be critical to optimal development, or conversely, an inability to independently regulate one’s own physiological arousal, indicative of a deficit in differentiating oneself from the family or dyadic system.

Analytical approaches to concordance

Researchers have identified two key analytic approaches to developmental data that may help clarify the implications of physiological concordance. Variable-centred analytic models are based on the assumption that the population is homogeneous with respect to how the predictors operate on the outcomes, and person-centred approaches describe differences among individuals in how variables are related to each other (Laursen & Hoff, 2006). Although these have been described as complementary rather than competing methodologies, studies tend to focus on variable-centred models whereby inter-individual variation, or the effects of predictors on outcomes at the group level, is established. However, it is now appreciated that the application of inter-individual findings to any one individual (i.e., generalizing from inter to intra-individual variation) is usually statistically invalid (except in rare cases where [i] the same statistical model applies to the data of all...
subjects in the population [homogeneity of the population] and [ii] the data must have invariant statistical characteristics across time; for instance, having constant mean and variance; Molenaar & Campbell, 2009). As such, researchers have called for the application of both variable- and person-specific analyses to developmental datasets. This is particularly relevant to cases for which broad within-group variability in children’s outcomes have been documented, in addition to important group-level effects.

*Child maltreatment as a stressful context*

CM is one important context for which both inter-and intra-individual variation in outcomes has been observed. CM, most commonly in the form of harsh physical punishment or abuse, or neglect of a child’s basic physical needs, is known to contribute to impairments across many domains of children’s functioning (e.g., Cicchetti & Toth, 2005; Shonkoff, Garner, & The Committee on Psychosocial Aspects of Child and Family Health, 2012); however, not all children display such deficits, and the mechanisms accounting for individual differences are not well understood (Cicchetti & Valentino, 2006). Maltreating parents themselves have displayed deficits in physiological regulation. For example, CM parents show higher resting HR and greater HR activation (Bugental et al., 1993; Bugental, Lewis, Lin, Lyon, & Kopeikin, 1999; Frodi & Lamb, 1980), cortisol hypersecretion (E. K. Lin, Bugental, Turek, Martorell, & Olster, 2002), and declines in galvanic skin response (Bugental & Cortez, 1988) in response to neutral and child-specific stimuli, compared to non-CM parents. This constellation of cardiovascular and neuroendocrine hyper-responding indicates a pattern of “threat-sensitivity” (Bugental, 2009), and may compromise a parent’s ability to engage in mutual, consensually shared experiences
with their child. To date, no study that we are aware of has examined physiological concordance in CM parent–child relationships. As CM is related to both group-level and intra-individual variation in developmental outcomes, it is possible that patterns of BD and WD physiological concordance differ between this at-risk group and normative mother–child relationships. Comparing patterns of concordance in CM and non-CM dyads may help shed light on the meaning of physiological concordance for synchrony within close dyadic relationships.

Therefore, we sought to determine whether WD and BD concordance in autonomic physiology would be observed among mothers and their children during resting conditions (that is, during the absence of environmental challenge), and whether the pattern of associations would vary as a function of their risk status. We examined HR, a measure of autonomic arousal reflective of both sympathetic and parasympathetic nervous system influences, and respiratory sinus arrhythmia (RSA), a measure of the change in oscillatory dynamics of the heart across the respiration cycle that is considered to be a measure of parasympathetic influence (Berntson et al., 1997; Porges, 1995) and to be indicative of stress vulnerability (Porges, 2009). The sympathetic and parasympathetic divisions of the autonomic nervous system represent the principal channels of interaction between the brain and bodily organs, and according to Porges’s (1995) polyvagal theory, have complementary roles in the achievement of homeostasis and the regulation of physiological responses to emotional stimuli. Researchers have therefore hypothesized that concordance in autonomic function might underlie shared empathic experiences between mother and child (Ebisch et al., 2012). Divergent links between resting HR and adjustment have been observed depending on the context, with lower resting HR linked to emotion expression in pre-schoolers (Cole, Zahn-Waxler, Fox, Usher, & Welsh, 1996), and to
externalizing problems in pre-adolescents (Dietrich et al., 2007). High resting RSA is thought to be critical to physiological self-regulation and appropriate engagement with the environment (Hofheimer, Wood, Porges, Pearson, & Lawson, 1995), with Porges (1995) describing how vagal tone fosters physiological homeostasis during states of low environmental demand to promote growth and restoration.

Our aim in examining concordance in a resting context was to examine a form of concordance that is not influenced by variance in external cues. As this resting phase comprises a condition of minimal environmental stimulation, arousal levels are indicative of self-regulatory processes that function to maintain internal homeostasis. Observing concordance at rest may help clarify whether parent–child difficulties with regulation extend beyond overt interactions to non-stressful contexts, and might thus be more pervasive than studies examining stressful interactions suggest. Therefore, our analyses examine concordance in those processes regulating internal homeostasis (rather than regulation in response to external demands), and serve to illustrate differences in BD and WD concordance depending on risk status.

Two forms of concordance were considered. First, associations in the rank order status of a mother and her child’s HR and RSA were examined to determine the extent of BD physiological concordance (e.g., do mothers who display higher average resting HR have children who also show higher average resting HR?). Second, dynamic concordance was defined as the extent of WD concordance observed in dynamic changes in mother and child HR and RSA across the duration of a phase. While some studies suggest that physiological concordance is indicative of synchrony (e.g., van Bakel & Riksen-Walraven, 2008), while others suggest it to indicate enmeshment, or failure to independently regulate one’s own arousal levels (e.g., Hibel et al., 2009), we did not make specific predictions regarding which type of
concordance would be observed in either group. Instead, our aim was to demonstrate that patterns of physiological concordance are likely to differ between normative and at-risk groups depending on how this is operationalized. We therefore hypothesized that patterns of WD and BD concordance would differ as a function of CM status (i.e., that CM group status would moderate BD and dynamic associations between mother–child HR and RSA).

We also examined the moderating effect of average maternal HR levels on dynamic WD concordance. We hypothesized that higher resting maternal HR would be associated either with lower dynamic concordance (if indicative of synchrony) or higher dynamic concordance (if indicative of enmeshment); therefore, we examined this moderator in an effort to shed light on the meaning (or interpretation) of observed patterns of concordance. As the aim of the analysis is to further explore the utility of dyadic physiological measures and their potential relevance to close dyadic interactions, the implications of the findings for mother–child dyads are not comprehensively discussed. Rather, a brief illustration of two methodological approaches to concordance is presented.

**METHODS**

*Participants*

The sample consisted of 52 CM and 52 non-CM mother–child dyads ($N = 208$ individuals) from low-income, rural communities. Children ranged in age between 3 and 5 years ($M = 3.75$, $SD = 0.75$), 53.8% were female, and 80.4% were Caucasian. Mothers ranged in age from 20 to 49 years ($M = 29.20$, $SD = 5.96$), averaged 13.0 years of education ($SD = 2.10$), and half (48.5%) were employed outside the home. Based on U.S. census income-to-needs ratios, the majority of families were classified
as near (39.3%) or below (47.1%) the poverty line. Among the subsample of CM children, 14 were identified as having been previously physically abused and 38 as previously physically neglected, based on CPS documentation of mother’s status as a perpetrator toward the target child, and using the Maltreatment Classification System (MCS; Barnett, Manly, & Cicchetti, 1993). Physical abuse was coded when there was evidence of a caregiver-inflicted physical injury to the child by other than accidental means. Physical neglect was coded based on documentation that the caregiver failed to meet the child’s minimum physical needs. Comorbidity of subtypes (i.e., physical abuse with neglect and/or emotional abuse; physical neglect with emotional abuse) was observed in 48.1% of the CM group, consistent with other published findings (e.g., Belsky, 1993; Kaufman & Zigler, 1989). Non-CM dyads were recruited from other public welfare agencies and a database maintained on birth announcements published in local newspapers. Non-CM mothers consented to verification that their family was free of CPS preventive or protective service records.

*Demographic variables*

CM and non-CM children did not differ on dimensions of child age as indicated in Table 20, and there was no difference in distribution of boys and girls between groups (24 boys in either group). CM and non-CM mothers did not significantly differ on employment status; $t(101) = -0.88, p = .38$; or age $t(102) = -1.99, p = .05$. However, mothers from the CM group reported fewer total years of education, $t(100) = 3.08, p < .003$ ($M = 13.60$ versus $M = 12.40$), and lower household income, $t(100) = 5.33, p < .0001$, than non-CM mothers. Ninety-six per cent of CM families reported incomes below $50,000 per year, as contrasted with 76.5% of non-CM families reporting income below $50,000 per year.
Table 20

Descriptive statistics and correlations among mother and child resting heart rate (HR) and respiratory sinus arrhythmia (RSA)

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<td><strong>CM Dyads (n = 52)</strong></td>
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<td></td>
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<tr>
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<td>2. Child sex</td>
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<td>-</td>
<td>.07</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Mother education</td>
<td>12.41*</td>
<td>2.04</td>
<td>.28*</td>
<td>-.15</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Mother HR&lt;sub&gt;a&lt;/sub&gt;</td>
<td>82.60*</td>
<td>9.94</td>
<td>-.11</td>
<td>-.18</td>
<td>.01</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Mother RSA&lt;sub&gt;a&lt;/sub&gt;</td>
<td>5.51</td>
<td>1.28</td>
<td>-.08</td>
<td>.13</td>
<td>-.21</td>
<td>-.69**</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>6. Child HR&lt;sub&gt;a&lt;/sub&gt;</td>
<td>103.27</td>
<td>11.59</td>
<td>-.13</td>
<td>-.24</td>
<td>.01</td>
<td>.48**</td>
<td>-.35**</td>
<td>-</td>
</tr>
<tr>
<td>7. Child RSA&lt;sub&gt;a&lt;/sub&gt;</td>
<td>5.81</td>
<td>1.13</td>
<td>-.03</td>
<td>.21</td>
<td>-.04</td>
<td>-.32*</td>
<td>.24</td>
<td>-.82**</td>
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<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>1</th>
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<th>5</th>
<th>6</th>
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<tbody>
<tr>
<td><strong>Non-CM Dyads (n = 52)</strong></td>
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<tr>
<td>1. Child age</td>
<td>3.77</td>
<td>0.73</td>
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<td>2. Child sex</td>
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<td>-</td>
<td>.03</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Mother education</td>
<td>13.63</td>
<td>1.95</td>
<td>.01</td>
<td>-.10</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Mother HR&lt;sub&gt;a&lt;/sub&gt;</td>
<td>77.21*</td>
<td>11.74</td>
<td>.11</td>
<td>.14</td>
<td>-.22</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Mother RSA&lt;sub&gt;a&lt;/sub&gt;</td>
<td>6.04</td>
<td>1.17</td>
<td>-.09</td>
<td>-.22</td>
<td>.11</td>
<td>-.62**</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>6. Child HR&lt;sub&gt;a&lt;/sub&gt;</td>
<td>99.85</td>
<td>9.65</td>
<td>-.40**</td>
<td>-.20</td>
<td>-.07</td>
<td>-.01</td>
<td>.10</td>
<td></td>
</tr>
<tr>
<td>7. Child RSA&lt;sub&gt;a&lt;/sub&gt;</td>
<td>6.29</td>
<td>1.16</td>
<td>.27</td>
<td>-.08</td>
<td>.13</td>
<td>-.08</td>
<td>.06</td>
<td>-.66**</td>
</tr>
</tbody>
</table>

*Mean value reflects average taken across all 30” epochs. In the case of M’s and SD’s, significance tests assess CM group differences. *p < .05. **p < .01

†We conducted a series of independent samples t-tests to compare CM subtypes on cardiac variables. Only one significant difference between abuse and neglect groups was observed; child RSA was marginally higher for children in the physical abuse group in comparison with children in the neglect group (M = 5.99 v. M = 5.70; p = .045). No significant differences on any demographic variables were observed.
Procedure

All procedures employed in this study were approved and monitored by the Office for Research Protection. Mother–child dyads were invited to participate if the mother was 18 years of age or older, spoke fluent English, and was living with her preschool child. Dyads completed a 3-visit protocol over a 2-3 week period conducted by a team of two trained interviewers, comprising two home visits for psychosocial and cognitive assessments, and a laboratory session: they were paid $150, and provided transportation, snacks, and children’s small toys/gifts. During the laboratory session, dyads participated in a five-minute resting condition in which mother and child dyads were seated closely together on a couch with lights dimmed, and instructed to rest quietly while viewing a low-action animated videotape. Further details of the larger protocol are reported elsewhere (Skowron, Kozlowski, & Pincus, 2010; Skowron et al., 2011).

Physiological Assessment. To monitor mother and child cardiac physiology, disposable pre-gelled Ag/AgCl electrodes were placed in a modified Lead II placement on the distal end of the right clavicle, lower left rib cage chest, and the lower abdomen. Data were acquired via Mindware Technologies© (Gahanna, OH) ambulatory electrocardiograph (ECG) MW1000A, transmitted via wireless signal to a computer and monitored by a research assistant. Heart rate data were quantified by taking the ECG signals and passing them through an A/D converter with ECG sampled at a rate of 500 Hz. Electrocardiograph data were processed offline using Mindware Technologies HRV 3.0.10 analysis program, and epochs were visually inspected by trained research assistants. Erroneously identified, or missing heart beats were manually deleted or inserted as appropriate. The resulting inter-beat interval time series was subjected to a fast-Fourier transformation, and power in the
respiratory frequency band was derived from the spectral density function. The RSA frequency band was set between 0.24 and 1.04 for children, and 0.12 to 0.40 for mothers. Heart rate and RSA were calculated in 30-second epochs across the 5-minute joint resting phase, and overall HR and RSA means for the task were calculated for mothers and children. Dynamic changes in mothers’ and children’s HR and RSA were operationalized by calculating concurrent concordance in centred HR or RSA values for each epoch across the 10 30-second epochs (i.e., we examined variation from epoch to epoch within the resting condition, rather than within-epoch or lead-lag associations).

Analyses

Mother and child HR and RSA data were collected simultaneously and longitudinally nested within dyads. Across 104 mother–child dyads comprising 208 individuals, HR data were collected for a total of 985 epochs for children, and 992 epochs for mothers with RSA data collected for 930 epochs for children, and 949 epochs for mothers. We used SAS PROC MIXED 9.3 to model dynamic WD concurrent associations between mother and child HR and RSA over the course of the resting period, and BD associations in overall mean HR or mean RSA (e.g., Saxbe & Repetti, 2010; Sliwinski, Smyth, Hofer, & Stawski, 2006). Using the Linear Mixed function in SPSS 18.0 produced identical results.

