

Factors that moderate the effect of laboratory-based social support on cardiovascular reactivity to stress

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ABSTRACT

Social support has been associated with cardiovascular disease (CVD) morbidity and mortality. Cardiovascular reactivity to stress (CVR) is thought to mediate the association between social support and CVD. Examining the effects of laboratory analogues of social support on CVR offers the possibility of experimental control over important confounding variables in social support research; however, such research has yielded conflicting findings. While a number of researchers found that laboratory-based social support attenuated CVR, others found increased CVR when social support was provided, and even that social support had no effect on CVR. A review of the relevant literature suggests that this inconsistency may be associated with a range of methodological issues relating to social support manipulations, evaluation potential, experimenter behaviour, sample characteristics, and personality variables that moderate the observed relationship between social support and CVR. Implications for social support research and for the design of socially supportive interventions are discussed.

Keywords: social support, acute stress, cardiovascular reactivity, cardiovascular disease.

RESUMEN

El apoyo social es una variable que ha sido asociada con la morbilidad y mortalidad en enfermedades cardiovasculares (ECV). La reactividad cardiovascular al estrés (RCV) parece mediar en la asociación entre apoyo social y ECV. El examen de los efectos de los análogos de laboratorio del apoyo social sobre la RCV ofrece la posibilidad de controlar experimentalmente importantes variables contaminadoras de la investigación sobre apoyo social; no obstante, dicha investigación ha producido hasta ahora evidencias contradictorias. Distintos investigadores han mostrado que la administración de apoyo social en tareas de laboratorio puede provocar tanto incrementos como descensos de la RCV, así como no tener ningún efecto sobre la misma. La revisión de la literatura sugiere que esta heterogeneidad de resultados puede ser debida a factores metodológicos relacionados con las manipulaciones experimentales del apoyo social, el potencial de la evaluación, el comportamiento del experimentador, las características de la muestra y las variables de personalidad que modulan la relación observada entre apoyo social y RCV. Se discuten en este trabajo las implicaciones tanto para la investigación sobre el apoyo social como para el diseño de intervenciones basadas en el apoyo social.

Palabras clave: apoyo social; estrés agudo; reactividad cardiovascular; enfermedad cardiovascular.

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Epidemiological research suggests that social support is inversely related to cardiovascular morbidity and mortality (Cohen, 1988; Eriksen, 1994), and is associated with the course of coronary heart disease (CHD) even after its onset (Berkman, Leo-Summers, & Horwitz, 1992; Case, Moss, Case, McDermott, & Elberly, 1992). One recent review concluded that various types of low social support confer a risk of 1.5 to 2.0 of negative CVD events in both healthy populations and in patients with CVD (Lett, *et al.*, 2005).

The specific mechanisms or processes through which social support influences cardiovascular health remain unclear. Kamarck, Manuck, and Jennings (1990) suggested that social support operates at a physiological level as a moderator of cardiovascular reactivity to stress (CVR). This suggestion is derived from the reactivity hypothesis, which states that excessive cardiovascular response to episodic stress contributes to the development of hypertension and coronary heart disease (Krantz & Manuck, 1984; Manuck, Kasprovicz, & Mulddon, 1990).

A number of researchers have examined the effects of social support on cardiovascular health from the perspective of the reactivity hypothesis. One approach adopted in this research involves the study of the effects of laboratory analogues of social support on CVR. Studies adopting this approach have yielded some conflicting findings. Although a number of researchers found that social support attenuated CVR to laboratory stressors (e.g., Kamarck, Manuck, & Jennings, 1990; Lepore, Mata Allen & Evans, 1993), others have found increased CVR when social support analogues are provided (e.g., Allen, Blascovich, Tomaka & Kelsey, 1991; Anthony & O'Brien, 1999), and that social support analogues had no effect on CVR (e.g., Sheffield & Carroll, 1994). Social support-CVR studies vary with respect to their treatment of methodological and individual difference variables that may moderate the effects of social support on CVR. A systematic review of methodological and individual difference variables in the social support-CVR literature has not been published.

METHOD

A computer-based search using PsycInfo, Medline, Ebsco and PubMed was undertaken to search for relevant articles published since 1990. Combinations of the following key words were entered into the search engines: cardiovascular, reactivity, activity, blood pressure (BP), heart rate (HR), stress, laboratory, support, social support, and affiliation. In addition, pertinent references were identified and titles relevant to the current review were obtained.

Inclusion and Exclusion Criteria

Published literature examining the effects of laboratory analogues of social support on CVR to acute stress was included. Only manipulations of conspecific social support were included. For example, while Allen *et al.* (1991) used pet dogs as support providers in one of their conditions, this condition will not be discussed in the review (although the other conditions of their study will be). Only studies of adult, non-clinical populations, which examined any of the various measures of CVR in laboratory settings, were

considered. As such, studies that examined ambulatory BP (e.g., Steptoe, 2000) were excluded. The effect of adult attachment and social support provided by a romantic partner on CVR was examined in one study (Feeney & Kirkpatrick, 1996). Given that all of the other studies used either a supportive confederate or non-romantic friend in the social support condition, Feeney and Kirkpatrick's study was excluded.

