

Kissing in Marital and Cohabiting Relationships: Effects on Blood Lipids, Stress, and Relationship Satisfaction

Kory Floyd, Justin P. Boren, Annegret F. Hannawa, Colin Hesse, Breanna McEwan, & Alice E. Veksler

Affection exchange theory and previous research suggest that affectionate behavior has stress-ameliorating effects. On this basis, we hypothesized that increasing affectionate behavior would effect improvements in physical and psychological conditions known to be exacerbated by stress. This study tested this proposition by examining the effects of increased romantic kissing on blood lipids, perceived stress, depression, and relationship satisfaction. Fifty-two healthy adults who were in marital or cohabiting romantic relationships provided self-report data for psychological outcomes and blood samples for hematological tests, and were then randomly assigned to experimental and control groups for a 6-week trial. Those in the experimental group were instructed to increase the frequency of romantic kissing in their relationships; those in the control group received no such instructions. After 6 weeks, psychological and hematological tests were repeated. Relative to the control group, the experimental group experienced improvements in perceived stress, relationship satisfaction, and total serum cholesterol.

Keywords: Affection; Affection Exchange Theory; Kissing; Lipids

As a nonverbal means of communicating affection, kissing is nearly ubiquitous among human cultures (Eibl-Eibesfeldt, 1970). Speculations vary as to its origins. Some suggest that kissing began with the practice of premastication, wherein mothers

Kory Floyd is Professor of human communication at Arizona State University, where the remaining authors are doctoral students. Order of authorship for all junior authors was determined alphabetically. This research was supported by grant R03 MH075757-01A1 to the senior author from the National Institute of Mental Health. The authors are grateful for the technical advice of Jason Short, MD; Harvey Wiener, DO; and Anne Vogel, RN. Correspondence to: Kory Floyd, Hugh Downs School of Human Communication, Arizona State University, PO Box 871205, Tempe AZ 85287-1205, USA. E-mail: kory@asu.edu

chewed up food and passed it directly from their lips to their babies' mouths; this mouth-to-mouth contact is thought to have then evolved into a more general expression of care and affection that was later applied to other relationships (Willett, 2001). Another common idea is that the physical proximity facilitated by kissing allows for subconscious assessment of the major histocompatibility complex (MHC), an important predictor of maladaptive mating prospects (Wedekind, Seebeck, Bettins, & Paepke, 1995). Whatever its origins, there is little question that kissing has a prominent place in the cadre of nonverbal communicative behaviors used to express interpersonal affection (see Floyd, 2006a; Guerrero & Floyd, 2006) and that it is provocative biologically, physiologically, and emotionally. To the extent that it mitigates the psychological and physiological effects of stress, as we will argue herein, kissing may also effect improvements in physical and mental health conditions that are exacerbated by stress. The present experiment was designed to ascertain the effects of increased romantic kissing on total serum cholesterol, two emotional health parameters (perceived stress and depression), and assessments of relationship satisfaction.

We begin this essay with a discussion of the biological, physiological, and emotional components of romantic kissing and a summary of research on its health outcomes. Next, we advance a theoretic argument, grounded in affection exchange theory, that romantic kissing within the context of a positively valenced relationship has stress-ameliorating effects. We then apply the stress-reduction hypothesis to a hematological outcome, total serum cholesterol, which is known to be exacerbated by stress. Finally, we apply the hypothesis to emotional health outcomes and evaluative assessment of the romantic relationship.

Structural Components of Kissing

As a nonverbal form of dyadic affectionate expression in personal relationships, kissing can be said to involve biological, physiological, and emotional components. We provide a brief description of each in this section. Although our discussion herein focuses on the biological, physiological, and emotional components of kissing, we acknowledge that kissing is also a cultural, symbolic, and sociological behavior, as are most forms of affectionate expression (see Floyd, 2006a). The parameters of our discussion reflect the scope and direction of our theoretic argument rather than a dismissal of these additional components.