First, we estimated associations between mothers’ overall average (BD) and dynamic (WD) HR on one hand, and children’s HR on the other, and tested whether maternal average HR moderated the extent of mother–child dynamic HR concordance. Covariates included child sex, age, and maternal education. Next, we examined CM group differences in concordance between mother’s mean HR (BD)
and dynamic HR (WD) and child HR. The Level 1 (WD) predictor was mother’s mean-centred HR during each of the 30-second epochs (i.e., mother’s HR at each epoch, centred around the grand mean; Mom HR_pmc), and the Level 2 (BD) predictors were mother’s overall mean HR level for the phase (i.e., average HR over the 10 epochs, centred around the grand mean; Mom HR_mnij), the covariates maternal education, children’s age, and sex) and CM status (CM vs. non-CM). CM group status was dummy-coded on the basis of mother’s status as a perpetrator of child abuse/neglect (i.e., CM group), with non-CM status coded as 0. Models were re-specified to test associations between maternal and child RSA, and finally to examine associations between maternal HR and child RSA.

RESULTS

Descriptive statistics

Table 20 shows the means, standard deviations, and zero-order correlations for mother and child overall task HR and RSA by CM status. There were significant associations between mother and child mean HR and mother mean HR and child mean RSA measures in the CM group, but not for the non-CM group. Age effects were observed in children’s resting HR values such that (for non-CM children only) younger children displayed higher resting HR, $r(52) = -.40, p < .01$. Lower child RSA levels were observed among younger non-CM children, $r(50) = .27, p = .06$. Sex differences were observed in children’s HR, $t(104) = 2.21, p = .03$, with girls posting higher average resting HR ($M = 103.7, SD = 10.60$) than boys ($M = 99.10, SD = 10.50$). Children’s resting RSA levels did not differ by sex, $t(100) = -0.64, p = .53$. In light of the socio-demographic stratification by CM status, maternal education was included as a covariate in the major analyses, along with children’s age and sex.
**HR and RSA by CM group status.** Independent t-tests assessed differences between mother and child mean resting physiology by CM status. CM mothers showed significantly higher resting HR ($M = 82.60, SD = 9.94$) and lower resting RSA ($M = 5.51, SD = 1.28$) than did non-CM mothers (HR: $M = 77.21, SD = 11.74$; RSA: $M = 6.04, SD = 1.17$, $t(102) = 2.52, p = .01$ and $t(102) = -2.21, p = .03$, respectively). As indicated in Table 20, no CM group differences were observed in children’s resting HR and RSA.

**Testing within- and between-dyad physiological concordance**

**HR concordance.** Dyadic associations in mother and child HR levels over time were analyzed using MLM procedures. In Model 1a (Table 2), the Level 1 (WD) predictor was mother’s mean-centered HR during each of the 30″ epochs (i.e., mother’s HR at each epoch, centred around the grand mean; Mom HR_pmc), and the Level 2 (BD) predictors were mother’s overall mean HR level for the phase (i.e., average HR over the 10 epochs; Mom HR_mn), and the covariates maternal education, children’s age, and sex). Age ($β = -3.43, p < .01$) and child sex ($β = -4.90, p < .05$) were significantly associated with child HR, such that younger children showed higher HR levels, and boys posted higher HR relative to girls. Maternal education was not significantly associated with child HR ($β = 0.09, p = .86$). Mothers with higher average resting HR had children who also posted higher resting HR, $β = 0.28, p < .01$. Dynamic (WD) associations were also observed as mother and child HR was positively correlated over the course of the 5-minute resting condition ($β = .33, p < .0001$). Further, the dynamic WD HR concordance was moderated by differences in mothers’ average HR ($β = -.02, p < .05$), indicating that dyads for which mothers who
showed greater HR elevations displayed lower dynamic HR concordance over time. Conversely, dyads for which mothers showed lower average HR displayed greater dynamic concordance in mother and child HR. However, as the magnitude of the WD effect was 0.33, and this was lowered by 0.015 (see Table 21) for every beat above maternal mean HR, this interaction effect is relevant only to those mothers with a mean HR of less than 22 beats above the mean. As such, this interaction effect is somewhat small.

**RSA concordance.** We then specified the same model substituting maternal and child RSA for maternal and child HR. None of the three covariates were significant predictors of child RSA ($\beta = 0.19, p = .21$ for age; $\beta = 0.15, p = .51$ for sex, and $\beta = 0.03, p = .54$ for maternal education). There was no association between overall mother RSA and child RSA ($\beta = 0.06, p = 0.11$); nor was a dynamic association in mother and child RSA observed ($\beta = 0.17, p = .06$). In addition, the cross-level interaction testing whether differences in mothers’ average RSA might moderate dynamic concordance in RSA was not significant ($\beta = 0.02, p = .41$). As no concordance in maternal and child RSA was observed, we did not test CM group status as a moderator.

**Mother HR- child RSA concordance.** Next, we re-specified the model to test concordance in mother HR and child RSA. As shown in Table 21, none of the covariates were associated with child RSA scores in Model 1b. Mothers with lower average resting HR had children who posted higher resting RSA scores, $\beta = -0.03, p < .0001$. Dynamic associations also were observed in mother HR and child RSA over time ($\beta = -0.02, p < .05$) such that lower maternal HR over time was associated with higher concurrent RSA in her child during the course of the 5-minute resting phase. Finally, a significant cross-level interaction was observed ($\beta = .002, p < .05$), such
that mothers with higher resting HR had lower dynamic concordance in mother HR and child RSA.

*Differences in dyadic physiological concordance by CM status*

**HR concordance by CM status.** In Model 2a, interactions between CM group status and both within- and between-mother HR were considered in addition to our covariates child age, sex, and maternal education. Though child’s overall mean resting HR did not differ by CM status as shown in Table 21, associations between mother and child HR were moderated substantially by CM status. Specifically, associations between average maternal HR and child HR were significant for the CM dyads only (β = 0.56, \( p < .0001 \)); not for non-CM dyads (β = 0.06, \( p = .60 \)). This difference between CM and non-CM groups was statistically significant, β = 0.51, SE = .18, \( p < .01 \), indicating that only maltreating mothers and children displayed significant associations in average resting HR. In contrast, WD dynamic associations in mother and child HR were present only among the non-CM dyads (β = 0.45, SE = .09, \( p < .01 \)), and not significantly so among CM dyads (β = 0.14, SE = .09, \( p = .05 \)). The findings indicate that over time, only among the non-maltreating dyads did a mother’s HR level showed positive, concurrent associations with her child’s HR. These BD and WD associations for child HR are depicted graphically in Figure 11 and Figure 12.

**Mother HR–child RSA concordance by CM status.** For Model 2b, in addition to the covariates child age, sex, and maternal education, reported in Table 21, CM group status and interactions between this and both within- and between-mother HR for child RSA were considered. Though child’s overall mean resting RSA did not differ by CM group, again the associations between mother HR and child RSA
Figure 11. Graphical depiction of association between mother and child HR by CM status, with the stronger association evident in the maltreating group.

differed significantly by CM status. Specifically, associations between average maternal HR and child RSA were significant for the CM dyads only ($\beta = -0.04$, $SE = .02$, $t = -2.43, p < .05$ for CM; $\beta = -0.01$, $p = .48$ for non-CM), indicating that lower average HR among mothers was associated with higher child RSA scores. Dynamic associations between mother HR and child RSA were present in both the non-CM dyads ($\beta = -0.04$, $SE = .009$, $t = -4.10$, $p < .0001$), and the CM dyads ($\beta = -0.02$, $SE = .01$, $t = -2.08$, $p = .04$), but were not significantly stronger in the non-CM dyads, $\beta = 0.02$, $SE = .02$, $p = .35$. Therefore, in contrast to the findings for maternal–child HR
concordance, greater HR over time in mothers in both groups showed concurrent associations with lower RSA in her child.

*Figure 12.* Histograms depicting the mother–child within-dyad concordance across the ten epochs. For the non-maltreating dyads, these correlations indicating concordance are, on average, significantly more positive.
Table 21

*Multilevel model parameter estimates of the within- and between-dyadic associations in mother and child physiology by CM status*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Children’s HR</th>
<th></th>
<th></th>
<th>Children’s RSA</th>
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<td>Model 1a</td>
<td>Model 2a</td>
<td>Model 1b</td>
<td>Model 2b</td>
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<td>-3.94</td>
<td>1.90’</td>
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<tr>
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<td>0.06</td>
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<td>0.45</td>
<td>0.09**</td>
<td>-0.04</td>
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<tr>
<td>Mother HR_mn × HR_pmc</td>
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<td>0.006’</td>
<td>-0.012</td>
<td>.006</td>
<td>0.002</td>
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<td>0.13’</td>
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### Table 21

Multilevel model parameter estimates of the within- and between-dyadic associations in mother and child physiology by CM status (continued)

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<td>Model 2b</td>
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#### Variance Components

**Between Dyad**

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<th>Estimate</th>
<th>$SE$</th>
<th>Estimate</th>
<th>$SE$</th>
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<th>$SE$</th>
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<tbody>
<tr>
<td>Intercept</td>
<td>91.40</td>
<td>13.53**</td>
<td>85.18</td>
<td>12.76**</td>
<td>1.23</td>
<td>0.19**</td>
<td>1.21</td>
<td>0.19**</td>
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</table>

**Within Dyad**

<table>
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<tr>
<th>Variable</th>
<th>Estimate</th>
<th>$SE$</th>
<th>Estimate</th>
<th>$SE$</th>
<th>Estimate</th>
<th>$SE$</th>
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<tr>
<td>Residual</td>
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<td>15.02</td>
<td>0.78</td>
<td>0.52</td>
<td>0.03</td>
<td>0.51</td>
<td>0.03</td>
</tr>
<tr>
<td>Mother HR$_{pmc}$</td>
<td>0.15</td>
<td>0.06**</td>
<td>0.14</td>
<td>0.05**</td>
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</tbody>
</table>

**Notes.** Unstandardized estimates and standard errors. Mother’s intercept is centered at 0. Slopes or rates of HR change are scaled in 30" epochs. Model is based on 10 occasions nested within 104 mother-child dyads. AIC = Akaike Information Criterion; -2LL = -2 Log Likelihood, relative model fit statistics. *$p < .05$. ***$p < .01$. 

-2LL: 5522.6, 5510.4, 2286.4, 2296.6
AIC: 5530.6, 5518.4, 2290.4, 2300.3
DISCUSSION

The present study examined BD and dynamic WD concordance in resting HR and RSA in CM and non-CM mother–child dyads. The findings indicate that evidence of physiological concordance, shown in previous work to be important to synchrony, varies depending on whether variable-centred or person-centred approaches are utilized. In the present study, the CM group demonstrated BD concordance between maternal HR and both child HR and RSA, while the non-CM group demonstrated WD concordance between maternal HR and both measures. Importantly, the CM group also demonstrated WD concordance between maternal HR and child RSA, suggesting also that physiological concordance varies depending on the autonomic measures assessed.

The findings also indicated that only maternal HR levels (i.e., not maternal RSA) were associated with children’s HR and RSA scores, such that average maternal resting HR moderated the extent of mother–child dynamic physiological concordance for both children’s resting HR and RSA levels. Specifically, mother–child dyads for which mothers had lower average resting HR showed greater dynamic (i.e., epoch-by-epoch) concordance over the course of the resting period. Here, greater positive dynamic concordance was observed in mother and child HR levels and greater negative (inverse) concordance emerged in mother HR and child RSA levels. Conversely, dyads headed by mothers showing higher resting HR exhibited weaker dyadic physiological concordance—that is, weaker positive dynamic concordance in mother–child HR levels and weaker inverse concordance in mother HR and child RSA levels. As such, elevated resting HR appears to impede dynamic concordance between maternal and child autonomic physiology. As CM mothers tend to exhibit higher resting HR than did non-CM mothers both in this study and in others (e.g.,
Frodi & Lamb, 1980), mother–child dyads characterized by CM appear more likely to display patterns of elevated physiological arousal that may disrupt dynamic concordance in autonomic physiology. As BD concordance was observed only for CM dyads, and WD concordance only observed for maternal HR and both child HR and RSA for the non-CM group, the findings suggest that WD concordance might be more indicative of adaptive synchrony than BD concordance. This is supported by the finding that elevated maternal arousal was associated with lower WD concordance. From a family systems perspective, this WD concordance in maternal HR and child HR and vagal tone at rest is likely to be indicative of lower emotional reactivity. The greater consistency of dynamic associations observed in non-CM mother and child physiology during the neutral context is likely to indicate a greater capacity to experience a novel situation (i.e., a low stimuli video presented during the resting period) similarly, with mutual awareness and immediacy in their individual experience of context. In contrast, the BD concordance observed only among CM dyads suggests that the highest risk mothers and children display trait-like elevations in autonomic arousal that are not present among the lower risk, non-CM dyads. However, as dynamic concordance in maternal HR and child RSA was observed in both groups, it appears that CM dyads also have the capacity to demonstrate WD concordance that might indicate synchrony, albeit less consistently than the non-CM group. Moreover, this further suggests that BD rather than WD concordance more conclusively differentiates between normative and CM dyads. Overall, the findings suggest that WD concordance is indicative of adaptive synchrony (e.g., Feldman, Magori-Cohen, Galili, Singer, & Louzoun, 2011) rather than of enmeshment, while BD concordance denotes disrupted dyadic relationships.
Participants in both the CM and non-CM groups came from low-income families; thus, the comparison group may also be characterized as at-risk for a number of adverse developmental outcomes. Given that CM status was not confounded with SES in this sample, it is likely that CM exposure, rather than low SES generally, is the key adverse environment pertinent to the findings. From a family systems perspective (e.g., Bowen, 1978; Kerr, 2008; Kerr & Bowen, 1988; Minuchin, 1974), in less differentiated family systems such as those in which child abuse and neglect are known to occur (Skowron et al., 2010), parent–child exchanges are thought to take on an anxious automaticity that extends into the physiological domain of functioning. These maltreating parents and their children may display matching levels of resting heightened autonomic arousal simply as a function of risk status. However, maltreatment can involve a host of negative parenting practices that may influence the degree to which physiological concordance is observed or disrupted. Numerous studies have implied that threat-biased adults (such as maltreating parents) appear to be more vigilant in parenting contexts (Bugental, 2009), report more negative emotions and attributions in the context of parenting, and display elevated physiological arousal (Bugental, 2009). Likewise CM children also show threat-biased perceptions and show greater chronic elevations in biologically-based stress reactivity (Gunnar, Frenn, Wewerka, & Van Ryzin, 2009; Pollak, 2008), than non-maltreated children. These and other findings (e.g., Casanova, Domanic, McCanne, & Milner, 1992) suggest that CM mothers may experience the parenting context, on a neurobiological level, as more threatening than their low-risk peers. According to Porges’s (2011) concept of neuroception, the nervous system engages in on-going evaluation of risk in the environment. To effectively shift from a defensive stance to positive relational engagement, one must first perceive the environment to be safe,
and only then does one proceed to inhibit a sympathetic response. The CM mothers and children in this study may be less capable in this regard, thus accounting for the observed BD associations in this group. The greater HR arousal experienced by CM mothers may also hinder them from displaying modest fluctuations in their level of HR arousal to the resting state stimuli that show concurrent associations with their child’s HR and parasympathetic responses to those same stimuli. The possibility of a ceiling effect suggested by polyvagal theory, whereby mothers with high resting HR are limited in their ability to further modulate their HR, must be considered. Alternatively, CM mothers and children may be less able to tune in to the immediate context and experience it in moment-by-moment ways, because their resting physiology is more influenced by chronic arousal that characterizes a defensive or alert stance.