A summary table of the 21 studies that fitted the inclusion criteria can be seen in Table 1. The table summarises the design of the 21 studies and includes a column of additional factors examined in each study. It can be seen from this table that while 15 studies found that some operationalisation of social support attenuated CVR (e.g., Kamarck *et al.*, 1990), the remaining 6 experiments report either that social support increased CVR (e.g., Allen *et al.*, 1991) or had no effect on CVR (e.g., Sheffield & Carroll, 1994). In addition, some of the 15 studies reporting positive effects of social support on CVR included conditions designed to be socially supportive, but which failed to attenuate CVR.

SUMMARY OF CONCEPTUAL ISSUES ARISING

Social Support

A major problem with social support research is that the concept of social support remains poorly defined and variously operationalised across the literature. It is now generally accepted that social support is a multidimensional concept. Taylor (2003) summarised past attempts at defining social support as follows: Social support is "information from others that one is loved and cared for, esteemed and valued, and part of a network of communication and mutual obligations from parents, a spouse or lover, other relatives, friends, social and community contacts such as clubs, or even a devoted pet (p. 235)." However, even this reasonably comprehensive description fails to encompass all aspects of social support that have been examined to date. In particular, this definition fails to take account of some aspects of social support that have been examined in laboratory based studies of social support.

Across the literature, a distinction is made between structural and functional social support. Structural social support refers to the size, type, density, and frequency of contact with the network of people surrounding an individual, and functional social support refers to the social support provided by that structure (Lett *et al.*, 2005). Four main types of functional social support have been identified: emotional (i.e., help that directly tackles emotional reactions); instrumental (i.e., help resulting in tangible effects); informational (i.e., providing information); and appraisal (i.e., help with evaluating a situation) support (House, 1981). Laboratory analogues of social support are generally confined to the manipulation of functional social support.

Cardiovascular Reactivity

Cardiovascular reactivity is a known risk factor for CVD (Krantz & Manuck, 1984; Treiber *et al.*, 2003). People with exaggerated levels of CVR are believed to be at increased lifetime risk of CVD as a result of gradual cardiac hypertrophy, of re-

Table 1. Laboratory Analogues of Social Support and CVR: Design Summary of Reviewed Studies.

Study	Social Support Conditions		CVR Markers		Stressor (Duration)	Participants: N and Gender Age (M; R)		Design	Other factors
	Friend support; Alone	Partner support; Alone	SBP, DBP, Pulse rate	MA (2 min.)		Student/Non-student	Mixed Design		
Allen, Blascovich, Tomaka & Kelsey (1991) ^o	Friend support; Alone	Partner support; Alone	SBP, DBP, Pulse rate	MA (2 min.)	45 female M= 38.95; R: 27-55	Mixed Design	-Evaluation apprehension -Laboratory v field		
Anthony & O'Brien (1999) Study 1 ^o	Alone, Supportive; Non- supportive	Alone, Supportive; Non- supportive	HR, CO, Heather index, LVET, MAP, PEP, SV, TPR	Role play-accused of shoplifting (3 min.)	54 female, 14 male M= 19; R: 17-30	Between Subjects	-Mere presence		
Anthony & O'Brien (1999) Study 2 ^o	Highly supportive; Supportive; Non-supportive	Highly supportive; Supportive; Non-supportive	HR, CO, Heather index, LVET, MAP, PEP, SV, TPR	Role play-accused of shoplifting (3 min.)	60 female, M= 20; R: 17-22	Between Subjects	-Evaluation apprehension -Threat -Comfort		
Christiam & Soney (2006)*	Evaluative + friend support; Non-evaluative + alone; Non- evaluative + alone	Evaluative + friend support; Non-evaluative + alone; Non- evaluative + alone	CO, TPR, SV, PEP	Speech task (3 minutes)	82 women Student	Between Subjects	-Evaluation -Interaction between social support and evaluation -Friendship quality -Stranger v friend support -Stress self-reports		
Christenfeld, Gerin, Linehn, Sanders, Mauth, Deich & Pickering (1997)*	Supportive Confederate, Supportive Friend	Supportive Confederate, Supportive Friend	HR, SBP, DBP	Speech-euthanasia (6 min.)	90 female M= 19.5	Between Subjects	-Stranger v friend support -Stress self-reports		
Edens, Larkin & Abel (1992) ^o	Stranger + touch; stranger + no touch; friend + touch; friend + no touch	Stranger + touch; stranger + no touch; friend + touch; friend + no touch	HR, SBP, DBP	MA (3 min.) Mirror-tracing (3 min.)	60 female Student	Between Subjects	-Touch -Friend v stranger -Effects of task		
Fontana, Diegnan, Vieneuve & Lepore (1999)*	Alone; With same sex stranger; With same sex best friend	Alone; With same sex stranger; With same sex best friend	HR, SBP, DBP	Role plays-stressful college situation (3 min.)	60 female M= 18.5	Between Subjects	-Non-evaluative conditions -Participants in follicular phase of menstrual cycle		
Gerin, Milner, Chawla & Pickering (1995)*	Alone; With new roommate	Alone; With new roommate	HR, SBP, DBP	'Safari' video game: High vs. low stress (3 min.)	26 female Students attending summer program	Within Subjects	-Direct effects vs. buffering hypothesis		
Gerin, Pieper, Levy & Pickering (1992)*	Alone vs. Emotional support provided	Alone vs. Emotional support provided	HR, SBP, DBP	Verbal attack- controversial issue (Session: 12-15 min.)	40 female Student	Between Subjects	-Social Comparison Theory		
Glynn, Christenfeld & Gerin (1999)*	Support; No support	Support; No support	HR, SBP, DBP	Speech-euthanasia (5 min.)	57 female; 52 male Student	Between Subjects	-Gender		
Hilmert, Kulik & Christenfeld (2002) Study 1 ^o	Supportive; Non-supportive, Experimenter present /absent	Supportive; Non-supportive, Experimenter present /absent	HR, SBP, DBP	Speech- that college is a valuable asset' (5 min.)	62 female Student	Between Subjects	-Evaluation apprehension -Motivation		
Hilmert, Kulik & Christenfeld (2002) Study 2 ^o	Supportive; Non-supportive, Experimenter present /absent	Supportive; Non-supportive, Experimenter present /absent	HR, SBP, DBP	Speech- that college is a valuable asset' (5 min.)	61 female Student	Between Subjects	-Evaluation apprehension -Motivation		
Hilmert, Christenfeld & Kulik (2002)*	Positive v. negative response; expert v. novice audience	Positive v. negative response; expert v. novice audience	HR, SBP, DBP	Public Speaking- abortion (5 min.)	64 female Student	Between Subjects	-Self-efficacy -Audience status		