Biological Components

At a biological level, kissing is a form of touch. Kissing typically involves direct contact between one partner's lips and/or tongue and the skin (whether the mouth, cheek, neck, hand, etc.) or hair of the other partner. Nontactile variations are observed (e.g., "blowing a kiss"), as are nonoral variations (e.g., rubbing noses). These exceptions aside, however, kissing—whether romantic or platonic—nearly always entails tactile contact with the lips, and romantic kissing is likely to involve tactile contact with the lips of both partners simultaneously (Floyd, 2006a). This is

significant from a biological standpoint because, compared to other parts of the body, the lips are highly sensitive to touch. That is, the lips have both an inordinate density of dermal and epidermal touch receptors (Stenn & Bhawan, 1990) and large cortical mapping in the primary somatosensory cortex, where information from somatosensory nerves is received (Lui & Tang, 2004). Consequently, kissing—particularly prolonged mutual kissing, involving both sets of lips—stimulates a strong tactile sensation. Moreover, it is common for kissing to invoke ancillary forms of touch, such as hugging, hand-holding, and hand-to-face touch, further adding to the tactile sensory experience (see Floyd, 2006a).

Physiological Components

Romantic kissing likely initiates a range of physiological responses associated with parasympathetic arousal, salivary exchange, and endocrine reactivity. Although little research has explicated these effects directly, one can speculate about the specifics of kissing's physiological correlates on the basis of research examining other forms of physical affection. Opining on the general physiological components of positive social intercourse, for instance, Uvnäs-Moberg (1997) wrote that serial interaction within the context of positive intimate relationships (which frequently involve kissing) “induces a psychophysiological response pattern involving sedation, relaxation, decreased sympathoadrenal activity, and increased vagal nerve tone and thereby an endocrine and metabolic pattern favoring the storage of nutrients and growth” (p. 146). In romantic relationships, physically affectionate interaction in the form of hand holding, cuddling, and hugging has been shown to have parasympathetic outcomes, including decreased blood pressure and reductions in the stress hormone cortisol (Grewen, Girdler, Amico, & Light, 2005; Light, Grewen, & Amico, 2005), as well as elevated epidermal temperature (Rubinsky, Hoon, Eckerman, & Amberson, 1985; Seeley et al., 1980). It is logical to expect kissing to be characterized by the same physiological profile.

One of the most socially consequential physiological components of kissing may involve the exchange of sebum, an oily substance composed of lipids and cellular debris that is secreted by the sebaceous glands. Sebaceous glands are found in the skin of mammals, and humans have more than any other mammal (Montagna & Parakkal, 1974). Some researchers (e.g., Comfort, 1974) have suggested that sebum is a *semio-chemical*, a chemical that carries a message and affects the behaviors of members of one's own species (such as pheromones) or another species (such as allomones). Nicholson (1984) has argued persuasively that sebum may play a role in feelings of attachment and bonding, both between sexual partners and between parents and children, which would partially explain the ubiquity of kissing as an expression of affection.

Emotional Components

Finally, kissing has an affective component, insofar as it usually occurs within the context of positively valenced relationships and for the purpose of conveying affection (Floyd, 2006a). There are exceptions, including the use of kissing in

nonromantic sexual interaction (Leonard, 1990), in perfunctory social greetings (Greenbaum & Rosenfeld, 1980), and in religious rituals (Penn, 2003). These exceptions aside, kissing is generally observed in relationships that are characterized by positive affect and is exchanged within those relationships as a means of expressing and reinforcing love, attraction, attachment, and affection, whether romantic or platonic (Floyd, 2006a). It is therefore logical to expect that kissing increases positive affect, at least on the part of the kisser, although evidence for this proposition is primarily anecdotal (e.g., Cane, 2005). Kissing behavior is included, however, in psychometric indices for relational closeness (Berscheid, Snyder, & Omoto, 1989), intimacy (Waring, 1984), and affection (Floyd & Morman, 1998), suggesting consensus among relationship researchers that kissing reflects positive affective states.

To the extent that kissing activates biological, physiological, and emotional processes, it may therefore have implications for health. We review the existing research subsequently.