Notably, maternal RSA did not demonstrate BD or WD concordance with either child HR or RSA for either group, suggesting that resting RSA concordance does not differentiate between normative and CM samples; however, RSA reduction in the context of challenge has shown links with sensitive parenting in previous studies (e.g., Moore et al., 2009). Therefore, maternal RSA might be more critical to synchrony outside of resting contexts. Subsequent investigations are needed to explore these patterns of WD and BD concordance by risk group, both in the context of challenge, and in conjunction with alternate measures of child and family function to further clarify our understanding of their impact for adaptive parent–child relationships and children’s outcomes.

The limitations of the current study include its restricted sampling of physiological measures, which were gathered from an intensive repeated-measures design during a single research session. However, as access to high-risk cohorts can
be difficult to obtain, the current findings are particularly valuable in highlighting how cardiovascular regulation might offer potentially important insights in difficult family relationships, and in particular the utility of examining both within- and between-person variations. In addition, the degree of physical contact between dyads may be relevant to this concordance (Feldman et al., 2011). Although the dyads in our study were instructed not to interact during this resting phase, mothers and children were seated together on a couch while measurements were taken, thus additional work might examine physical proximity as a factor relevant to concordance. Additional work using a sample balanced for maltreatment subtypes (i.e., physical abuse, sexual abuse, or neglect), might shed further light on the types of stressful contexts that influence concordance in physiology.

In conclusion, the present study illustrates the importance of employing both variable-centred and person-specific approaches to the study of dyadic concordance in physiological responsivity. Further, the findings suggest that interpersonal relationships within families may be experienced as differentially stressful at the dyadic level. Importantly, the findings suggest that parents may display different cardiovascular stress responses depending on aspects of their relationship with their child. However, although the present study sheds light on this in terms of HR and RSA, whether effects are observed at the haemodynamic level remains to be established. In addition, it is unclear whether maladaptive parental stress responses are confined to shared experiences with one’s child or are a function of elevated arousal more generally, particularly as generalized elevated arousal has been documented for CM parents in prior research. Therefore, the final study aims to examine a more detailed haemodynamic profile of parents during both an acute cognitive stressor and during a dyadic interaction with their child. In doing so, we examine influences on
parental responsivity during dyadic interaction while controlling for CVR in response to acute stress.
Chapter 6: STUDY 5

DO PERCEPTIONS OF CHILD CHARACTERISTICS MODERATE THE DEGREE TO WHICH PARENTS FIND INTERACTIONS WITH THEIR CHILDREN STRESSFUL COMPARED WITH COGNITIVE STRESS?

INTRODUCTION

Thus far, the relationship of naturalistic support and personality has been investigated and the discriminant validity of naturalistic support as a predictor of an objective health index has been established. Subsequent experimental studies have demonstrated that analogues of support provision and receipt have distinct influences on cardiovascular recovery and CVR during live support interactions. Although Study 3 established that concordance in physiological arousal is characteristic of supportive but not of collaborative dyads, the peer-to-peer context in which one dyad member served as support provider to the other was experimentally manipulated. Notwithstanding the advantages of this manipulation, it must be acknowledged that this may not be reflective of the real-world context in which such dyads receive and provide support. One type of relationship that is fundamentally consistent in terms of provider/recipient role is the parent–child relationship, with parents consistently providing tangible and emotional support to their child, who is typically unable to provide meaningful support in return. Thus, in Study 4, physiological concordance within parent–child dyads was analyzed, with concordance between maternal HR and child HR and RSA shown to differ between high- and low-stress parent–child relationships, and to be influenced by the overall level of maternal arousal. Given that
parental arousal appears to be important to concordance in these dyads, the nature of parental responsivity during dyadic interaction warrants further attention, particularly given the more ecologically valid recipient/provider distinction that characterises these dyadic relationships. Accordingly, the present study examines parental responsivity during both an acute stressor and during a dyadic interaction with the child. In doing so, we sought to determine whether perceptions of one’s dyadic partner (i.e., parent perceptions of the child) influence the extent to which dyadic interaction is more or less physiologically stressful than an acute stressor, thereby controlling for individual differences in stress responses.

Social support research is conducted almost exclusively with adult samples, with relationships within child and adolescent cohorts deemed “peer relationships” rather than “supportive ties”. However, the provision of support from parent to child has been described as a defining characteristic of the parent–child relationship (Wrzus, Wagner, Baumert, Neyer, & Lang, 2011). Moreover, this provision within the context of a caregiving role is fundamentally inequitable. Contrary to a central assumption of exchange and equity theories, imbalanced parent–child relationships are not invariantly discomfiting for support recipient and provider, suggesting that overall relationship quality, rather than equity in support, may be important in at least some types of close relationships. As equity is not critical to the optimal functioning of these relationships, researchers have examined parent and child characteristics that may influence the quality of interactions within these relationships and may illuminate the conditions under which such relationships are discomfiting, stressful, or physiologically burdensome.

As discussed in Chapter 5, several studies demonstrate that child characteristics, or parent perceptions of such, influence parental physiological
functioning during stress and during parent–child interaction (Bugental & Cortez, 1988; E. K. Lin et al., 2002). Many of these conclude that various patterns of stress responsivity are evidence for affective and behavioural tendencies specific to parent–child interactions. However, studies tend not examine the parent’s typical responsivity to an acute cognitive stressor, precluding an examination of the extent to which these responses during stressful dyadic interaction differ from an individual’s neutral stressor response. This is important because it is unclear whether physiological responses like the inconsistent dynamic concordance observed in the high stress relationships of Study 4 are the by-product of general disrupted autonomic arousal or are interaction-specific.

As outlined in Chapter 1, the usual function of a physiological increase is to prepare an organism to respond behaviourally to a stressor, with increases in response to psychological stress provoking a degree of metabolic responding beyond that which is metabolically necessary. Rather than assuming these increases in the context of dyadic interaction to shed light on relational qualities of dyadic interactions, individuals displaying lower reactivity to dyadic interaction in comparison to their typical acute stress response might be said to demonstrate a relatively adaptive response during dyadic interaction. In contrast, those experiencing dyadic interaction as more physiologically stressful than an acute cognitive stressor might be demonstrating relatively maladaptive responses. For example, should challenging behaviour be positively associated with parental CVR during interactions with one’s child, we could conclude that (i) challenging behaviour (or perceptions of such) exacerbates the typical stress response of the parent, or, given reactivity is a stable individual difference characteristic, that (ii) parents of children higher in challenging behaviours demonstrate hyper-reactivity to psychological stress in everyday life.
What we cannot assume is that these high reactors are lower reactors to general psychological stress, and are demonstrating an elevated response to parent–child interaction as a function of this challenging behaviour. Therefore, assuming physiological responsivity during dyadic interactions to indicate specific relational qualities is conceptually problematic. Consideration of whether physiological responsivity during interactions is adaptive or maladaptive may be assisted by benchmarking responses, where possible, against the reactivity demonstrated to short-term, controlled cognitive stressors.

Few, if any studies have examined how parent perceptions of their child might influence their physiological reactivity to dyadic interaction while controlling for the parent’s typical responsivity to acute stress. Several studies do conclude that parents’ perceptions of children moderate their stress reactivity during dyadic interactions, for example, Martorell and Bugental (2006) in a sample of 60 high-risk mothers, found that those with low perceived power in caregiving relationships (i.e., who attributed greater power to children than to self) displayed high cortisol reactivity to infants and toddlers with a difficult temperament pattern. E. K. Lin et al. (2002) reported that undergraduate women with low perceived power demonstrated elevated cortisol and HR responses to children’s elevated vocal pitch (a social dependence/immaturity cue). While the studies involve a degree of comparison with toddlers of easy temperament and normal-level vocal pitch sounds, no control stressor task is included. Therefore, while these studies facilitate comparisons between high and low challenge responses in relation to the child, the extent to which these reflect typical stress responsivity remains unclear.

Drawing on this work, the present study sought to examine whether perceptions of child characteristics influenced parental CVR during an acute stressor
and during dyadic interaction with the child. We hypothesized that parental
perceptions of the child would influence CVR during the dyadic interaction,
independently of any influence on CVR to a cognitive stressor. Specifically, we
predicted that negative perceptions of the child (e.g., higher ratings of challenging
behaviour) might be related to maladaptive cardiovascular arousal (in terms of greater
reactivity to the dyadic interaction that to the cognitive stressor). Conversely, it was
expected that positive perceptions of the child might be related to adaptive (i.e.,
lower) responses to the dyadic interaction relative to an acute stressor. In establishing
the CVR patterning specific to interactions with one’s child, we sought to elucidate
whether aspects of the social relationship might be relevant to the differences between
CVR during acute stressors and dyadic interaction.

METHODS

Recruitment and screening

Participants were recruited via letters to schools, mailings to university staff
and relevant campus societies, and advertisements placed through local community
groups. Interested participants contacted the researcher by email or telephone. Parents
were screened and interviewed by telephone, and scheduled for attendance at the
laboratory on campus. Owing to the time restriction imposed by school attendance
(100% of participating children were enrolled in formal education), laboratory
appointments defaulted to between 3 and 7 p.m., minimizing time of day effects on
affect and CVR.
Participants

Participants comprised 21 parent–child dyads, the gender composition of which is outlined in Table 22. All adult participants rated their health as “Excellent” \((n = 3)\), “Very good” \((n = 16)\), or “Good” \((n = 2)\), the other options being “Fair” and “Poor”. Similarly, all parents rated their child’s health as either “Very healthy, no problems” \((n = 13)\) or “Healthy, a few minor problems” \((n = 8)\), the other options being “Sometimes quite ill” or “Almost always unwell”. Parents ranged in age from 36 to 44 years \((M = 40.46, SD = 2.75)\) and had a mean BMI of 23.57 kg/m\(^2\) \((SD = 3.41)\); 2 were smokers. Participating children ranged in age from seven to 10 years \((M = 8.46, SD = 1.30)\) and were enrolled in primary school between 1\(^{st}\) and 4\(^{th}\) class inclusive. No parents reported any child history of cardiovascular problems or psychological diagnoses; one parent reported use of medication for hypertension. One child was reported to suffer from asthma and two others from allergies; no other medical issues were reported, therefore, the sample overall was in good health.

Parents’ education level ranged from Leaving Certificate or equivalent to postgraduate degree (thereby approximating Levels 5 to 10 on the National Framework of Qualifications). All children bar three lived in owner-occupied accommodation. All parents bar one mother reported current marriage/cohabitation with the study child’s other parent. Eighteen participating parents were of Irish nationality, the remaining three were from other countries (including two non-native but fluent English speakers). Nineteen of the children were of Irish nationality.
Table 22

*Cross-tabulation of dyad gender composition*

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<th>Girls</th>
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</tr>
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<td></td>
<td>7</td>
<td>1</td>
<td>21</td>
</tr>
</tbody>
</table>

*Design*

The study comprised a single-group design assessing cardiovascular arousal over four phases, resting baseline, acute stressor, dyadic interaction, and jigsaw puzzle. Physiological data for both parents and children were gathered. These were analyzed separately (rather than in terms of concordance). As such, the primary analyses focus on the parental data. As in the previous four studies, the first phase was included to obtain resting baseline cardiovascular data for each participant. The acute stressor and dyadic interaction phases were employed to facilitate examination of parental responsivity during dyadic interaction while controlling for the acute stress response. Finally, the difficult jigsaw puzzle comprised a child stressor. As the primary research question involved examining parental responsivity during dyadic interaction while controlling for their acute stress response, the data from this fourth phase were not analyzed in detail. Data from the first three of these phases, namely, the resting baseline, the parental stressor, and the dyadic interaction were analyzed in the present study, to contrast responses to an acute stressor with those during dyadic interaction, while controlling for resting levels.
Chapter 6. Cardiovascular function during dyadic interaction

*Cardiovascular assessment*

Parents’ cardiovascular measures were assessed using a Finometer as detailed in Chapter 2 (p. 89; *Cardiovascular assessment*).

Children’s SBP, DBP, and HR were assessed using a Dinamap Vital Signs Monitor (Model 8100, Critikon, Florida, USA). Dinamap monitors provide cardiovascular readings that closely resemble more invasive methods (e.g., intra-arterial recordings) and are commonly used in psychophysiological studies (Murray-Close & Crick, 2007). A built-in microprocessor tests oscillation data for artefacts, averages obtained values and then displays SBP, DBP, and HR values in digital format. A sensitive transducer within the cuff measures cuff pressure and minute pressure oscillations allowing an oscillometric method of determining blood pressure. According to its manual (Corporation, 1988), the Dinamap has a blood pressure accuracy mean error of $\leq 5$ mmHg and a standard deviation of $\leq 8$ mmHg. For HR, the pulse rate accuracy is $\pm 3.5\%$. The appropriate-size occluding cuff according to manufacturer specifications was placed on the participant’s non-dominant arm and measures sampled at 2-minute intervals. For the purpose of the present analysis, the more comprehensive data for adults were analyzed in detail.

*Psychometric assessments*

*The Strengths and Difficulties Questionnaire.* The Strengths and Difficulties Questionnaire (SDQ; R. Goodman, 2001) is a very widely used behavioural questionnaire for children and adolescents, with the parent-report (rather than the self-report) version employed in the present study to profile child behaviour. The scale contains 25 items scored on a 3-point Likert scale from “Not true” to “Certainly true”, with five items assessing each of emotional symptoms, conduct problems,
hyperactivity/inattention, peer relationship problems, and prosocial behaviour. In low-risk or general population samples such as this one, it is considered preferable to use a three-subscale division of the SDQ which combines the emotional and peer subscales (internalizing problems), and the conduct and hyperactivity subscale (externalizing problems), alongside the prosocial scale (A. Goodman, Lamping, & Ploubidis, 2010). The internalizing and externalizing subscales, (representative of intense emotions and suppressed behaviour, and intense emotions and active behaviour, respectively [(Vaalamo et al., 2002)]) may also be summed to form a “total difficulties” score.