Table 1. (Continued)

Study	Social Support Conditions	CVR Markers	Stressor (Duration)	Participants: N and Gender Age (M; R)	Design	Other factors
Kamarck, Annunziato & Amateau (1995)*	Friend support; alone	HR, DBP, SBP	Sitrop task (6 min.) MA (3 min.)	96 female M=20 R: 18-30 97% students	Between Subjects	-Affiliation -Threat -Emotional response -Task appraisal -Hostility -Non-evaluative -Touch
Kamarck, Mannuck & Jennings (1990)*	Friend + Touch; Alone	HR, SBP, DBP	MA, Concept formation	39 female M=18.8	Between Subjects	-Affiliation -Participants in follicular phase of menstrual cycle -Cynicism
Lepore (1995)*	Same sex confederate present; alone	HR, SBP, DBP	Lecture-euthanasia (5 min.)	52 female, 52 male	Between Subjects	-Cynicism
Lepore, Mala Allen & Evans (1993)*	Alone; Supportive confederate; Non-support confederate	SBP, DBP	Speech-euthanasia (6 min.)	47 female, 43 male M=20.8	Between Subjects	
Sherfield & Carroll (1996) ^o	Supportive v. Non-supportive; Disagreement v. agreement	HR, SBP, DBP	Identification of paintings (4 min.)	45 female; 45 male M=21.6 R: 17-35 Student	Between Subjects	-Effects of confirming support
Sherfield & Carroll (1994) ^o	Alone; Friend present; Stranger present	HR, SBP, DBP	MA	60 female; 60 male M=21.1	Mixed Design	-Gender
Suganuma & Ura (2001)*	Instrumental v. socio-emotional support; high v. low legitimacy of influence	MIBP	(6 min.) Vocab task MA (5 min.)	91 female College age	Mixed Design	-Instrumental v. Socio-emotional support
Thorsteinsson & James (1998)* (HR only)	Supportive video	HR, SBP, DBP	*Fire Chief video game (5 min.)	20 female; 20 male M=20 R: 18-35	Between Subjects	-Video-relayed support
Uchino & Garvey* (1996)	Support available; No support available	HR, SBP, DBP	Role play-shoplifting (3 min.)	21 female, 28 male Student	Between Subjects	-Availability of support
Uno, Uchino & Smith (2002)*	Emotional support; instrumental support; no support	DBP, SBP, S.V, CO ₂ , TRP, PEP, RSA	Speech tasks-on 3 current event topics (3 x 1min)	88 female M=21	Between Subjects	-Emotional v. instrumental support -Gender of support provider -Relationship quality.