Research on the Health Effects of Kissing

Most research on the health effects of kissing has focused on the implications of salivary exchange and potential blood exchange (via trace amounts of blood in the saliva) in romantic kissing. These effects include facilitating the transmission of viral infections, such as influenza (Schoch-Spana, 2000), herpes simplex viruses (Cowan et al., 2002), and infectious mononucleosis (Carbary, 1975). For instance, a matched cohort study of adolescents 15 to 19 years of age found that intimate kissing quadruples the risk of meningococcal meningitis (Tully et al., 2006). Romantic kissing can also facilitate transmission of food allergies (Maloney, Chapman, & Sicherer, 2006) and drug allergies (Liccardi, Gilder, D'Amato, & D'Amato, 2002; Mancuso & Berdondini, 2006) from one partner to the other. Other scientists have warned of the potential for avian flu or HIV transmission from romantic kissing if microlesions are present on the oral mucosa of the infected partner (Maged, 2006; Piazza et al., 1989). Still other research has indicated that passionate kissing can change the DNA composition of saliva, but only within the first minute after kissing has ceased (Banaschak, Möller, & Pfeiffer, 1998).

In addition to its potential negative health outcomes, kissing has also been shown to elicit some health benefits. Thus far, research on its positive health outcomes has focused on physiological responses to allergens. In an experiment involving 30 patients with allergic rhinitis (AR) and 30 patients with atopic dermatitis (AD), for instance, Kimata (2003) found that kissing a romantic partner for 30 minutes significantly reduced skin wheal responses to house dust mite and Japanese cedar pollen (but not histamine), and significantly decreased plasma levels of nerve growth factor, brain-derived neurotrophic factor, neurotrophin-3, and neurotrophin-4, relative to nonclinical controls. In a later experiment, Kimata (2006) demonstrated that kissing for 30 minutes significantly decreased production of allergen-specific immunoglobulin E (IgE) in atopic patients, relative to nonclinical controls. The findings from these two studies are important because allergic skin wheal responses and IgE production

are exacerbated by stress in AR and AD patients. Kimata (2003, 2006) reasoned that if kissing a romantic partner is a stress-alleviating activity, it should therefore precede significant reductions in these allergic responses. The same logic guides the present experiment: if romantic kissing ameliorates the psychological and physiological experience of stress, it should therefore effect improvements in other health outcomes (besides allergic responses) that are exacerbated by stress.

In the next section, we offer a theoretic and empirical argument for kissing as a stress-alleviating communicative behavior. Subsequently, we review physiological and psychological outcomes that have been shown to be aggravated by stress, and hypothesize that increased kissing can enhance these outcomes.

Kissing as a Stress-Alleviating Behavior

Researchers have long observed that many forms of physical affection behavior in personal relationships, including kissing, reduce signs of distress. For instance, De Chateau and Wiberg (1977) reported that when mothers spent more time kissing their infants at suckling, the infants smiled more and cried less frequently. Affection exchange theory (AET: Floyd, 2002, 2006a) provides that communicating affection in close relationships initiates neuroendocrine processes that maximize reward and buffer the individual against the physiological effects of stress, and that these benefits are independent of those associated with receiving affectionate expressions. Several studies have illustrated this pattern. For instance, Floyd (2006b) examined the effects of expressed and received affection on diurnal variation in the steroid hormone cortisol. Cortisol normally follows a strong diurnal (i.e., 24-hour) rhythm wherein it peaks immediately after awakening and drops continually during the day, reaching its lowest point around midnight (Kirschbaum & Hellhammer, 1989). A high degree of diurnal variation in cortisol levels reflects healthy regulation of the hypothalamic-pituitary-adrenal axis, one of the body's principal mechanisms for responding to acute stress; "flattened" diurnal curves, showing little change in cortisol values from morning to evening, are therefore indicative of chronic stress (Chrousos & Gold, 1992; Giese, Sephton, Abercrombie, Duran, & Spiegel, 2004; Heim, Ehlert, & Hellhammer, 2000). As hypothesized, Floyd (2006b) found that, with the effect of received affection controlled for, expressed affection was directly related to the magnitude of morning-to-evening change in cortisol ($\beta = .56$).