This score is employed in the present study, with analyses using the internalizing and externalizing reported where appropriate. Therefore, three aspects of our target variable, parent perceptions of child behaviour are used. Reliability estimates and scale scores are reported in Table 21. Notably, the prosocial scale demonstrated unacceptably low internal reliability, with no variance in scores reported for two of the five items, such that all parents selected “certainly true” for items 9 (helpful if someone is hurt, upset, or feeling ill) and 17 (kind to younger children). Therefore, we were unable to employ these scores and analyses focused only on the difficulties subscales. In addition, reliability was low for the other subscale scores, but was improved by using the recommended categorization of internalizing and externalizing rather than their component subscale scores. While most research deems a cut-off of .70 as “acceptable”, others have described lower estimates as acceptable in some cases, for example, when there is meaningful content coverage of some domain and reasonable uni-dimensionality (Schmitt, 1996; Youngman, 1979). Although one mother reported a high score for son’s peer problems, and one father reported high scores for daughter’s conduct problems, all total difficulties scores fell within the normal range, confirming that the sample is normative. Number of close friends the
child had (as reported by the parent) was inversely associated with total difficulties as rated on the SDQ ($r = -0.53$, $p = .02$).

*The EAS Temperament Survey.* In addition to the SDQ, two further assessments were administered. The 20-item EAS Temperament Survey (EAS-TS; Buss & Plomin, 1984) assesses child temperament across four dimensions with five items for each subscale, which include emotionality (e.g., “Child gets upset easily”), activity (e.g., “Child is always on the go”), sociability (e.g., “Child finds people more stimulating than anything else”), and shyness (e.g., “Child tends to be shy”), the latter two of which are sometimes combined to form a sociability score. The EAS was selected due to significant conceptual overlap with previously identified temperament dimensions and because of its brief nature and wide use in the relevant literature (e.g., Kamp Dush, Kotila, & Schoppe-Sullivan, 2011). Past research has demonstrated the psychometric adequacy of the EAS in Western settings (Buss & Plomin, 1986; Hubert, Wachs, Peters-Martin, & Gandour, 1982) and the adequacy of parent perceptions as valid measures of children’s temperament (Slabach, Morrow, & Wachs, 1991).

*The Pianta Child-Parent Relationship Scale.* Parent–child relationship quality was assessed using the parent-report Pianta Child–Parent Relationship Scale (PCPRS; Pianta, 1992). This 30-item scale was adapted from the Student-Teacher Relationship Scale (Pianta, 1996) and consists of three sub-scales tapping into positive aspects of, and conflict and dependency in the relationship. Each item on the scale is scored from one (definitely does not apply) to five (definitely applies), with five items for the Dependence subscale (e.g. “My child reacts strongly to separation from me”), 12 for the Positive Aspects or Closeness relationship sub-scale (e.g. “I share an affectionate warm relationship with my child”) and 13 for the Conflict sub-scale (e.g. “My child
sees me as a source of punishment and criticism”). While this scale has been widely used in epidemiological studies (e.g., the U.S. Head Start Impact Study), normative data are unavailable.

Table 23

*Child characteristics (N = 21)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Norm.</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
<th>α</th>
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<tbody>
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<td>Birth order</td>
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<td>0.85</td>
<td>1-4</td>
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<tr>
<td>No. siblings</td>
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<td>2.19</td>
<td>1.07</td>
<td>1-4</td>
<td>-</td>
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<tr>
<td>No. close friends</td>
<td>-</td>
<td>3.56</td>
<td>1.58</td>
<td>1-7</td>
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<tr>
<td>Prosocial behaviour(^a)</td>
<td>6-10</td>
<td>9.26</td>
<td>0.80</td>
<td>7-10</td>
<td>.21*</td>
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<tr>
<td>Emotional symptoms(^a)</td>
<td>0-3</td>
<td>1.58</td>
<td>1.27</td>
<td>0-4</td>
<td>.38</td>
</tr>
<tr>
<td>Peer problems(^a)</td>
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<td>1.76</td>
<td>1.76</td>
<td>0-7</td>
<td>.77</td>
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<tr>
<td>Conduct problems(^a)</td>
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<td>1.00</td>
<td>1.20</td>
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<td>.57</td>
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<tr>
<td>Hyperactivity(^a)</td>
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<td>2.74</td>
<td>1.82</td>
<td>0-5</td>
<td>.70</td>
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<td>Internalizing problems(^b)</td>
<td>-</td>
<td>2.68</td>
<td>2.45</td>
<td>0-9</td>
<td>.62</td>
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<tr>
<td>Externalizing problems(^b)</td>
<td>-</td>
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<td>Total difficulties score(^c)</td>
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<td>.59</td>
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<td>Emotional Symptoms(^d)</td>
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<td>1.23</td>
<td>0-4</td>
<td>.43</td>
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<tr>
<td>Internalizing(^d)</td>
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<td>2.40</td>
<td>0-9</td>
<td>.67</td>
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<tr>
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<tr>
<td>Difficulties(^d)</td>
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<td>5.95</td>
<td>3.76</td>
<td>0-13</td>
<td>.67</td>
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</tbody>
</table>

\(^a\)Score from relevant subscale of the SDQ

\(^b\)Internalizing score computed as sum of emotional and peer problems; externalizing score computed as sum of conduct and hyperactivity problems.

\(^c\)Sum of all SDQ subscales excluding prosocial behaviour

\(^d\)Scores for improved reliability; item 16 “nervous or clingy in new situations” was removed from the emotional symptoms subscale, and correspondingly from the internalizing and total difficulties scales. For the externalizing scale, item 5 “often has temper tantrums or hot tempers” is removed.

\(^*\)Contains two items with no variance in scores.
Table 24

Cross-correlations among psychometric measures

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
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</thead>
<tbody>
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<td>1. Difficulties</td>
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<td>-.09</td>
<td>-.12</td>
<td>.40</td>
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<td>.16</td>
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<td>2. Internalizing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.30</td>
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<td>-.06</td>
<td>.51*</td>
<td>-.05</td>
<td>.49*</td>
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<td>3. Externalizing</td>
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<td>-</td>
<td>.17</td>
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<td>-.10</td>
<td>.04</td>
<td>-.53*</td>
<td>-.03</td>
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<td>4. Prosocial</td>
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<td>-.03</td>
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<td>-.12</td>
<td>-.10</td>
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<td>5. Emotionality</td>
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<td>-</td>
<td>-</td>
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<td>.57*</td>
<td>.36</td>
<td>-.19</td>
<td>.51*</td>
<td>.51*</td>
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<td>6. Activity</td>
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<td>-</td>
<td>-</td>
<td>-.72**</td>
<td>.39</td>
<td>-.19</td>
<td>-.17</td>
<td>.04</td>
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<td>7. Sociability</td>
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<td>-</td>
<td>-</td>
<td>-.32</td>
<td>.19</td>
<td>.03</td>
<td>.21</td>
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<td></td>
<td></td>
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<tr>
<td>8. Shyness</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-.16</td>
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<td>10. Conflict</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-.25</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>11. Dependency</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-.20</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Notes: * $p < .05$, ** $p < .01$, denote significant inter-correlations between variables. Scales 1-4 are derived from the SDQ; scales 5-8 are derived from the EAS-TS, and scales 9-11 from the PCPRS.
Chapter 6. Cardiovascular function during dyadic interaction

**Procedure**

Upon arrival at the laboratory, height and weight measurements were obtained from each participant using a set of scales. Consistent with recommended practice for children aged seven and older (Society for Research in Child Development, 1990), parents and children each provided informed consent, with parents also consenting for their children to participate. Parent and child were seated opposite each other at a large table and given time to acclimatize to the laboratory setting. The protocol involved a 10-minute vanilla baseline period and three laboratory tasks with a brief resting period interspersed between each. The tasks included a 3-minute serial subtraction stressor, a 5-minute dyadic puzzle, and a 5-minute jigsaw task, intended to comprise a parental stressor, an interactive task, and a child stressor, respectively. Reading material was provided for both parent and child during the baseline period (a standard nature magazine for adults, and for an illustrated book of Irish legends for children). During the monitoring period, the experimenter was seated out of view behind an opaque screen. The session was taped unobtrusively to facilitate retrospective checks on adherence to task instructions. When the monitoring period was complete, participants were disconnected from the monitors and debriefed. Children received a Certificate of Participation for their involvement. Besides reimbursement for parking expenses incurred, parents were not rewarded (with the exception of one parent, a student of Psychology, to whom course credit was awarded).

**Serial subtraction.** For this task, mothers were asked to count aloud backwards in 7s from a four-digit number. Participants were verbally prompted to commence and cease the task. If participants faltered, they were prompted to continue counting and if they could not recall their most recent number, they were provided with a new 4-digit
number. Serial subtraction tasks reliably elicit physiological stress responses and are widely used in psychophysiologica research (e.g., Ginty & Conklin, 2012; Matthews et al., 1993). All participants reported that the task was both difficult and stressful.

**Interactive task.** A children’s puzzle game (*Spaghetti Junction*; made by *Orchard Toys*) served as the interactive task. The object of this game is to construct a road using puzzle pieces. Each brightly coloured piece contains a picture of a vehicle on a segment of road, with a number of traffic cones at each end of the road segment. The player’s goal is to place the each piece such that the vehicles are travelling in the same direction, and so that the number of traffic cones at one end of a segment tallies with the number of cones on the linking end of the next segment, in a manner similar to the game Dominoes. In addition to these puzzle pieces, some blank corner pieces are provided to enable turns on the road. This game was selected as straightforward yet engaging, and facilitative of parent–child interaction. Participants were instructed that they may work together to complete the task, but that the child had the responsibility of placing each piece, a restriction imposed in similar research to pressurize parental regulatory capacities during parent–child interaction (Hoffman, Crnic, & Baker, 2006; Skowron et al., 2011). All children reported that this game was novel.

**Jigsaw puzzle.** The stressor selected comprised a difficult jigsaw puzzle (an *Animal Families* scene from BBC Earth; *Jumbo Toys*). The child was informed that the jigsaw was to be completed without help from the parent, and that the parent had paperwork to complete during this time and so would be unable to assist. Parents were supplied with a questionnaire to minimize engagement with the child. Parents were further instructed to redirect the child’s attention to the jigsaw puzzle should they seek assistance.
Data analysis

As outlined in the Design section, analyses of parental data were based on three phases of a single-group design (i.e., resting, stressor, and dyadic interaction). Specifically, 2 × 1 repeated-measures ANCOVAs were employed with phase as the repeated measures variable (2 levels: stressor and dyadic interaction), resting levels (i.e., the first phase) controlled for as a covariate in each ANCOVA, and the psychometric score of interest treated as an additional covariate. As such, the ANCOVAs identified the effects of each covariate on the change between parental stress reactivity and dyadic interaction responses, while controlling for resting levels. As the SDQ produces three subscores for use in general populations, ANCOVAs were conducted using each of these (i.e., for internalizing, externalizing, and the total difficulties score, comprising the sum of internalizing and externalizing). Significant phase × SDQ covariate interactions are interpreted as indicating effects of psychometric scores on the difference in responses between stressor and dyadic interaction phases. Rather than lose power in the analyses by including gender as an additional covariate from the outset, findings were confirmed by re-conducting analyses on the women only. Where analyses using the overall difficulties score represent the subscore analyses, these are outlined. Where analyses are not significant at the general level, analyses for internalizing or externalizing specifically are reported. To corroborate significant findings, 2 × 1 repeated-measures ANCOVAs are conducted with phase (2 levels: resting and stressor/interaction) as the repeated measures variable, and the SDQ score as covariate. Descriptive statistics pertaining to the children’s data are presented, but owing to the smaller amount of data gathered and their secondary relevance to the research question here, these are not analyzed further.
RESULTS

Descriptive statistics

Owing to technical difficulties with the monitoring equipment, data from one parent (a mother) were discarded, leaving a remaining sample of 20 adults. Overall, parents had baseline SBP of 121.60 ± 16.89 mmHg, DBP of 73.98 ± 11.90 mmHg, HR of 60.37 ± 7.72 bpm, CO of 4.61 ± 1.72 l/min, and TPR of 1.43 ± 0.60 pru. Sex differences in resting levels were observed for CO, t(18) = -2.92, p = .009, such that women had higher resting CO (M = 1.52 vs. M = 0.89). Aside from a borderline effect for SBP (p = .06; M = 104.65 for men and M = 124.59 for women), no other sex differences were observed (ps ≥ .49). Overall, parents had a mean stressor SBP of 149.99 ± 22.39 mmHg, DBP of 88.65 ± 17.15 mmHg, HR of 68.22 ± 9.09 mmHg, CO of 5.41 ± 1.94, and TPR of 1.51 ± 0.73. One-way ANOVAs indicated no associations between SDQ scores and resting measures.

Reliable cardiovascular data for children are more difficult to obtain, in part because of the lower measurement accuracy of small cuff sizes, and the need for children to remain still until cardiovascular measures are returned. Despite these difficulties, reliable data were successfully obtained for 15 children of the sample. Children had an average resting SBP of 106.32 mmHg (SD = 8.13), resting DBP of 61.61 mmHg (SD = 5.80), and resting HR of 82.06 bpm (SD = 9.07). During the dyadic interaction, children had a mean SBP of 108.55 mmHg (SD = 7.59), a mean DBP of 63.31 mmHg (SD = 4.74), and HR of 87.94 bpm (SD = 10.48). During the jigsaw puzzle, children had an average resting SBP of 105.67 mmHg (SD = 6.12), resting DBP of 63.18 mmHg (SD = 2.47), and resting HR of 86.20 bpm (SD = 11.11).
Occurrence of reactivity

Repeated-measures ANOVA revealed significant differences between baseline and stressor reactivity for SBP, $F(1, 19) = 35.29, p < .001$, partial $\eta^2 = .65$; DBP, $F(1, 19) = 14.31, p = .001$, partial $\eta^2 = .41$; HR, $F(1, 19) = 19.59, p < .001$, partial $\eta^2 = .51$; for CO, $F(1, 19) = 4.45, p = .047$, partial $\eta^2 = .19$; but not for TPR, $F(1, 19) = 0.15, p = .71$, partial $\eta^2 = .01$. Therefore, SBP, DBP, HR, and CO reactivity was significantly elicited by the serial subtraction stressor, consistent with the cardiac response typically observed by similar stressors (including the mental arithmetic stressor employed in Chapter 3).

During the dyadic task, parents had an average SBP of 147.29 mmHg, DBP of 86.84 mmHg, HR of 71.46 bpm, CO of 5.45 l/min, and TPR of 1.55 pru. Paired-samples $t$-tests revealed no significant differences between stressor and dyadic reactivity, except for TPR, $t(19) = -5.31, p < .001$, which was higher during the cognitive stressor than during dyadic interaction ($M = 1.50, SD = 0.51$ vs. $M = 0.08, SD = 1.00$).

Associations between measures at rest, stress, and during interaction

Pearson’s correlations revealed baseline SBP, DBP, and TPR to be uncorrelated with their equivalent stressor measures ($r = +.44, p = .06; r = +.33, p = .15, r = -.01, p = .67$, respectively). Baseline HR and CO were significantly correlated with stressor measures ($r = +.62, p = .004; r = +.58, p = .007$, respectively). However, resting SBP was positively correlated with SBP during the joint task ($r = +.50, p = .03$). Therefore, resting SBP, while not significantly correlated with stressor reactivity, was associated with elevated reactivity during dyadic interaction, such that parents displaying elevated arousal at rest displayed elevated systolic arousal during the
dyadic interaction. Cross-correlations between baseline, stressor, and joint task measures are reported in Table 23, with correlations between SDQ and reactivity measures in Table 24. Scrutiny of these indicates that all stressor measures are correlated with their corresponding interaction parameter, as previous work examining family-oriented interactions has shown (Lassner, Matthews, & Stoney, 1994). Our primary analyses investigate the effects of psychometric scores on the degree and direction of associations between these stressor and interaction measures.