CVR= cardiovascular reactivity; HR= heart rate; SBP= systolic blood pressure; DBP= diastolic blood pressure; heart rate index= myocardial contractility; LVEF= left ventricular ejection time; MAP= mean arterial blood pressure; PEP= pre-ejection period; SV= stroke volume; TRP= temporal peripheral resistance; CO= cardiac output; RSA= respiratory sinus arrhythmia; MA= mental arithmetic task; N= sample size; M= mean age; R= age range.

* indicates that some attenuating effect was found for social support on CVR. In some instances this effect is qualified by various factors.
^o indicates either than no attenuating effect for social support on CVR was found or that support increased CVR.

setting of resting BP levels, or of third variables that underlie both CVR and disease (Lovallo & Gerin, 2003). Cardiovascular reactivity is relatively stable over time (Sherwood, Girdler, Bragdon *et al.*, 1997) and, as with other physiological measures, it is less contaminated by social desirability factors than psychometrically assessed dependent variables such as questionnaire measures of stress and anxiety. However, it is important to remember that CVR is only one of a number of physiological mechanisms that may mediate the relationship between social support and CVD. In fact, it seems most likely that social support has its effect on cardiovascular health by buffering the effects of both stress and negative emotions on multiple bodily systems. For example, social support has been associated with effects on both the endocrine and immune systems (e.g., Cohen, Doyle, Skoner, Rabin, & Gwaltney, 1997; Seeman, Berkman, Blazer, & Rowe, 1994).

The majority (16 of 21) of the studies examined systolic blood pressure (SBP), diastolic blood pressure (DBP) and HR. Lepore *et al.* (1993) included only SBP and DBP, and Sugauma and Ura (2001) employed mean arterial blood pressure (MAP) as a single physiological dependent variable in their study. Three of the reviewed studies (Anthony & O'Brien, 1999; Christian & Stoney, 2006; Uno, Uchino & Smith, 2002) measured CVR using impedance cardiography methods. Because blood pressure and HR are multiply determined endpoints, the approach adopted by these three studies allows a more detailed understanding of the effects of social support on cardiovascular functions. Dependent variables in the three studies included temporal peripheral resistance (TPR), cardiac output (CO), stroke volume (SV), and pre-ejection period (PEP), a measure of sympathetic control of the heart. Anthony and O'Brien, and Uno *et al.* additionally measured respiratory sinus arrhythmia (RSA), which provides a measure of parasympathetic control of the heart, and Anthony and O'Brien additionally examined left ventricular ejection time (LVET) and heather index, which is an indicator of myocardial contractility. A thorough discussion of CVR is beyond the scope of the present paper, but is offered by Kamarck and Lovallo (2003).

METHODOLOGICAL ISSUES

Issues relating to Social Support

Can laboratory analogues of social support adequately represent the complex set of behaviours, thoughts and emotions that people experience in everyday social interactions? Do varied laboratory analogues of social support represent a single construct? In attempting to answer these questions, it is important to look closely at operational definitions of social support across our reviewed studies.

Friend Support. In general, laboratory analogues of social support have involved participant's friends or confederates of the experimenter acting as social support providers. In eight of the reviewed studies, friends were used to provide social support. A consistent pattern of findings did not emerge across these eight studies. Some of the studies found that CVR was lower in the presence of a friend than CVR when alone (Gerin, Milner, Chawla, & Pickering, 1995; Kamarck, Annunziante, & Amateau, 1995), or in the presence

of a confederate (Edens, Larkin, & Abel, 1992; Christenfeld, Gerin, Linden, *et al.*, 1997). Also, Kamarck *et al.* (1990) reported that physical touch by a friend reduced CVR relative to CVR when alone. However, Allen *et al.* (1991) found that CVR was higher in a friend's presence than when alone and other researchers report that there is no difference between CVR in the presence of a friend and CVR when alone (Edens *et al.*, 1992; Sheffield & Carroll, 1994).

Given the inconsistencies in findings with regard to friend support, attention needs to be paid to procedural specifics. In all studies, the friend was recruited through asking participants to bring along their same-sex best friend. It is possible that people who have a friend available to come with them to the laboratory differ from people who do not have such a friend readily available to them. This might lead to a bias in sampling.

Evaluation potential, or the potential for participants to feel that they are being evaluated by social support providers, may result in increased CVR in conditions designed to be socially supportive. Allen *et al.* (1991), Edens *et al.* (1992), and Sheffield and Carroll (1994) did include evaluative contexts in the sense that the friends present as supporters could observe participants' performance. When Fontana *et al.* (1999) applied a non-evaluative context, friend support reduced CVR relative to stranger support and alone conditions. Christian and Stoney (2006), on the other hand, report that the presence of either an evaluative or non-evaluative friend did not attenuate or increase SBP, DBP or HR relative to a non-evaluative alone condition. Unlike earlier studies, Christian and Stoney specifically compared conditions where evaluative and non-evaluative friends were present during stressor tasks. Furthermore, these researchers included multiple measures of CVR in their analyses and were able to further investigate associations among social support, evaluation potential and CVR in their sample. Their results showed that participants with friends present in either evaluative or non-evaluative roles showed decreases in vascular responding to stress (evidenced by lower TPR). Vascular responding is associated with hypertension and endothelial dysfunction, both of which are important predictors of CVD (Saab & Schneiderman, 1993; Schwartz, Gerin, Davidson *et al.*, 2003). In summary, the presence of a friend had a positive health effect even though it had no main effect on BP or HR.