In a later experiment, Floyd, Mikkelson, Tafoya, et al. (2007) found that during episodes of acute stress (in which cortisol levels are typically elevated), expressing affection in writing to a loved one accelerates the return of cortisol to normal levels. Grewen et al. (2005) similarly found that nonverbal affectionate interaction reduced cortisol levels for both men and women, and also elevated levels of the neurohypophysial hormone oxytocin in women (see also Turner, Altemus, Enos, Cooper, & McGuinness, 1999), whereas Floyd, Hesse, and Haynes (2007) found a strong inverse relationship ($\beta = -.85$) between expressed affection and glycohemoglobin (an index of average blood glucose level, which is elevated by stress), after controlling for the effects of received affection. In two experiments, Floyd, Mikkelson, Hesse,

and Pauley (2007) also demonstrated that an affectionate writing exercise reduced total serum cholesterol (which is also elevated by stress) in a group of healthy adults.

The associations between affectionate behavior and well-being are not limited to physical health outcomes, but extend to mental health as well. Using a comparison-groups method, Floyd (2002) demonstrated that highly affectionate adults report less stress, lower susceptibility to depression, greater overall mental health, and higher satisfaction with their romantic relationships than do their less affectionate counterparts. Given the strongly reciprocal nature of expressed and received affection, one could conceivably argue that the mental and relational benefits associated with expressing affection are simply those associated with the amount of affection received in return. AET provides, however, that communicating affection is beneficial on its own (i.e., its benefits are independent of those of received affection), and four studies by Floyd et al. (2005) demonstrated that expressed affection accounts for significant variance in stress, depression, relationship satisfaction, and mental health even when received affection is controlled for.

Collectively, these studies reflect AET's proposition that affectionate behavior ameliorates the physiological and psychological effects of stress. In the present experiment, we test the ability of romantic kissing to improve a variety of physiological and psychological outcomes of stress, each of which is detailed subsequently

Physiological Effects of Stress: Total Cholesterol

If affectionate behavior ameliorates stress, as AET predicts and as previous investigations have established, then it is logical to predict that it will also effect improvements on physiological parameters that are exacerbated by stress (as Kimata's experiments with allergy responses have demonstrated). The present investigation focuses on total serum cholesterol as a candidate outcome. Cholesterol is a lipid, which is a water-insoluble organic compound present in the cell membranes of all body tissues. Cholesterol performs a number of essential physiological functions, including maintaining membrane fluidity, producing bile, and contributing to the metabolism of fat-soluble vitamins (Shier, Butler, & Lewis, 2004). It is also largely responsible for the production of steroid hormones, such as cortisol, aldosterone, progesterone, the estrogens, and testosterone. The liver produces most of the body's cholesterol, although the consumption of foods that are high in cholesterol, trans fat, and/or saturated fat (such as egg yolks, red meat, full-fat dairy foods, and fried foods) contributes to elevated cholesterol levels in the bloodstream (Mader, 2005). American Heart Association guidelines provide that, for healthy adults, total serum cholesterol should be less than 200 mg/dL; HDL should be above 40 mg/dL for men and above 50 mg/dL for women; LDL should be less than 100 mg/dL; and triglycerides should be less than 150 mg/dL (American Heart Association, 2007). Chronically elevated cholesterol (a condition known as *hypercholesterolemia*) often leads to the formation and accumulation of plaque deposits in the arteries, which can contribute to atherosclerosis or coronary heart disease.

Multiple studies have demonstrated that stress is associated with elevations in total cholesterol and changes in its constituent components, including triglycerides,

high-density lipoproteins (HDL, or “good cholesterol”) and low-density lipoproteins (LDL, or “bad cholesterol;” see, e.g., Bacon, Ring, Lip, & Carroll, 2004; McCann et al., 1995; Muldoon et al., 1995; Stoney, Niaura, Bausserman, & Metacin, 1999). The specific mechanisms through which stress elevates cholesterol level are as yet unknown, although some speculation suggests that they may reflect evolved processes through which stress-induced increases in energy (in the form of metabolic fuels such as glucose and fatty acids) initiate ancillary processes that elevate levels of LDL in the bloodstream (see Steptoe & Brydon, 2005). Other speculation points to activation of the sympathetic nervous system and the rapid release of catecholamines (such as epinephrine and norepinephrine) and glucocorticoids (such as cortisol). It has been documented that lipoprotein lipase activity is inhibited by both norepinephrine and cortisol (Jansen & Hulsmann, 1985; Miller, Gorski, Oscai, & Palmer, 1989), which decreases the clearance of triglycerides, decreases HDL concentrations, and increases LDL concentrations (Huttunen, Ehnolm, Kekki, & Nikkila, 1976).