Effects of parent perceptions on CVR

The main analyses addressed our hypothesis that parent perceptions of the child would influence reactivity during the dyadic interaction specifically, independent of their acute stressor responses. Repeated-measures ANCOVAs were conducted with phase (2 levels: stressor and interaction) as the repeated measures variable. Resting levels were entered as a covariate, and the SDQ subscale of total difficulties (i.e., combined internalizing and externalizing problems) entered into each ANCOVA.

The ANCOVA for SBP revealed a main effect for total difficulties on SBP, $F(1, 17) = 6.30, p = .02$, partial $\eta^2 = .27$. Parents reporting high difficulties demonstrated lower responses to the stressor and dyadic interaction as shown in Figure 13. No phase x difficulties interactions were observed. Therefore, parents reporting high difficulties displayed blunted or dampened systolic responsivity regardless of phase. Omitting the three men from the analyses produced similar results; $F(1, 14) = 3.59, p = .08$, partial $\eta^2 = .20$. 

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Table 25

Cross-correlations among SDQ scores and change scores for stressor and dyadic interaction

<table>
<thead>
<tr>
<th>Variable</th>
<th>Internalizing</th>
<th>Externalizing</th>
<th>Prosocial</th>
<th>Total Difficulties</th>
</tr>
</thead>
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<td>-0.41</td>
<td>-0.33</td>
</tr>
<tr>
<td>HRs</td>
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<td>0.22</td>
<td>-0.12</td>
<td>0.24</td>
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<td>-0.07</td>
<td>-0.17</td>
<td>-0.09</td>
</tr>
<tr>
<td>TPRs</td>
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<td>-0.01</td>
<td>-0.26</td>
<td>-0.07</td>
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<td>0.06</td>
<td>-0.22</td>
<td>0.09</td>
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</table>

Notes: s = stressor, j = joint task (dyadic interaction), * p < .05. Resting measures were not correlated with any subscale.
Figure 13. Baseline and serial subtraction stressor values for parents (N = 20; error bars denote standard errors of the mean)
Table 26

Cross-correlations between resting measures and changes scores for stressor and dyadic interaction for parents

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<td>-.54*</td>
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<td>-.06</td>
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<td>-.56*</td>
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<td>.65**</td>
<td>.03</td>
<td>.87**</td>
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<td>7. Stressor DBP</td>
<td>-.48*</td>
<td>-.13</td>
<td>.74**</td>
<td>.48*</td>
<td>.83**</td>
<td>-.12</td>
<td>-.06</td>
<td>.72**</td>
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<td>8. Stressor HR</td>
<td>-.07</td>
<td>-.39</td>
<td>-.15</td>
<td>-.42</td>
<td>.23</td>
<td>.05</td>
<td>-.42</td>
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<td>9. Stressor CO</td>
<td>-.59</td>
<td>.65**</td>
<td>.11</td>
<td>.02</td>
<td>.62**</td>
<td>-.49*</td>
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<tr>
<td>10. Stressor TPR</td>
<td>.05</td>
<td>.65**</td>
<td>-.38</td>
<td>-.37</td>
<td>.92**</td>
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<tr>
<td>11. Joint SBP</td>
<td>-.59**</td>
<td>-.07</td>
<td>.47*</td>
<td>.09</td>
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<td>12. Joint DBP</td>
<td>-.34</td>
<td>-.16</td>
<td>.75**</td>
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<tr>
<td>13. Joint HR</td>
<td>-.18</td>
<td>-.42</td>
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<td>14. Joint CO</td>
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<td>15. Joint TPR</td>
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Notes: *p < .05, **p < .01, denote significant inter-correlations between variables
For DBP, there was no main effect of time $F(1, 17) = 1.49, p = .24$, partial $\eta^2 = .08$, or of total difficulties, $F(1, 17) = 0.46, p = .51$, partial $\eta^2 = .03$. A phase × difficulties interaction on DBP was observed, $F(1, 17) = 7.2, p = .02$, partial $\eta^2 = .30$. Scrutiny of the graphical results revealed that for parents rating low difficulties, DBP decreased from stressor to dyadic interaction as shown in Figure 15. For parents rating high difficulties, DBP remained constant from stressor to dyadic interaction. Therefore, parents scoring their children low on challenging behaviour found interacting with their children less physiologically stressful relative to an acute stressor than did those rating their children high on such behaviour, as hypothesized. Removing the men from the analysis did not change the findings, $F(1, 14) = 4.50, p = .05$, partial $\eta^2 = .24$.

![Difficulties](image)

**Figure 14.** Graph of main effects of difficulties on SBP (based on stressor and joint task change scores from baseline, and median split of difficulties data; error bars denote standard error of the mean)
For HR, again, there was no main effect of time $F(1, 17) = 1.98, p = .18$, partial $\eta^2 = .10$, or of difficulties on reactivity, $F(1, 17) = 0.01, p = .93$, partial $\eta^2 < .001$. The phase $\times$ difficulties interaction on HR did not reach significance, $F(1, 17) = 3.74, p = .07$, partial $\eta^2 = .18$. However, examining the internalizing and externalizing subscales separately revealed a significant phase $\times$ externalizing interaction, $F(1, 17) = 5.70, p = .03$, partial $\eta^2 = .25$. Visual scrutiny of Figure 15 revealed parents rating low externalizing demonstrated an increase in HR from stressor to interaction and with HR for parents rating high externalizing remaining constant; that is, the opposite pattern than was observed for DBP. When the men were omitted from this analysis, the results were no longer significant, $F(1, 14) = 0.35, p = .56$, partial $\eta^2 = .02$. There were no effects of internalizing on HR.$^{11}$

For CO, there was a main effect of total difficulties, $F(1, 17) = 5.05, p = .04$, partial $\eta^2 = .23$, and a significant phase $\times$ difficulties interaction, $F(1, 17) = 8.78, p = .009$, partial $\eta^2 = .34$. Scrutiny of the graphical results indicated that parents rating low difficulties had higher CO overall, and an increase in CO from stressor to dyadic interaction, with those rating high difficulties experiencing a decrease, as shown in Figure 12. These results maintained significance when the three men were excluded from the sample, $F(1, 14) = 7.98, p = .01$, partial $\eta^2 = .36$. Therefore, low difficulties was associated with elevated CO overall and an increase in CO from stressor to dyadic interaction, consistent with an active or cardiac response.$^{12}$

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$^{11}$ As per the $2 \times 1$ ANCOVA for DBP, the supplementary ANCOVA for HR revealed no main $F(1, 18) = 0.19, p = .67$, partial $\eta^2 = .01$ or interactive effect $F(1, 18) = 3.64, p = .07$, partial $\eta^2 = .17$ of externalizing on HR stress reactivity.

$^{12}$ Again, the supplementary ANCOVA for resting and stressor CO revealed no main $F(1, 18) = 1.64, p = .22$, partial $\eta^2 = .08$, or interactive $F(1, 18) = 0.15, p = .70$, partial $\eta^2 = 008$ effect of difficulties on CO.
Figure 15. Graph depicting difference between stressor and interaction DBP reactivity in mmHg and as a percentage of the acute stress response (based on stressor and joint task change scores from baseline, and median split of difficulties data)
Chapter 6. Cardiovascular function during dyadic interaction

For TPR, there were no main or interactive effects of difficulties. A phase × internalizing interaction was observed that did not reach conventional significance level, $F(1, 17) = 4.02, p = .06$, partial $\eta^2 = .19$. Scrutiny of the graphical results indicated that for parents rating low internalizing behaviour, TPR remained relatively constant as shown in Figure 16. For those rating high internalizing behaviour, TPR increased from stressor to dyadic interaction, with similar results when the men were excluded from the analysis, $F(1, 14) = 3.29, p = .09$, partial $\eta^2 = .19$.

Given this trend towards TPR patterning for internalizing score, the analysis for CO was repeated utilizing this subscale. The ANCOVA score revealed a significant phase × internalizing interaction $F(1, 17) = 8.08, p = .10$, partial $\eta^2 = .32$, but no such interaction for externalizing behaviour. Visual scrutiny indicated that parents rating low difficulties demonstrated an increase in CO from acute stressor to dyadic interaction, while parents rating high difficulties demonstrated a decrease as shown in Figure 17. Therefore, parents rating low in internalizing particularly, demonstrated a myocardial pattern of increasing CO and constant/decreasing TPR, with those rating high in internalizing demonstrating a vascular pattern of decreasing CO and increasing TPR. Re-conducting this TPR analysis for the women only produced a similar interaction, $F(1, 14) = 6.59, p = .02$, partial $\eta^2 = .32$.

Cross-tabulation of internalizing and externalizing scores

As some effects reported here appear to be contingent on the recommended internalizing/externalizing conceptualization of overall difficulties, a cross-tabulation of scores for these dimensions was conducted based on median splits of the data. Although using median split procedures to transform continuous variables into dichotomous variables is undesirable for several reasons, possibly leading to an
increase in Type II errors and loss of potentially valuable information even in large samples (MacCallum, Zhang, Preacher, & Rucker, 2002; Maxwell & Delaney, 1993; Royston, Altman, & Sauerbrei, 2006) this is done only to give an indication of how internalizing and externalizing co-occur at higher levels in the present sample. Scrutiny of Table 27 indicates that a quarter of children (3 girls and 2 boys; all mother-reports) fall into both the high internalizing and high externalizing cell, leaving 16 children who are not high scorers on both characteristics, suggesting discriminant validity to this conceptualization. Scrutiny of the cross-correlations between psychometric variables also indicates these aspects to be associated with different relationship dimensions; internalizing is positively associated with conflict within the relationship ($r = +.49$, $p = .03$), while externalizing is negatively associated with closeness in the relationship ($r = -.53$, $p = .01$).

Table 27

*Cross-tabulation of low and high internalizing and externalizing scores (based on median split of the data)*

<table>
<thead>
<tr>
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<th>Externalizing</th>
<th>Low</th>
<th>High</th>
<th>Total</th>
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<tbody>
<tr>
<td>Internalizing</td>
<td>Low</td>
<td>7</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>3</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>10</td>
<td>11</td>
<td>21</td>
</tr>
</tbody>
</table>
Figure 16. Graph of phase × externalizing interaction on HR and phase × difficulties interaction on CO (based on stressor and joint task change scores from baseline, and median split of externalizing/difficulties data)
Figure 17. Graph depicting difference between stressor and interaction reactivity in pru and as a percentage of the stress response (based on stressor and dyadic interaction task scores from baseline, and median split of the difficulties data)
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Figure 18. Graph of phase × internalizing interaction on CO (based on stressor and joint task change scores from baseline, and median split of internalizing data)

Relationship conflict as a predictor of interaction CVR

The final analyses examined relationship conflict as a predictor of CO and TPR CVR. As conflict was correlated with that aspect of behaviour associated with myocardial and vascular responsivity, it is possible that conflict is more important than behaviour per se.

For CO, there was no main effect of conflict on CVR, $F(1, 17) = 0.08$, $p = .78$, partial $\eta^2 = .005$ and no phase × conflict interaction, $F(1, 17) = 0.23$, $p = .64$, partial $\eta^2 = .01$. For TPR, there was no main effect of conflict on CVR, $F(1, 17) = 0.56$, $p = .46$, partial $\eta^2 = .03$ and no phase × conflict interaction, $F(1, 17) = 0.04$, $p = .54$, partial $\eta^2 = .02$. Therefore, parent-reported conflict did not appear to influence CVR during the social interaction, confirming that perceptions of typical child behaviour appear to be more critical to CVR than overall relationship quality.
Additional data checks

Additional checks for effects of psychometric characteristics on CVR revealed significant main effects of emotionality, \( F(1, 17) = 6.15, p = .02 \), partial \( \eta^2 = .27 \) and sociability \( F(1, 17) = 4.49, p = .049 \), partial \( \eta^2 = .21 \) on HR. A near-significant main effect of conflict was observed, \( F(1, 17) = 4.38, p = .052 \), partial \( \eta^2 = .21 \). For CO, a significant main effect of emotionality was observed, \( F(1, 17) = 5.12, p = .04 \), partial \( \eta^2 = .23 \). All effects were such that higher psychometric scores were associated with elevated HR/CO measures. No interactions with phase were observed for any measure; therefore, the use of child behaviour as a focal measure in this study appears justified.

DISCUSSION

The findings of the present study confirm that parental perceptions of child behaviour influence their stress responsivity to dyadic interaction with the child, and moreover, indicate that these perceptions influence the degree to which the interaction is more or less stressful than engaging in an asocial stress task. The present study examined cardiovascular responses to both an acute stressor and to a dyadic interaction in a sample of parents interacting with their children. The preliminary findings suggest that parents who experience higher basal levels of arousal might also display elevated reactivity during dyadic interactions with their children. Previous studies have linked elevated resting levels to exaggerated stressor responses in adults (Balanos et al., 2010); however, elevated resting levels were not associated with stressor CVR in the current sample, yet predicted elevated reactivity during the interaction.
A key finding of the present study is that parental perceptions of child behaviour may determine the degree to which responsivity dyadic interactions constitutes a myocardial rather than vascular response. As many prior studies of parent–child interaction tend not to examine underlying haemodynamic variables (e.g., Bornstein & Suess, 2000; Mills-Koonce et al., 2009), this finding suggests a potentially important mechanism between strained parent–child relationships and child self-regulatory difficulties warranting additional research. One explanation for this patterning is that parents’ perceiving their child as habitually somewhat difficult do not actively engage with the child during dyadic interactions. Rather, a cardiovascular response indicative of passive coping is observed. An interesting question is whether this style is elicited by specific actions on the part of the child, or whether it constitutes a habitual response on the part of the parent.

As the difficulties measure predicted blunted systolic responses, an important question for additional research is whether blunted reactivity is a mechanism linking child behavioural patterns (or parental perceptions of such) to well-being in the long-term, particularly in terms of physiological regulation. Because difficulties ratings were linked to parental CVR, a mechanism by which problem behaviour may influence a child’s own emerging physiological regulatory capacities may be through the physiological responsivity of the parent, who is critical to the child’s regulatory development. As little research to date has examined challenging behaviour in terms of the internalizing/externalizing taxonomies advocated by the SDQ authors, the present findings suggest that this type of classification may be worthwhile. It is possible that these ratings constitute a proxy for parenting stress, which might form a potent chronic stressor and thus induce maladaptive patterns of CVR. Importantly, should this mechanism be substantiated, a role for support becomes apparent in aiding
coping with such stress. While the present study cannot confirm this hypothesis, exploration of parenting stress and family adjustment measures in the context of a better-powered sample may shed light on this issue.