Another problem with friend-support conditions is that people have long histories of supportive and non-supportive interactions with their best friends. This pre-experimental history cannot be experimentally controlled and it is likely to contribute to within-group variance. Uno *et al.* (2002) looked at relationship quality as a possible moderator of the effects of friend support on CVR. They defined friendships as either ambivalent, consisting of both positive and negative feelings, or purely positive. Emotional support received via the medium of handwritten notes within friendships characterised as purely positive was related to lower increases in CO compared to a no-support condition. Emotional support received within an ambivalent friendship was associated with larger increases in CO when compared to individuals in the no-support conditions. Females who interacted with an ambivalent, female friend had the largest changes in DBP, TPR and PEP compared to the other conditions. Thus, Uno *et al.* concluded that relationship quality is an important factor that moderates the influence of social support

on cardiovascular functioning. Uno *et al.* did not fully control for evaluation potential in their design; although social support providers were not in the room where participants were giving their speeches, participants were informed that they would be listening to the speeches from an observation room.

Confederate Support. In an attempt to increase experimental control, some researchers have employed trained confederates to provide standardised social support to participants. In the majority of studies employing confederates to provide social support, attenuated CVR was found in social support conditions (Christenfeld *et al.*, 1997; Fontana *et al.*, 1999; Gerin, Pieper, Levy, & Pickering, 1992; Kamarck *et al.*, 1990; Lepore *et al.*, 1993). However, Anthony and O'Brien (1999) reported no significant differences in CVR between supportive and non-supportive conditions where social support was provided by same-sex confederates. Furthermore, Edens *et al.*, (1992) reported that while the presence of a friend was associated with decreased CVR, neither the presence of a stranger nor touch attenuated CVR. In summary, although social support provided by strangers appears to have positive effects in most situations, the attempts of strangers to provide social support may not always be effective in terms of reducing CVR.

Video-relayed social support. While relationship quality is an important potential confound when friends provide social support, confederate support may lack validity. Furthermore, despite the fact that these confederates are trained to provide equivalent social support across all participants, it remains likely that there will be some slight differences in their behaviour across participants. One group of researchers have attempted to overcome this problem by operationalising social support as a pre-recorded video of either a supportive or non-supportive confederate (Thorsteinsson, James, & Gregg, 1998). These researchers found a significant attenuating effect for social support on HR.

The decision to employ friends, confederates or videos as support providers in social support-CVR research depends on the specific research questions being addressed. It is likely that various sources of social support may be differentially effective for different types of problems (Mitchell, Billings, & Moos, 1982). For example, if the social support that is needed in a given situation is mere presence, then friends and family may only be as effective as strangers. However, if instrumental support is necessary, then an expert, who is a stranger, might be more effective.

Laboratory Analogues of Different Types of Social Support. Some of the most useful social support-CVR studies in terms of informing theory have examined the effects of different functional support types on CVR. Two studies (Suganuma and Ura, 2001; Uno *et al.*, 2002) compared the effects of laboratory analogues of instrumental and emotional social support on CVR. In Uno *et al.*'s study, standardised notes, handwritten by support providers, were given to participants by the experimenter. Uno *et al.* revealed no main effect for the effects of instrumental versus emotional support on CVR. Suganuma and Ura had friends of participants give advice about how best to complete a stressor task in the instrumental support condition, and they had friends of participants give positive feedback in the emotional support condition. Results showed that while emotional support was associated with attenuated CVR, instrumental support was associated with

increased CVR. Future research employing replicable laboratory analogues of the four types of functional support (emotional, instrumental, informational and appraisal support), and examining their effects on CVR would greatly contribute to the development of a coherent theory of social support.

Available vs. Enacted Social Support. As well as being distinguishable by type, functional support can be described as available or enacted (Tardy, 1985). Whereas available support refers to access to a particular type of support from the environment, enacted support refers to the manifestation of available support in the form of actual functional support received from others. When studied specifically, the correlations between available and enacted support are low, indicating that the two dimensions are not interchangeable (Dunkel-Schetter & Bennett, 1990; Sarason, Sarason, & Pierce, 1990). A number of researchers have suggested that the relationship between perceived availability of support and health outcomes may be more reliable than the relationship between enacted support and health outcomes (e.g., Helgeson, 1993). In fact, Sarason et al. (1990) suggest that the enactment of social support affects health solely through its impact on the receiver's perceptions of support availability.