Because blood lipids are exacerbated by stress, and because affectionate behavior has stress-ameliorating physiological effects, we therefore hypothesize that increased kissing improves blood lipids by decreasing total cholesterol. Two experiments by Floyd, Mikkelsen, Hesse, et al. (2007) demonstrated, for instance, that total cholesterol was decreased as a result of serial affectionate writing; the present trial tests the ability of a romantic kissing intervention to effect improvements on the same hematological outcome. Our specific hypothesis was as follows:

H1: In healthy adults, increasing romantic kissing reduces total serum cholesterol.

Psychological Effects of Stress: Depression, Perceived Stress, and Relationship Satisfaction

We further anticipate that increasing affection in one’s romantic relationship will produce emotional benefits, including enhanced perceptions of relationship satisfaction and reductions in perceived stress and depression. Several cross-sectional studies have established that affectionate behavior in romantic, platonic, and familial relationships is inversely associated with depression and stress and directly associated with relationship satisfaction (Floyd, 2002; Floyd et al., 2005; Floyd & Morman, 1998). It is certainly the case that increases in relationship satisfaction, and/or decreases in stress or depression, might lead one to become more affectionate—indeed, affectionate behaviors typically increase in frequency and intensity as romantic love develops (see, e.g., Huston, Caughlin, Houts, Smith, & George, 2001; Owen, 1987). On the basis of AET, we propose herein that the obverse causal model may also be operative, wherein increasing affectionate behavior improves one’s perceptions of satisfaction, stress, and depression.

H2: In healthy adults, increasing romantic kissing reduces perceived stress and susceptibility to depression.

H3: In healthy adults, increasing romantic kissing increases satisfaction with the romantic relationship.

Method

Participants

Participants ($N = 52$) were equal numbers of healthy male and female adults. Ages ranged from 19 to 67 years, with an average of 28.63 years ($SD = 8.36$). Most of the participants (78.4%) were Caucasian, whereas 11.8% were Asian/Pacific Islander, 7.8% were Hispanic, 2.0% were African American, 2.0% were Native American, and 3.9% were of other ethnic origins (these percentages sum to > 100 because participants were allowed to indicate more than one ethnicity). At the time of the study, 17.6% had completed some college but had no degree, 2.0% had completed an associate (2-year) degree, 29.4% had completed a baccalaureate (4-year) degree, 49.0% had completed a masters degree, and 2.0% had completed a professional doctorate (e.g., MD, JD).

Procedures

This study was a federally registered Phase I clinical trial (registry #1001 R03 MH075757-01A1), and was approved by the university's institutional review board.

Prescreening procedures

Participants were recruited from among the staff, undergraduate student, and graduate student populations at a large university in the southwestern United States. The study was advertised in three ways: a) via an electronic advertisement on the university's online campus newspaper, b) via flyers posted on bulletin boards around campus, and c) via an electronic announcement sent to various university listservs. In all cases, prospective participants were directed to an online prescreening measure to determine their eligibility for the study. To be considered eligible, prospective participants had to: a) be 18 years of age or older; b) be able to speak and read English; c) be living full-time with a spouse or romantic partner; d) weigh at least 110 pounds; e) report no history of diagnosis or treatment for hypercholesterolemia; f) report no current use of blood-thinning agents such as Coumadin; g) report no history of type 1 or type 2 diabetes; h) report that they were not currently pregnant or breast-feeding; and i) report no more than mild anxiety about having a capillary blood draw. A total of 188 prospective participants filled out and submitted the online prescreening questionnaire; of that number, 127 (67.6%) met all of the qualifications. Women and men were equally likely to be qualified for the study ($p > .05$). The most common reasons for disqualification were lack of current cohabitation with a romantic partner and body weight of less than 110 pounds.

Laboratory procedures

Qualified participants who consented to take part in the study made an appointment to visit the Communication Sciences Laboratory and were sent a link to a longer online questionnaire to fill out beforehand. Participants were instructed to be fasting when they reported to the lab, having had nothing to eat or drink besides water for at

least 8 hours. Due to the fasting requirement, all lab sessions were scheduled between 7 a.m. and 10 a.m.