A threat to internal validity is the fact that parents completed the measure of their child’s behaviour subsequent to the dyadic interaction. As such, it is possible that their experience of the interaction may be confounded with their ratings of child behaviour. However, the SDQ contains several items that could not be considered pertinent to the dyadic interaction, for example, “Shares readily with other children” and “Has at least one good friend”. Moreover, it seems unlikely that experiences during a brief dyadic interaction would substantially influence ratings of a long-term relationship. Nonetheless, this caveat must be borne in mind when considering the present results. The low internal reliability of the prosocial measure was also problematic and precluded analysis of this dimension in the present study. Prior studies have established internal validity for the scale in larger comparable samples (Stone, Otten, Engels, Vermulst, & Janssens, 2010), though others have noted that the mode of administration may increase the likelihood of socially desirable responses (McCrorry & Layte, 2012). Although this measure was not administered in an interview format, it is possible that social desirability concerns resulted in the lack of variance on two of the five items.

Although the present study is limited by its restricted sample size, the findings suggest important avenues for additional research that may be explored on a larger scale. Researchers have tended not to consider family or parent–child relationships from a social psychological or social support perspective; rather, these relationships have received empirical attention in the context of developmental psychology concerns. However, to neglect parenting as a process relevant to support is to dismiss
the primary caregiving role held by a sizeable proportion of adults at some stage in their lives. Considering the large body of work exploring spousal support and interactions, it seems remiss to ignore parent–child interactions given that at some developmental stages, parents may spend more time with their child than their spouse, with the child also sharing in the time spouses spend together. These support dynamics of parent–child relationships may be critical to well-being both in childhood, and in adulthood, where the balance of support provision tends to shift towards the adult child. In the latter case, the transition from support recipient to a sometimes chronic caregiving role has well-documented influences on well-being (Capistrant et al., 2011), and factors influencing the adjustment to this may shed light on the implications of prolonged support provision for health. Particularly, benchmarking physiological functioning against individuals’ typical reactivity patterns may be a useful exercise in additional research. This both provides a context for interpreting influences on reactivity during dyadic interaction, and statistically controls for individual differences in stress reactivity, which have been well-documented in the reactivity literature.

In conclusion, the present study suggests that child characteristics or parent perceptions of such, even within the spectrum of normal child behaviour, moderate cardiovascular stress responses during both acute stress exposure and during dyadic interaction. Importantly, the findings suggest that dyadic interaction may be conceptualized as more or less stressful than a typical acute stressful experience. Further, these effects are apparent at both the gross and haemodynamic levels.
Chapter 7

OVERALL DISCUSSION

Integrated Summary of Studies

The present research examined the utility and validity of social support — that aspect of social relationships involving the provision and receipt of emotional or tangible assistance — as a buffer of cardiovascular stress responses relevant to physical health. Five methodological refinements were incorporated to help advance our understanding of the effects of social relationships on health. Firstly, the validity of a naturalistic support measure was established in relation to a broad personality framework based on Eysenck’s Personality Questionnaire. Secondly, analogues of support provision were contrasted against support receipt and social contact in order to identify effects specific to receipt, rather than those arising from general embeddedness in a social network. Thirdly, in contrast with studies examining only subjective measures, objective indices of well-being were utilized (namely; resting cardiovascular levels, CVR to and recovery from psychological stress). Fourthly, assessment of cardiovascular arousal was operationalized not only at the individual level but also as a dyadic construct, in terms of concordance in cardiovascular arousal between dyad members. Finally, cardiovascular responses to dyadic interaction were benchmarked against individual stress responses to an acute cognitive stressor. Overall, five empirical studies were reported.
Overview of Study 1

Results from Study 1 suggest that there is indeed overlap between perceived social support and trait personality. However, with less than 10% of variance explained for each support index, this finding also confirmed the validity of the perceived social support construct as being relatively independent from overarching personality traits. Although the results help affirm the construct validity of this social support measure, this complicates arguments that perceived support comprises an individual difference variable, instead of reflecting support actually received from social ties. Given the documented discrepancy between measures of received and perceived support, alternative explanations must be considered. One possibility is that psychometric assessments of perceived available support are tapping into social relationship quality rather than specific support acts. Indeed, as supportiveness (or at least, the availability of such when required by the recipient) is considered inherent in good quality relationship ties, the present findings suggest this as one explanation for the incongruity between the effects of perceived and received support. It may be that perceived support serves as a proxy for overall relationship quality, rather than for broad personality traits.

A novel aspect of this investigation was the consideration of SDR alongside trait personality. Study 1 confirmed the proposition that having an unduly large network of supporters who provide assistance with stress may be considered as socially undesirable or as an admission of weakness or inability to cope, consistent with some social psychological perspectives on support receipt (e.g., theories of social comparison). Conversely, reporting satisfaction with support was positively associated with scores on the impression management measure, suggesting that admitting deficiencies in one’s network might also be viewed in a negative light.
Importantly, the network–SDR link was observed only for men and not for women. This coincides with several perspectives suggesting that quality social interaction is more highly prioritized by women than by men. It is possible that men perceive admissions of need as less congruent with typical male behaviour, whereas women consider nurturing one’s social ties as an important part of everyday life. The larger subsample of women suggests that these effects are more likely to reflect true gender differences rather than issues of sample size. Of course, the stress-and-coping perspective could not be completely ruled out. It is plausible that individuals high in self-presentation or impression management tendencies do have smaller support (as opposed to social) networks, resulting in smaller perceived network size.

Examination of physical health indices (namely, resting cardiovascular levels) favoured some discriminant validity in measures of social support, which independently predicted both SBP and HR. However, as extraversion and support satisfaction were associated with lowered SBP, a question arises over whether links between network support and physical health might be accounted for by overlap between network support and extraversion. The finding that SBP and HR were predicted by support indices is consistent with much research indicating that support tends to influence cardiac rather than vascular aspects of physiological arousal (e.g., Hughes & Howard, 2009; Kamarck et al., 1990). Regarding personality however, the analysis revealed that the oft-neglected trait of psychoticism predicted elevated levels, suggesting emotional impulsivity might be important for cardiovascular function and worthy of additional research. Overall, the independence of effects in the cardiovascular analyses is consistent with the psychometric findings.
Overview of Study 2

Having established the independence of naturalistic support measures from broad models of personality, subsequent experimental studies were designed to test the alternative hypothesis derived from social psychology theories that support receipt is confounded with support provision. In doing so, we sought to clarify whether embeddedness or support provision, rather than receipt, contributes to well-being. As such, Study 2 examined patterns of cardiovascular activity during the mental activation of social support schemas of provision and receipt, in addition to a control social contact group.

Individuals who underwent a schema protocol designed to activate thoughts of support provision displayed increases in CVR during this phase in comparison to those engaged in a support receipt activation task, or to a control group. These increases appeared to be driven by increases in vascular resistance, though this trend did not reach conventional levels of statistical significance. Critically, this finding served to undermine social psychological theories of support provision for contexts in which the individual is already undergoing stress. In addition, the results failed to uphold social support receipt (or a schema analogue of such) as being beneficial for cardiovascular recovery, suggesting either (i) stress-phase specificity in support effects or that (ii) a greater sample size is needed to detect effects here.

The introduction of hostility to the analyses revealed these increases for support providers to be exacerbated by trait hostility. This finding coheres with other published work (Holt-Lunstad et al., 2008) suggesting that individuals high in hostility find support provision more physiologically taxing than support receipt. Importantly, this suggests that the many studies implicating hostility and related traits
such as anger, or Type-A personality, with elevated risk of CVD might consider support provision as a contextual variable that enhances this risk.

**Overview of Study 3**

Study 3 extended Study 2 by employing a dyadic protocol to assess the effects of support provision and receipt on CVR during live social interactions. Importantly, the findings of this study suggest that concordance in CVR might be critical to the benefits derived from supportive interactions, with concordance in both SBP and DBP observed for supportive but not collaborative dyads. The effects of perceptions of support on concordance were also tested. However, no significant effects were observed. This suggests that involvement in the interaction was sufficient to engender concordance, though there are further possibilities such as variability in relationship quality worthy of investigation.

Although perceptions of support did not influence concordance, perceptions of support provision and receipt predicted variations in CVR according to role. For recipients and collaborators, perceived receipt was associated with elevated CVR, with no effect for support providers. This is partially consistent with social exchange and reciprocity theories in that receipt was detrimental, and only for those groups who reported greater receipt than provision. It is also possible however, that the observed association between support receipt and CVR might result from the opposite causal relationship; in other words, elevated levels of stress in one person in a dyad may have elicited more social support from their partner. This association might also be underpinned by a third variable such as perceived need. Individuals who considered themselves as in need of support might have shown elevated cardiovascular arousal in
addition to reporting greater support availability, based on a typical expectation that support will be provided from the dyadic partner.

As equity theories hold equality in support receipt and provision as ideal, we might have expected providers who received reciprocal support from their partners to demonstrate adaptive (i.e., buffered) responses during the interaction. However, support receipt was unrelated to providers own arousal levels. Importantly, perceptions of provision generally buffered CVR across three of the five cardiovascular indices, DBP, CO, and TPR. For recipients and collaborators, this is in line with equity theories, but for providers, this might be considered more congruent with esteem-enhancement theory, which places provision as superior to equity or receipt.

Finally, support recipients demonstrated elevated CVR in comparison to both providers and collaborators. Interestingly, participant ratings of support receipt and provision were not significantly different across groups, but the balance in receipt and provision differed by support role. This is somewhat consistent with the idea that individuals are not accurate accountants of their own support provision or receipt. Further, it suggests that support provision and receipt may be considered in terms of their relativity to one other, rather than in absolute terms.

*Overview of Study 4*

Study 4 continued to examine dynamic concordance in CVR, this time using data from a sample of mother–child dyads characterized by high or low relationship stress. In utilizing a parent–child sample, we sought to examine cardiovascular function in dyadic relationships characterized by ecologically valid rather than experimentally-manipulated provider–recipient roles. In this study, concordance in
maternal resting HR and child HR and RSA was observed. Critically, the type of concordance was moderated by dyad type, with dyads characterized by CM demonstrating substantially less dynamic or epoch-by-epoch concordance than normative dyads. In contrast, CM mothers and children demonstrated greater concordance between overall levels of maternal HR, and child HR and RSA. This study highlighted differences in physiological concordance as a function of interpersonal stress, underscoring the potential for concordance as a useful alternative to measures of physiological function gathered from just one member of each dyad. Notably, although WD concordance was observed in both groups, this was stronger for the non-CM group. As BD concordance was consistently observed only for the CM group, this more conclusively distinguished between high– and low–stress dyadic relationships.

**Overview of Study 5**

Having established patterns of cardiovascular function during typical social interactions, Study 5 sought to compare cardiovascular function during acute cognitive stress with that during dyadic interaction. As with Study 4, parents and their children were studied, in order to examine dyads characterised by ecologically valid provider–recipient roles. The findings indicate that parents’ perceptions of child behaviour moderate the extent to which their cardiovascular responses during dyadic interaction resemble those during their acute stress response. Overall, parents who rated their children as high in difficult behaviour displayed greater responsivity during dyadic interaction than in response to acute stress. This suggests that an individual’s responsivity during dyadic interaction might be usefully conceptualized as being more or less stressful than their typical acute stress response. This finding also suggests that
even within normative parent–child samples, perceptions of one’s dyadic partner influence the nature of the cardiovascular response to dyadic interaction. Particularly, it seems that parents who consider their child as habitually showing difficult behaviour experience interactions with their child as more physiologically stressful than a typical asocial stressor.

Importantly, the findings also indicate that blunted responding may be relevant, with parents who perceive their child as showing more difficult behaviour demonstrating blunted systolic responses to both the asocial stressor and dyadic interaction. As this type of responding was consistent across both task phases, it was cannot be considered specific to the dyadic interaction. As such, it is possible that this response pattern is indicative of individual differences in parental qualities, rather than parental perceptions of the child as related to the child’s actual behaviour. It may be that individual differences in personality underlie this pattern of generalized blunted responding and relatively negative ratings of child behaviour. In contrast, it seems more likely that perceptions of child behaviour are directly relevant in cases where patterning specific to the interaction with the child was observed.

The use of a well-validated measure of child behaviour in this study served to enhance the applicability of the findings to existing work (e.g., Cipriano, Skowron, & Gatzke-Kopp, 2011). The results also supported the use of the SDQ measure over other relationship aspects such as perceptions of child temperament or of the parent–child relationship. Unlike most previous studies of physiological function during social interaction, this study is notable in benchmarking such physiological responses against typical stress responses, thereby offering a methodological advancement on previous dyadic research. This further provides a context for interpreting responses during social interactions as stressful or non-stressful.
Overall Implications of the Findings

*Social support as an individual difference variable*

Previous research has been neglectful of the possibility that measures of naturalistic social support might be tapping into underlying latent variables represented by broad personality models. The present findings indicate perceived support to be sufficiently independent of orthodox personality traits (such as neuroticism or extraversion) as to encourage future research using such measures. Of course, what constitutes “sufficiently independent” in relation to overlapping psychometric constructs is debatable, and may vary depending on the specific instruments and the outcome variables assessed. Notably, Marshall et al. (1994) considered that the less than 30% of variance explained for most of their measures was somewhat low; based on this estimation, the 10% of variance in network size explained in Study 1 is certainly very modest. Nonetheless, Study 1 demonstrated that perceived support reports are susceptible to bias, with men’s reported network size being a function of their scores on a measure of social desirability bias.

In addition, a number of findings underscore the assertion that individual difference variables have much to contribute to our understanding of cardiovascular responses, both independently and in conjunction with social support. In Study 1, extraversion was linked with reduced resting SBP and psychoticism with elevated resting DBP. In Study 2, the exacerbating effect of support provision on cardiovascular recovery was most salient for individuals high in trait hostility. Interestingly, some researchers have conceptualized hostility and social support as interrelated (Gallo & Smith, 1999), which is consistent with the view that hostility is a trait that inherently arises from the individual’s experience of social interactions. The
present findings suggest that hostility may be more entwined with support provision than with support receipt, which seems logical given that one presumably has more control over the support they choose to provide than that received from social ties. In addition, some researchers have hypothesized that a disjunction between person and situation characteristics may induce elevated reactivity (Davis & Matthews, 1996). Additional research may be warranted to investigate whether person–situation mismatch extends to relevant characteristics besides hostility. Moreover, future research may explore whether the hostility–provision mismatch is more discomfiting than hostility–receipt simultaneously across cognitive, affective, and physiological domains.