Uchino and Garvey (1997) reported a significant attenuating effect for availability of social support on HR and SBP. They concluded that having access to social support results in adaptation to stress in the absence of enacted support. Only five participants (four in the social support available condition and one in the no-support available condition) asked for some form of assistance. The CVR scores of these five participants did not significantly affect the analysis. Uchino and Garvey's study suggests that the availability of social support may be sufficient to attenuate cardiovascular responses. In other words, offering help may be as effective as providing help in terms of reducing CVR.

Gender of Support Provider. Epidemiological evidence suggests that marriage is more beneficial for men than it is for women (Wiklund *et al.*, 1988). Less is known about why this is the case. If gender differences in the laboratory social support paradigm match the epidemiological findings, then it might be possible to draw some tentative conclusions about the differential effects of social support provided by males and females. In one of the reviewed studies, support from women attenuated CVR, but support from men did not (Glynn *et al.*, 1999). None of the other studies examined the differential effects of male and female support provision.

Evaluation Potential. The previous section referred to the possibility that evaluation potential might affect the results of studies examining the social support-CVR relationship. In general, the reviewed studies showed that when a support provider was capable of observing task performance and did not provide verbal feedback to performers, social support increased rather than attenuated CVR to stress (e.g., Edens *et al.*, 1992; Allen *et al.*, 1991). When participants were not observed by support providers, social support attenuated CVR (e.g., Kamarck *et al.*, 1990; Fontana *et al.*, 1999). Thus, it has been suggested that evaluation potential is accounting for the results observed. Indeed, based on the results of their meta-analysis, Thorsteinsson and James (1999) reported that evaluation potential is a likely moderator of the social support-CVR relationship.

One recent social support-CVR paper sought to shed light on the problem of

evaluation potential in laboratory social support research (Christian & Stoney, 2006). There were four conditions in the study: evaluative with friend present or not present; non-evaluative with friend present or not present. Although the authors reported no main effects of evaluation potential on HR, SBP or DBP, evaluation potential did affect other measures of CVR. Participants who were evaluated by friends exhibited greater myocardial responding (evidenced by increases in CI and PEP) than participants in other conditions. Interestingly, myocardial responding has been associated with stress responses to challenge, as opposed to threat (Blascovich & Katkin, 1993). The challenge-threat distinction is based on the transactional model of stress (Lazarus, 1975). When an individual believes that they have sufficient resources to cope with a stressor, it is perceived as a challenge. If an individual believes that they do not have sufficient resources to cope with a stressor, it is perceived as a threat.

Thorsteinsson *et al.* (1998) suggest that the reason for the differential in the results of Kamarck *et al.* (1990) and Edens *et al.* (1992) may have been gender incongruence. While both studies used all female samples, Kamarck *et al.* used a male experimenter and Edens *et al.* used a female experimenter. Thorsteinsson *et al.* suggest that this gender incongruence may have resulted in increased evaluation apprehension and thus, increased CVR. Gender incongruence does not account for all of the inconsistencies across the literature. However, the idea that characteristics of the experimenter could affect CVR by affecting subjective experiences of evaluation potential is a worthwhile one, and it constitutes a further possible moderating factor in the social support-CVR relationship.

Hilmert, Kulik and Christenfeld (2002) designed an experiment to assess the effects of different levels of evaluation potential, operationalised as experimenter presence or absence, on the social support-CVR relationship. They report that social support only had an attenuating effect on CVR when the experimenter was present. In the experimenter-absent condition, support increased CVR relative to non-support. They suggest that evaluative concerns are greatest when the experimenter is present and that the supportive audience may convey that the performer is achieving the goal of performing well. In contrast, support increased CVR when the experimenter was absent. The authors postulate that under conditions of low evaluative concern (experimenter absent) social support may serve to increase task involvement. They also propose that a non-supportive audience is unlikely to stimulate active coping when evaluation concerns are low.

In another study Hilmert, Christenfeld, and Kulik (2002) manipulated audience status and found that the effects of audience feedback (positive or negative) on CVR were intensified before an expert audience. In this study, the positive feedback condition could be described as supportive with confederates indicating approval and interest, both verbally and non-verbally. The negative feedback condition could be construed as non-supportive as two confederates behaved disapproving and disinterested respectively. Thus, the results of this study have implications for the present review in that they support the idea that evaluation potential, which is expected to be greater in front of an expert audience, moderates the social support-CVR relationship. However, the researchers did not find significant differences in self-reported anxiety between participants who performed in front of expert versus novice audiences.

In previous research of a similar nature, Kamarck *et al.* (1995) manipulated experimenter status, dress, demeanour and the evaluative emphasis in task instructions in order to create conditions of high and low social threat. Their aim was to examine the stress-buffering hypothesis of social support, which predicts greater benefits of social support for those individuals who are experiencing high levels of stress (Caplan, 1974; Dean & Lin, 1977). They confirmed their specific hypothesis that the response-attenuating effects of affiliation under stress are limited to conditions that involve high social threat. However, Kamarck *et al.* in their manipulation of threat also manipulated evaluation potential. Thus, their results may be interpreted to conclude that social support has an attenuating effect on CVR when evaluative concerns are high, and not when evaluative concerns are low.