When they reported for their Time 1 (T_1) laboratory visit, participants completed informed consent forms and were asked about their compliance with the fasting instructions (all participants reported compliance). A researcher (one of the junior authors) then activated a Heat Factory (Vista, CA) brand single-use 50°C hand warmer and asked the participant to hold it in his or her nondominant hand while the participant's height and weight were recorded. The purpose of the hand warmer was to stimulate blood flow prior to the capillary puncture. Next, the researcher retrieved the hand warmer and used a 70% isopropyl alcohol swab to cleanse the third digit fingertip of the participant's nondominant hand. Using a 1.75-mm Tenderlett surgical blade lancet (International Technidyne Corp., Edison, NJ), the researcher punctured the capillary bed and wiped away the first secretion of blood with a sterile gauze pad (see McCall & Tankersley, 2003). The researcher then aspirated 80 μ l of capillary blood into two glass tubes coated with lithium heparin, an anticoagulant. Half of the blood was used for the lipid assessment, and the other half was used for immunocompetence assays not reported here. After the capillary blood draw, the puncture site was bandaged. The participant was offered juice and a cookie, was paid \$15, and was told to expect an e-mail from the senior author on a specified date, which would contain additional information and instructions for the study.

Following the 6-week trial (which is described below), participants returned to the laboratory under the same conditions and instructions for their Time 2 (T_2) assessments. The only procedural difference between the first and second lab visits was that participants' height was only assessed during the first visit; otherwise, the procedures were identical. Participants were paid an additional \$15 at the completion of their second laboratory visit. For one experimental group participant, the T_2 lipid assessment registered an analytic error after the participant had already left the lab, and we were not able to reschedule that participant for an additional test; this participant was therefore excluded from analyses involving changes in total cholesterol.

All researchers involved in the study had received university training in the avoidance of bloodborne pathogens and employed universal precautions while drawing and handling blood samples, including the use of synthetic (nonlatex) gloves. After each capillary blood draw, lancets, test materials, and gloves were discarded into biohazardous waste containers.

Experimental procedures

Assignment to conditions for the 6-week trial was done upon completion of the T_1 laboratory assessments. To ensure an equal sex distribution across conditions, we used stratified random assignment (via a randomizer software program) to assign participants to the experimental and control groups. A series of 2 (condition) \times 2 (sex) ANOVAs confirmed that the experimental and control groups did not differ significantly from each other in their T_1 values for total cholesterol, relationship satisfaction, depression, or stress.

Participants in both conditions were e-mailed by the senior author on a preannounced Monday. All participants were thanked for their participation and were told to expect an e-mail from the senior author every Monday for the duration of the 6-week trial. They were told that some of these e-mails would simply contain information about the study and that some would contain links to short online questionnaires that participants would be asked to complete.

Participants in the experimental group were also given instructions in the initial e-mail message that their task during the 6-week trial was to increase, to a noticeable degree, their frequency and duration of kissing with their cohabiting romantic partner. The specific text of the message was as follows:

Over the next 6 weeks, we would like you and your spouse or romantic partner to kiss more frequently than you normally do. At first, you might set aside a few minutes each day specifically for kissing. Over time, you will probably find that it becomes a more routine part of how you interact. The point is for the two of you to kiss each other more often and for longer periods of time than you typically do right now. We hope you will enjoy this part of the study. It's fine to tell your spouse or romantic partner what you have been instructed to do. We hope you will both make increased kissing a priority over the next 6 weeks.

Participants in both conditions received e-mails from the senior author every Monday thereafter for the 6-week duration of the trial. The messages on the first, third, fourth, and sixth Monday consisted of reminders about the study instructions and indications of when participants would be contacted to schedule their T₂ laboratory visits. The messages sent to the experimental group also contained reminders to continue kissing with elevated frequency. On the second and fifth Mondays, participants' messages contained a link to a short online questionnaire that participants were asked to complete as soon thereafter as possible. The questionnaire contained items checking the manipulation and indexing changes in participants' eating and exercising behaviors and general health.

To minimize experimenter expectancy effects, all of the junior authors (who conducted the laboratory sessions) were kept blind to the manipulation instructions and assignment to experimental conditions, and had no access to any of the participants' questionnaire data during the study procedure. The senior author, conversely, was not involved in collecting or analyzing any of the blood samples.