*Social psychological theories of support*

A core objective of this research was to consider the effects traditionally attributed to support from social psychological perspectives. This was pursued in three laboratory studies. The findings were broadly consistent and suggested some value and also some redundancy for social support in terms of predicting cardiovascular responses. In analyses of resting levels, perceived support emerged as a robust predictor of both SBP and HR. In Study 2, different patterns of cardiovascular recovery were observed for participants exposed to support provision and support receipt manipulations, underscoring the separability of these constructs. This separability was also noted in Study 3, where recipients and collaborators demonstrated greater CVR during the interaction than that exhibited by support providers. These contrasting findings suggest that support provision and receipt may differ in their effects on cardiovascular stress responses as a function of the
background stress the individual is experiencing. Alternatively, provision and receipt may differ in their effects depending on the aspect of the stress response examined.

The implications of the present findings are partially, but not fully, in line with some social psychological perspectives on social support. This is most salient in Study 2 and Study 3. In Study 2, support provision exacerbated rather than enhanced cardiovascular stress recovery. Theoretical accounts from social psychology comment chiefly on equity in support exchange, or on the benefits to be gained from support provision, but outside of this fail to specify the circumstances under which support may be most useful or detrimental. The present findings suggest that this oversight may account for the only partial corroboration of these theories. A critical aspect lacking from equity and esteem–enhancement theories is the consideration of individual difference variables. In Study 2, this effect for support provision was most salient for individuals high in trait hostility. In the same manner by which researchers have often upheld support as invariantly useful, it seems social psychological perspectives have neglected to consider support provision as potentially detrimental.

In Study 3, neither equity nor reciprocity in support provision and receipt moderated either individual responses or dyadic concordance in physiology. Instead, perceived provision and receipt individually influenced CVR. Although these findings do not appear to endorse equity or reciprocity theories, it is possible that direct assessments of these constructs (rather than estimates calculated from separate measures of provision and receipt) might have buffered CVR.

**Aetiological implications of the findings**

To best contextualize these differences in provision and receipt effects on cardiovascular aetiology, the long line of evidence reporting buffering effects on
cardiovascular indices must be acknowledged. Theoretical models of coping have focused on active or passive coping styles and their accompanying haemodynamic responses, with, for example, increases in TPR thought to indicate passive coping or a reduction in task engagement (Sherwood et al., 1990). The present findings suggest that support provision may influence vascular aspects and, as such, be related to passive coping responses. In Study 2, the effects of support provision appeared to be driven by changes in vascular resistance, though this effect was not statistically significant at the conventional level. In Study 3, perceiving support provision was also associated with buffered TPR. However, changes in DBP and CO were also observed, suggesting that the effects of provision are not uniformly vascular in nature and may vary depending on the type of provision and the stressor context. Models of social support suggest that support assists with actively dealing with an external stressor, by enhancing the recipient’s perception of their coping resources and reducing the perceived stressfulness of the stressor. In contrast, providing support to a person who is dealing with a stressor, rather than coping with that stressor directly, is likely to be perceived as a passive and even frustrating process. In some instances, because support providers cannot directly tackle the stressor faced by the support recipient, support provision might be expected to resemble passive coping, and so elicit vascular rather than myocardial responses.

Support provision might also represent an active response style, particularly in cases where tangible provision is involved. Certainly, providing support is more “active” than taking no action at all. Indeed, in some cases, it is the inability to provide support (rather than the provision of it) that might be considered passive; for example, in cases where an ill person is unable to be of tangible use to their caregiver. However, in the present series of studies, support providers were not directly
confronted by the stressor. A schema analogue was employed in Study 2, the burden of task completion was placed on the recipient for Study 3, and parents were restricted from helping their child actually place the puzzle pieces in Study 5. The external validity of these manipulations of support provision must be considered. Particularly, these manipulations simulate a more passive than active type of provision and may not be applicable to supportive contexts where the provider directly deals with the stressor on behalf of the recipient.

Concordance and perceptions of relationships

Concordance or attunement of physiological responses across dyads was an important and somewhat novel aspect of the present research, and was investigated in Study 3 and Study 4. In both studies, dynamic concordance appeared to denote higher quality relationships. Dynamic SBP and DBP concordance was observed in supportive but not collaborative dyads in Study 3, and dynamic concordance in maternal HR and child HR and RSA observed in non-CM but not CM dyads in Study 4. While concordance in physiological responses may thus have implications for the benefits found in supportive relationships, insufficient research in this area means that it is somewhat difficult to situate the findings in the context of previous literature. Some theoretical accounts (Feldman, 2007a, 2007b) suggest that concordance in physiology underlies attunement with emotional states, and so may lead us to consider whether skillful support provision might be marked by greater synchrony (be it affective or physiological). Other perspectives, such as family systems theory (Bowen, 1978), suggest that concordance in physiology may reflect enmeshment in another’s arousal or emotional state, or the inability to regulate one’s own arousal. Overall, given that dynamic concordance was observed only in supportive dyads in
Study 3, and in the non-CM dyads in Study 4, it appears that the former perspective is favoured by the present data.

In particular, Study 4 offers a methodological contribution to our understanding of concordance that has been overlooked in many previous studies. Critically, the findings indicate that effects may vary according to the manner in which concordance is operationalized, be it as WD or BD. Including both operationalizations may enhance our understanding of the meaning and implications of concordance in additional research. Another key finding of Study 4 was that elevated maternal arousal was related to lower levels of dynamic concordance, leading to a more detailed exploration of parental physiological reactivity during dyadic interaction in Study 5.

In Study 5, parental cardiovascular responses to both a cognitive stressor and a dyadic interaction were analyzed. As noted in Chapter 6, several pertinent studies have been generous in their interpretation of links between relational aspects and responses to dyadic interaction, concluding that links between responsivity during dyadic interaction and various aspects of relationships (e.g., sensitive parenting) are specific to dyadic interaction, when these may equally apply to the acute stress response. Study 5 demonstrated that these responses to dyadic interaction may be quantified as a proportion of the typical stress response. Moreover, Study 5 confirmed that parental perceptions of child behaviour influence the relative nature of the dyadic interaction response. Critically, the fact that behaviour rather than relationship quality specifically influenced cardiovascular responses suggests that perceptions of one’s partner rather than the related perceptions of one’s relationship with one’s partner are sufficient to influence our responses to dyadic interaction. Additional research may integrate these findings using parent–child samples with the literature derived from...
general population studies. For example, parental tendencies to rate child behaviour in a certain way may not reflect child behaviour as much as a personality trait like hostility, or neuroticism. The generalizability of these findings is restricted by sample size limitations; however, the use of a more comprehensive haemodynamic assessment than much previous research, in addition to a very widely employed measure of child behaviour adds to the strength of this study. Particularly, as effects were observed at the haemodynamic level, it appears that dyadic parent–child interaction has effects on cardiovascular aetiology beyond HR and RSA, those indices frequently assessed in developmental studies the context of emotion regulation. As such, dyadic parent–child interactions may have implications beyond regulatory outcomes, for longer-term cardiovascular health.

*Methodological issues*

The present research is strengthened by a number of methodological advancements. The continuous and comprehensive monitoring afforded by the Finometer facilitated a more detailed examination of cardiovascular variables than has been achieved in many previous studies of social support (e.g., Fritz, Nagurney, & Helgeson, 2003; Holt-Lunstad et al., 2008). Standardized stressor tasks were employed in Study 2 and Study 5 to elicit cardiovascular stress reactions. The schema activation task employed in Study 2 has also been successfully utilized in prior studies (Gramer & Reitbauer, 2010; Ratnasingam & Bishop, 2007; Smith et al., 2004). Of course, a conspicuous methodological strength is the inclusion of support provision analogues within protocols typically employed only to examine the effects of support receipt – thereby facilitating comparison between support receipt and provision. Moreover, this strength extends to the data analysis, where individual-level and dyad-level CVR, in the form of dyadic concordance, were analyzed.
Chapter 7. Discussion

Some methodological modifications are suggested by the findings, particularly in relation to the number of conditions employed in the laboratory studies. For example, in Study 2 (Chapter 3), a three-group design was utilized to examine mental activation of support provision, support receipt, and neutral social contact after engaging in an acute stressor. A more comprehensive design would have expanded this to six groups, examining mental activation across the three conditions subsequent to and prior to the stressor, to enable comparisons of effects on both CVR and cardiovascular recovery. However, given the sample size this would require, activation subsequent to the stressor was prioritized; particularly as some studies have already established clear effects for perceived support activation on CVR. An additional study might consider utilizing such a design but dropping the social contact conditions from the present study, thereby leaving a more manageable 2 × 2 experiment that maintains the facility to contrast support provision with support receipt.

Similarly, while the main focus of Study 3 (Chapter 4) involved a dyadic perspective on social support provision and receipt, the benefit of hindsight suggests potential value in an additional condition where participants complete the stressor task alone. Study 3 facilitated comparisons of provision and receipt effects within a single framework, using both individual and dyad-level measures of CVR. However, a question remains in that we cannot establish whether either of these contexts (i.e., completing a stressor with support, or completing the task in conjunction with a partner) is more physiologically demanding than facing the challenge alone. On the one hand, individuals completing the challenge alone may feel under greater stress, owing to the social loafing that a collaborative condition might invoke (Karau & Williams, 1993). Alternatively, individuals in an “alone” condition might feel less
socially evaluated than their peers in the collaborative condition. In this sense, the comparable effects for support recipient and collaborator CVR may mask different underlying mechanisms leading to these responses. Recipients may feel under greater stress when challenged to complete the task than collaborators, but may simultaneously find that elevated CVR to be buffered by skillful provision. Nonetheless, on balance, the appropriate conditions were prioritized given the primary research questions addressed, with the Study 3 successfully identifying concordance in CVR between dyad members.

Analytical issues

Several analytical strengths must also be noted in relation to the present research. Dyadic designs in this study were subjected to MLM techniques in order to address the research hypotheses. It must be acknowledged that alternative techniques have been outlined in the literature; for example, the Actor-Partner Interdependence Model (APIM; Cook & Kenny, 2005). The APIM uses the dyad as the unit of analysis and proposes that each actor’s score on an independent variable may not only influence her/his score on the outcome variable but also the partner's score on this outcome. In addition, the model takes into account the interdependence of reports from two partners of the same couple. In the APIM framework, each dyad member is considered an actor as well as a partner in the dyad. Each individual outcome can be influenced by actor effects (Level 1), partner effects (Level 1), interactions between actor and partner effects (Level 2), and by dyad-level effects (Level 2). This framework does not require dyads to be distinguishable, since both actor and partner effects and interactions are assessed for both members. However, scrutiny of the literature indicates that the APIM has chiefly been employed in cases where the data
are drawn from distinguishable dyad members. For example, Peterson and Smith (2010) utilized an APIM approach in their study of 33 depressed individuals and their spouses (all male–female couples, and therefore also distinguishable in terms of gender), as did Thomson, Molloy, and Chung (2012), in their study of 84 coronary graft patients and their spouses. In Study 3, our focus was on dynamic concordance between two types of dyad, rather than actor or partner effects within either dyad type. The APIM may be the more appropriate for future studies examining lead-lag associations in dyad members’ CVR. Therefore, our MLM strategy examining concurrent associations was appropriate and has certainly been prolifically documented in the relevant literature, though the alternative strategy is acknowledged.

Of course, there are limitations to the various statistical techniques utilized. For example, the analytic approach to the psychometric data in Study 1 was not the only appropriate strategy that might have been applied. A few similar studies have employed principal components analysis (PCA) or factor analysis (FA) to identify structural similarities between broad and narrow psychometric measures. With FA, as a method of identifying unobservable latent variables, variance can be partitioned into common variance (factors) and unique variance, which are estimated separately, explicitly recognizing the presence of error. On the other hand, PCA is used for data reduction, and so produces observable composite variables (components), which account for a mixture of common and unique sources of variance. In FA, a factor’s success is gauged by how well it helps the researcher understand the sources of common variation underlying observed data; in PCA, a component’s success is gauged simply by how much variance it explains (Preacher & MacCallum, 2003). Marshall et al. (1994) utilized both PCA and multiple regression to examine the factor structure of their health-relevant instruments in relation to the NEO Five-Factor
Inventory, and to determine the extent to which individual scales could be explained with reference to these personality scales. Ferguson’s (2001) “joint factor analysis” of Eysenck’s model of personality and the dispositional COPE inventory comprised a PCA on a relatively small sample of 154 participants. As such, alternative analytic strategies might have been adopted for this aspect of Study 1; however, the multiple regression techniques we employed had the advantage of addressing the core research question while also maintaining coherence with the cardiovascular analyses conducted as an additional part of Study 1. Had the research question focused on structural similarity between personality and support models, rather than on the actual measurement overlap or predictive value of the support instruments, we might have employed PCA here.

It is also notable that similar research questions have been investigated using secondary data analysis. Judge, Heller, et al. (2002) conducted a meta-analysis of correlations between the Big Five personality traits and job satisfaction scores, while Judge, Erez, et al. (2002) similarly ran a meta-analysis of existing correlations between neuroticism, locus of control, self-efficacy, and self-esteem. Therefore, an opportunity remains to consolidate the existing literature reporting bivariate associations between support indices and personality characteristics, particularly as no such support measure was included in the Marshall et al. (1994) battery of health-relevant instruments.

Finally, the novelty of concordance as a construct of interest also carries with it some analytical concerns. In the present thesis, those studies examining concordance did so by analyzing concurrent rather than lead-lag associations in dyad members’ cardiovascular responses. Given the dearth of studies considering concordance in the context of social support interactions, this is an appropriate
starting point for this type of research. However, despite the limited work on physiological concordance between dyad members, there are still multifarious ways of operationalizing the construct. These vary according to the precision of measurement achieved, the duration of the time lag between measures, and the nature of the interaction itself, apparent in the resting (Study 4) and interaction (Study 3) conditions analyzed in the present thesis. In Study 3, physiological data were averaged over two-minute epochs to maintain consistency with the limited dyadic research investigating similar interactions (Newton & Bane, 2001; Newton & Sanford, 2003). However, an alternative strategy might also have examined more fine-grained measures as was done using the resting data in Study 4. Moreover, while the concurrent analyses identified concordance as one means by which social relationship aspects of quality may influence physiological arousal, lead-lag analysis may shed additional light on the dimensions of support driving concordance within supportive dyads. The development of a theoretical model predicting such effects might facilitate the application of such analyses in additional research.

Limitations of the present research

The present research clarified the role of social support and relationship qualities as a predictor of cardiovascular risk markers. However, a number of issues must be considered in the interpretation of these findings. In the present studies, the primary use of a healthy student population rather than a clinical disease-status sample facilitated the examination of social support effects free of possible confounds such as disease severity and alteration of cardiovascular response by medication. On the one hand, this approach to the research supplies a “clean” baseline from which additional studies can build upon to incorporate disease risk. Nonetheless, as was
alluded to in Study 3, it is likely that social support influences physiological mechanisms differently in individuals who are under chronic stress, or for whom disease status is reached. As such, this research offers a restricted view of the strength of the relationships between social support and progression of disease. Nevertheless, these associations are important at the population level, in that resting levels, CVR, and cardiovascular recovery are known to be long-term predictors of CHD in healthy individuals. Moreover, these results are even more relevant in light of the classic atheroetiological valorization of social support as a positive influence on well-being.