The results of Kamarck *et al.* (1995) as well as Christenfeld *et al.* (1997) indicate the importance of experimenter presence and behaviour on the social support-CVR relationship. Interestingly, Kamarck *et al.* found that the effects of social support continued to influence CVR even after the supporters had left the room. This has implications for the importance of people's social relationships outside of the laboratory in the hours before the study, as well as on the potential for availability of social support to attenuate CVR (e.g., Uchino & Garvey, 1997).

Issues relating to Laboratory Stress

Some authors have reported no significant differences in CVR to various types of stressors (e.g., Turner, Girdler, Sherwood, Light, 1990), but others have indicated poor inter-task consistency (e.g., Hughes, 2001). Stressors in the current selection of studies included social (e.g., speech tasks) and non-social (e.g., mental arithmetic tasks) stressors. Although there is a bias towards non-social tasks in the literature generally (Lassner, Matthews, & Stoney, 1994), the stressors utilised across the 21 studies reviewed here represent a balance between the two categories. This balance is appropriate, given that social support may have differential effects in social and non-social stressful situations. Lassner *et al.* suggested that individual differences in CVR might be stable across asocial and social stressors in women, but not in men and boys. This is an interesting finding and one that highlights the need to pay attention to gender in cardiovascular research.

Over half of the reviewed studies employed speech tasks as stressors (see Table 1). Speech task across the studies varied in duration and content, highlighting a number of problems for social support-CVR research. First, there is a lack of consensus on the optimum length and type of speech stressor. Second, inconsistency in the findings of social support-CVR studies may be due to the differences in stressors employed and not because of any systematic effects of social support. Third, although speech tasks have been shown to reliably increase CVR, other constructs can affect the range and magnitude of CVR. For example, the simple act of speaking can increase CVR (Tardy, Thompson, & Allen, 1989), and very few researchers adjust their data for time spent speaking.

Mental arithmetic tasks were employed in seven studies (see Table 1). One advantage of mental arithmetic stressors over other stressors is that performance on

mental arithmetic tasks can be readily assessed and task difficulty can be adjusted according to an individual's performance. Two of the studies used video games to provoke stress. Gerin *et al.* (1995) had participants play a 'Safari' video game. Thorsteinsson, James, and Gregg (1998) utilised the game 'Fire Chief'. Both of these tasks were successful in eliciting stress responses. Video games potentially represent an effective way of providing participants with a controlled stressful experience that can be adjusted according to performance. It is plausible that the effects of social support on CVR in various situations could be examined through the presentation of various stressful social situations in video games, e.g., effects of carrying out a task with a computer simulated other, versus alone.

Issues relating to Individual Differences

The identification of the types of social support that predict outcomes, as well as for whom and under what circumstances, are fundamental questions in social support research (Lett *et al.*, 2005). To date, however, research on interactions between social support and individual differences across situations has been limited. In a sample of 887 post-myocardial infarction patients (Frasure-Smith *et al.*, 2000), depressed patients with low perceived social support had higher mortality risk than all other patients in the year following myocardial infarction. Conversely, depressed patients with high perceived social support were not at increased risk for mortality. This research supported the idea that multiple nonlinear processes are likely to interact within individuals to influence mortality (Cloninger, 2005).

Gender. The sample size across the 21 studies ranged from 26 to 109, with a combined sample size of 1,634 participants. Of these, 81% were female and 67% were students. Of the 21 studies reviewed, only eight included male participants. This gender imbalance represents a serious weakness in the literature, especially given that cardiovascular disorders are more prevalent in males. Furthermore, CVR is not the same across males and females. Although women tend to have higher levels of HR reactivity than do men (Stoney, Davis, & Matthews, 1987), the opposite is taken to be true for SBP (Stoney, Matthews, McDonald & Johnson, 1988).

Kamarck *et al.* (1990) report that they selected an all-female sample in light of evidence suggesting that women are more responsive than men to the type of experimental manipulations they were employing. A number of the studies that were carried out after Kamarck *et al.* (1990) were attempting to replicate some aspects of that study (e.g., Kamarck *et al.*, 1995; Anthony & O'Brien, 1999). This fact may explain some of the gender bias in the literature.

In addition to the problem of external validity, the bias in sampling highlights the importance of controlling for menstrual phase in the research. Although evidence related to the effects of menstrual phase on blood pressure and HR suggests that responses are not different in the follicular versus luteal phase, there is some evidence to suggest that the cardiovascular response overall is affected by menstrual phase. In other words, although blood pressure and HR reactivity are not different across the phases, the mechanisms underlying elevations are influenced by cycle phase (Girdler, Pederson,

Stern & Light, 1993). Thus, Anthony and O'Brien (1999), Christian and Stoney (2006), and Uno *et al.* (2002) should have been particularly concerned with controlling for menstrual phase or investigating the effects of menstrual phase on their results.