In a similar vein, it should be noted that with the exception of the CM group in Study 3, the samples utilized were somewhat homogenous in terms of some SES indicators such as education level. Researchers have observed that support can be socially patterned according to SES (Stringhini et al., 2012), accounting for some of the adverse effects of low SES on health outcomes (Antonucci, Ajrouch, & Janevic, 1999; Fagundes et al., 2012; Gorman & Sivaganesan, 2007; Salonna et al., 2012). As such, the use of homogenous samples strengthens the validity of the findings, but does caution against generalizing these to samples of higher or lower SES, particularly in terms of educational attainment.

The relatively small numbers of men studied also limits the external validity of the present findings. This limitation was partly as a result of design and partly owing to logistical rather than conceptual considerations. For example, as prior work on schema activation has demonstrated clearer effects for women, a sample of women was conceptually more useful in Study 2 in clarifying aspects that have been neglected in this research. A sample equally weighted for men and women would not have provided incremental value in proportion to the recruitment issues entailed. However, samples balanced for gender in Study 1 and Study 4 would have been
valuable, particularly in Study 1 where resting cardiovascular and psychometric data were gathered from 48 men. As women comprise approximately 80% of the Psychology student cohort in the National University of Ireland, Galway, the available sample of men was limited. For Study 4, women were prioritized as traditional parenting roles suggested that a larger sample might be recruited. For Study 5, while advertisements and recruitment materials were targeted towards parents rather than mothers specifically, the majority of respondents were mothers.

Nonetheless, reasonable sample sizes were obtained in each case to conduct the statistical tests that were used. This is particularly the case for Study 1, where attempts to extract a gender-balanced sample size from a gender-imbalanced participant pool may have resulted in a sample somewhat less representative of the general population. As the hypotheses being tested specifically involved the idea of bias in psychometric measures of support, to push for a balanced sample here may have been counterproductive. Achieving a comparable sample of men may have included men who were relatively less willing to complete the social support measures, possibly resulting in a sample particularly high in social desirability bias or self-conscious regarding their social network reports.

Some well-known truisms regarding gender differences in psychosocial variables were not replicated in the present sample which calls for caution in interpreting the results. Contrary to the literature on gender norms in personality, males in Study 1 did not score lower than females on neuroticism, while males in Study 4 did not post higher scores for trait hostility. While we cannot strictly interpret non-significant effects, these observations do suggest that gender differences may not always be detectable in small samples, or that differences at a population level may not be present in samples with specific characteristics. Nonetheless, some previous
studies have failed to identify gender differences on these measures (e.g., Newton, Bane, Flores, & Greenfield, 1999). Interestingly, where no gender differences were observed in neuroticism (in Study 1), there were also no gender differences in support satisfaction.

Future research

Several strands of additional work are suggested by the present thesis. Firstly, the concept of concordance has received comparatively little attention in the context of social support interaction, despite growing appreciation for the potential importance of this within the developmental psychology literature (Harrist & Waugh, 2002). Indeed, several published studies may have the opportunity to re-analyze data in this manner. For example, Holt-Lunstad et al. (2008) monitored physiological responsivity from both support recipients and providers in their laboratory-based study, but reported these data only at the individual level. Kiecolt-Glaser et al. (2005) examined the proinflammatory cytokines plasma interleukin-6 and tumour necrosis factor α before and after conflict and support interactions between marital dyads, but again, analyzed these at the level of the individual. Although Newton and Bane (2001) did not examine support per se, their study of dyadic interactions between unacquainted partners also facilitates a re-analysis investigating concordance in CVR as a function of social dominance (see also, Newton et al., 1999).

The present thesis evaluated social psychological theories of support in terms of their influence on cardiovascular responsivity. Although these theories may not have been intended to generalize to physiological variables, they go some way towards contributing to a much-needed theoretical framework for the study of support provision and receipt. A fundamental question that might be addressed in future
Chapter 7. Discussion

research involves testing social psychological theories from both physiological and psychological perspectives. Whether divergent effects on cardiovascular, hormonal, immunological, and emotional aspects of well-being are observed remains to be established. As studies have previously reported disjunctions in these effects (e.g., Christian & Stoney, 2006), a more comprehensive evaluation of support provision effects might expand on the types of outcome variables included. Indeed, in Study 3 of the present thesis, support recipients reported a decrease in NA from time 1 (prior to the interaction) to time 2 (after the interaction), yet demonstrated elevated CVR during this time. Of course, this decrement might also be attributable to elevated NA values at time 1 owing to anticipatory stress regarding the task, or particularly lowered values at time 2 owing to relief after completing the task. However, no significant differences in affect at either time were observed.

The present thesis examined whether tendencies to report support might be more adequately conceptualized in terms of (a) a broad theoretical model of personality and (b) one facet of social embeddedness. Personality was not a considerable predictor of support, and overall, support provision and receipt exerted differential effects on CVR, suggesting discrimination between these aspects. However, in some instances, the reciprocality of support provision and receipt dimensions was observed. For example, in Study 3, support providers and recipients did not differ significantly on the gross quantities of support provided or received, but did differ in the balance of provision/receipt reported, suggesting that individuals may perceive support not in terms of absolute quantity but as relative to the support they provide. An interesting line of additional research may identify whether specific personality traits or combinations of these are predictive of tendencies to provide or to report provision of support, or tendencies to balance support transactions in favour of
the individual or their social ties. Regarding the psychometric component of Study 1, further research might involve employing both Eysenck’s and Costa and McCrae’s models of personality alongside support measures, to confirm that the less-than-perfect correspondence between the SSQ6 and Eysenck’s model is generalizable to this rival broad theoretical model and to other support instruments. Similarly, alternative measures of impression management might be employed to establish the reliability of SDR effects on self-reported social support measures.

Our studies of ecologically-valid provider–recipient distinctions utilized parent–child samples. Other examples of naturally-occurring inequitable relationships, such as the relationship between dependent parents and their adult children might be examined in future research. Additional work might also make use of the Finometer or similar continuous monitoring devices to obtain comprehensive cardiovascular assessments for children as well as for adults. In Study 5, a second Finometer was not employed as a finger cuff of the appropriate specifications has not been validated for use with children (although some studies have used the finger cuff as a wrist cuff, which is contrary to the manufacturer’s’ recommendations). However, as the technology on which the Finometer is based has been validated for use with individuals under the age of 18, the development of an appropriate cuff should facilitate future research using this equipment. Particularly, this may be advantageous in terms of the additional haemodynamic variables assessed, in comparison with less comprehensive monitors such as the Dinamap.

**Overall conclusions**

The overarching aim of this research was to investigate inconsistencies in the social support literature bearing on cardiovascular aetiology. Throughout the research,
there was an emphasis on applying social psychology theories to the traditional
support literature, in order to affirm or refute classically held conceptions that may
have been biased by the weight of historical research findings. At a basic level,
influences of support on resting cardiovascular levels were assessed, with subsequent
studies extending to laboratory manipulations of support provision and receipt,
followed by examination of stress responsivity in a type of relationship (parent–child)
that is fundamentally inequitable. In the first instance, direct effects of
psychometrically–assessed support were found on resting cardiovascular levels,
important predictors of long-term cardiovascular health in normal populations. In
experimental paradigms, partial evidence for social psychological theories of support
was observed. Schema analogues of provision exacerbated cardiovascular recovery,
and supportive dyads were marked by dynamic concordance in CVR suggesting one
mechanism by which supportive interactions may influence cardiovascular
responsivity. Dynamic concordance was further observed in high quality compared to
low–quality parent–child relationships, with the underlying haemodynamics of
parental responses explored in the final study.

Overall, this thesis has (i) established the independent contributions of
naturalistic support and trait personality to the prediction of resting cardiovascular
levels, (ii) found that mentally–activated support provision exacerbates rather than
enhances cardiovascular recovery from acute stress, (iii) established dynamic
concordance in CVR as one possible mechanism by which support may be beneficial
for cardiovascular responsivity, (iv) confirmed that this concordance differs between
high and low quality social relationships, indexed by presence/absence of child
maltreatment in a parent–child sample, and (v) demonstrated for the first time in a
parent–child sample that perceptions of one’s child influence the nature of parental
cardiovascular responses during dyadic interaction, relative to their typical acute stress response. This research adds substantially to investigations of social relationship effects on health, particularly by adopting a dyadic perspective on what is a multi-dimensional construct with important implications for well-being.
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APPENDIX A

Parent Information Sheet

Dear parent,

This research is about blood pressure patterns during interactions between parents and their children. An example of an interaction would be playing together or helping your child with homework. We are studying this group because the parent–child relationship is a very important one. It also gives us an opportunity to measure children’s blood pressure during interactions with their parents.

This research does not involve a health check-up. If you think you need your blood pressure checked, you should make an appointment with your local GP.

What the study involves:

The study involves 3 sections

1. Telephone or face-to-face checklist
2. Laboratory session with your child
3. Take-home questionnaire

1. A checklist of demographic and health information, such as age, child age, health status, and so on. This is completed over the phone or during a brief interview with the researcher on campus.

2. Parents and children come to the psychology lab at NUIG. We will connect you both with blood pressure monitoring devices. Your blood pressure will be monitored for about half an hour together. During this time, you and your child will have some games to play, for example, a jigsaw puzzle.

These interactions are videotaped. They are taped to analyse aspects of the lab session that might be important to the research. For example, we might want to measure how many jigsaw pieces a child completes. These tapes are kept anonymous and viewed only by the researcher and an assistant.

The take-home questionnaire includes standard questions measuring personality, social relationships, and your child’s everyday behaviour. Most responses involving ticking a box and this will take some time to complete. No part of the questionnaire is used to diagnose problems. If there is something in the responses that might be important for you to know, we will talk to you.
What we will do with the data:
All data is anonymous and completely confidential. No identifying information will be used in any publications. The information collected from all parents and children is pooled together. The findings will be published in scientific journals.

According to ethical guidelines concerning research at NUI Galway, we are obliged to keep all information for 5 years after the study has been completed. This data will remain anonymous.

You are free to withdraw from this study at any time, including during the laboratory session. For example, if you are uncomfortable with blood pressure monitoring, or if your child is not enjoying the participation, you may of course choose to stop participating.

We will remain very grateful for your time.

If you have any questions about this research, please contact: Ann-Marie Creaven, phone: 091-493264; 085-1855560; email: a.creaven1@nuigalway.ie or her research supervisor, Dr. Brian M. Hughes, phone: 091-493658; email: brian.hughes@nuigalway.ie. If neither one of these people are able to answer your questions to your satisfaction you may contact the Secretary of the NUI Galway Research Ethics Committee, Eithne O Connell, c/o Office of the Vice President for Research, NUI Galway, ethics@nuigalway.ie.

If you would like to participate or simply want more information, please return the contact slip to the class teacher. This will enable the researcher to call you and discuss the study with you.

You may also contact Ann-Marie Creaven directly by telephone or email: again, the details are: telephone: 091-493264; 085-1855560; email: a.creaven1@nuigalway.ie.

Thank you for taking the time to read about this study!
APPENDIX B

Consent Form

Social relationships and cardiovascular responses during parent–child interaction.

I confirm that I have read and understand the information sheet for the study.

I confirm that my child has read and understands the child information sheet.

I understand that all information will remain confidential and anonymous (with the exception of a child protection issue arising).

I understand that we can withdraw at any time during the study without giving any reason.

I _______________________________ (name of parent/ guardian)

(a) consent to take part in this study AND
(b) consent for my child to take part in this study.

Child’s Name: ____________________________

Child’s Date of Birth: ______________________

Signature of Parent/ Guardian: ________________

Contact Number __________________________

Date: ______________________

__________________________ ________________________
Researcher Date Signature
People at the university in Galway are carrying out a study on young people and parents and we would like you to take part!

Many sets of parents and children in the West of Ireland are coming to the laboratory to take part in the research. Research is just a fancy word for finding out about something. We are finding out about blood pressure. You might have heard about blood pressure in school or seen it measured on TV. It is important for us to learn more about families and how blood pressure works. Taking part in this research will help us to do this.

What does taking part mean?

Taking part in this study means we are going to

- Measure your blood pressure and
- Play some games and complete some tasks

The blood pressure part means that we are going to connect you to a piece of equipment that goes on your arm, like the picture. This is called a blood pressure cuff. Your parent will be wearing one of these too.

You and your parent will be in the laboratory together. Sometimes you will have a game to play, sometimes your parent will have a task to do, and sometimes you will have something to do together. The games involve puzzles for you to complete. These different activities will take about half an hour in total to finish. We have everything we need in the lab so you don’t need to bring anything with you. You should dress in comfortable clothes so that you can wear the cuff on your arm.

If you find the time in the lab uncomfortable in any way you can tell your parent and we can finish in the lab early. We would like to make sure you understand that finishing early is ok. If you decide you would not like to take part that is ok too.
Appendices

If you have any questions about the games or the blood pressure monitor (machine), you can ask Ann-Marie, the researcher, when you come to visit the lab. Thank you for reading about this study!
Child’s Consent Form

I ____________________________ (your name)

Agree to wear the blood pressure cuff while I read and play the puzzle games.

I know that if I do not feel like doing the puzzles or wearing the cuff at any time I can stop.

I know that the information I give is confidential – this means that the researcher will not tell other people my answers.

I know that my name will not be used when the researcher writes about the research.

Signature:

______________________________

Date:

______________________________
Appendices

APPENDIX E

Debriefing Information

Thank you for participating in this research study: Social relationships and cardiovascular responses during parent–child interaction.

Study aims:
The aim of the study is to examine cardiovascular activity of parents and their children in response to interaction and in response to challenging tasks. Our cardiovascular responses to challenging tasks like those in this study have links to our cardiovascular health. We are investigating how our wider support networks might influence our cardiovascular responses to mildly stressful tasks and situations involving social interaction.

What happens to the data:
We would like to remind you that all data are completely confidential and anonymised, and no identifying names or schools will be listed in any publications arising from this data. The data from this project are pooled and statistically analyzed.

More information:
Again, if you have any questions regarding this research, please contact: Ann-Marie Creaven, phone: 091-493264; email: a.creaven1@nuigalway.ie or her research supervisor, Dr. Brian M. Hughes, phone: 091-493658; email: brian.hughes@nuigalway.ie. If neither one of these individuals are able to address your concerns satisfactorily you may contact the Secretary of the NUI Galway Research Ethics Committee, Eithne O Connell, c/o Office of the Vice President for Research, NUI Galway, ethics@nuigalway.ie.

If you would like to receive details of presentations or publications arising from this data, please let the researcher know and these will be made available to you as they arise. If you would like more detailed information on the study aims and protocols, please let us know.

Thank you for your time and participation!