The bias across the studies with regard to the use of student participants is not unique to social-support research. However, it is an important issue here since the main uses of socially-supportive interventions are not likely to be with student populations.

Person Variables. Lepore (1995) investigated the interactive effects of social support and hostility on CVR, and reported that individuals who generally mistrust others, as expressed by high scores on the Cook and Medley (1954) Hostility Scale, do not benefit from social support to the same extent as individuals who tend to be more trusting of others. Kamarck *et al.* (1995) reported that participants scoring high on hostility and low on dominance actually showed larger CVR to social threat when accompanied by an affiliative partner. One problem with both Lepore and Kamarck *et al.* is that evaluation potential was high in all conditions. As such, the findings of the study may be caused by different reactions to evaluation across the groups, rather than to social support.

One variable that has received very little attention in social support-CVR research is structural social support, which has been shown to affect CVR (see Hughes, 2002 for a review). An analysis of the relationship between structural social support and CVR in supportive and non-supportive laboratory conditions would appear worthwhile. Examples of other variables that may interact with social support in the laboratory, all of which require further study, include depression, neuroticism, optimism, socioeconomic status, health status, education level and race.

IMPLICATIONS FOR SOCIAL SUPPORT-CVR RESEARCH

This review examined methodological and individual difference variables that moderate the effects of social support on CVR. One issue that stands out as critical for researchers of the social support-CVR relationship is evaluation potential. We acknowledge that it is difficult to provide a valid analogue of social support that excludes the possibility for evaluation apprehension on the part of the participant. It is difficult to have participants believe that they are supported when the supporter cannot observe their performance. However, knowing that one is being observed is, in turn, likely to influence CVR. Even more problematically, some supportive conditions may result in more evaluation apprehension than those conditions designed to be non-supportive. In spite of the difficulties, researchers of the social support-CVR relationship must embrace evaluation potential as a variable to be examined and understood.

The decision of whether to employ friend versus confederate support in social support-CVR research should be based on the research question being tested. Researchers should be aware that the two types of social support are not interchangeable. The generalisability of social support-CVR research is greatly hampered by the use of all-female and all-student samples across the majority of the studies (see Table 1). The effects of social support on CVR in more diverse samples with respect to age, gender and occupational status should be examined. A particularly important concern for future

research should be to include more male participants and to examine gender differences in the social support-CVR relationship. It also appears wise to employ measures of CVR that allow detailed analysis of the variables that determine HR and BP (e.g., Christian & Stoney, 2006; Uno *et al.*, 2002). It is clear that relationships between social support and CVR can be masked when only HR and BP are measured.

Given the inconsistency across the results of studies of the social support-CVR relationship to date, there appears to be good reason to promote greater consistency with regard to laboratory tasks, experimenter behaviours and operationalisations of social support. Until a standardised format is adopted, extrapolation across studies using different but seemingly similar constructs may be misguided.

IMPLICATIONS FOR SOCIALLY SUPPORTIVE INTERVENTIONS

The reviewed literature highlights some issues that should be taken into account when designing socially-supportive interventions for use in applied settings. These interventions could be used with populations at-risk for the development of CVD and also as part of cardiac-rehabilitation programmes. From this review of social support-CVR relationships, it seems clear that the provision of social support is complex. It appears that socially supportive interventions should be non-evaluative whenever possible. Although further research is required to confirm, female support providers may be more effective than male support providers. Receiving social support from a friend appears to have more positive effects than receiving social support from a stranger. However, this is not always the case and it may be wise to take relationship quality into account before inviting friends or relatives to be part of an individual's intervention. Further research on interactions between social support and other variables will allow more conclusions to be drawn on who might be likely to benefit most from socially supportive interventions. Hostile individuals may not benefit from social support, or different types of interventions may be required for hostile and non-hostile individuals. Finally, there is limited evidence to suggest that the mere availability of social support may have positive effects on cardiovascular health. As such, providing numbers for people to call when stressed or simply giving people access to social support resources may be sufficient.

CONCLUSION

As a whole, the social support-CVR literature demonstrates much experimental sophistication, but lacks a coherent theoretical basis. Future research should seek a unifying theoretical model of social support that will generate empirically testable hypotheses about stress responses. Such a model, which needs to incorporate evaluation apprehension, friendship and affiliation factors, as well as individual differences, will hold the key to the development of a richer understanding of social support.

One issue that emerges very clearly from an analysis of social support-CVR research is that very subtle, and seemingly innocuous, differences in laboratory analogues of social support and experimental design affect CVR. Social relationships are complex

and attention needs to be paid to multiple levels of complexity in social support research and in the design of socially supportive interventions.

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