Questionnaire Measures

Relationship satisfaction was measured with the unifactorial 7-item Relationship Assessment Scale (RAS; Hendrick, 1988). Items included, "How well does your partner meet your needs?" and, "How good is your relationship, compared to most?" Coefficient alpha was .88 at T₁ and .93 at T₂. *Depression* was assessed with the Iowa Short Form (Kohout, Berkman, Evans, & Cornoni-Huntley, 1993) of the Center for Epidemiological Studies Depression (CES-D) scale (Radloff, 1977). The unifactorial 11-item measure asked participants how frequently they experienced symptoms such as loss of appetite, changes in sleep patterns, or self-dislike. Coefficient alpha was .90

at T_1 and .89 at T_2 . *Stress* was measured with the Perceived Stress Scale (PSS) developed by Cohen, Kamarck, and Mermelstein (1983). Items asked participants how often, in the past month, they had experienced stress, anger, nervousness, difficulty coping with irritations, and difficulty dealing with change, among other symptoms. Coefficient alpha was .90 at T_1 and .90 at T_2 .

Biochemical Analysis

Total serum cholesterol was assessed in mg/dL with the Cholestech LDX, a Clinical Laboratory Improvement Amendments (CLIA)-waived in-vitro diagnostic monitor manufactured by Cholestech (Hayward, CA). For this test, 40 μ l of capillary blood was aspirated into a heparinized glass tube and then applied to a sterile test strip that was assessed by the monitor. During the experiment, the monitor was quantitatively calibrated on a daily basis and tested with manufactured controls monthly. Moreover, it has been extensively validated for cholesterol assessment in published clinical examinations (Gregory, Duh, & Christenson, 1994; Rogers, Misner, Ockene, & Nicolosi, 1993).

Manipulation Checks

A 13-item Likert-type scale was administered on the second and fifth Mondays of the 6-week trial. Participants were sent a link to the questionnaire by e-mail, completed the questionnaire online, and submitted their answers electronically. When completing the questionnaire, participants were asked to think specifically about the previous 2 weeks. Each item on the scale was a declarative statement with which participants were asked to indicate their level of agreement on a scale ranging from 1 (strongly disagree) to 7 (strongly agree). Embedded within the items was the statement, "My romantic partner and I have been kissing more than we normally do." This item provided a direct test of the manipulation. An additional item read, "My romantic partner and I have expressed our love for each other verbally more often normal." This item was included both to lessen the uniqueness of the kissing item and to allow for nonmanipulated changes in verbal affection to be controlled for in the causal analyses. The remaining items, which were included as potential control variables, assessed changes in eating patterns (2 items), exercising behaviors (2 items), general health (2 items), relationship conflict (3 items), and "filler" items related to the couple's interaction patterns (2 items). Means and standard deviations (separated by time and condition) and T_1 - T_2 correlations for all 13 items appear in Table 1.

Results

Manipulation Checks

Scores for each of the 13 manipulation check items were compared by condition. For the direct manipulation test ("My romantic partner and I have been kissing more than we normally do"), those in the experimental group scored significantly higher than did those in the control group, $t(48) = 5.51$, p (one-tailed) $< .001$, $d = 1.59$, indicating success for the manipulation. Concerns that increases in nonverbal

Table 1 Means, Standard Deviations, and T₁-T₂ Correlations for Items Used in Manipulation Check

Item	Experimental group		Control group		T ₁ -T ₂ r
	T ₁ M/SD	T ₂ M/SD	T ₁ M/SD	T ₂ M/SD	
I have been exercising less than I normally do.	3.65/2.60	4.31/2.85	4.96/2.60	4.52/2.97	.40**
My diet has been healthier than usual.	5.30/1.94	4.15/2.09	5.13/1.98	4.64/2.16	.39**
My RM and I have had more conflict than normal.	2.30/1.40	3.38/2.52	2.65/1.87	3.52/2.33	.50**
My RM and I have faced a major financial decision.	4.26/2.49	3.12/2.60	4.87/2.63	4.72/3.09	.28
My diet has been less healthy than it usually is.	3.22/1.54	4.27/2.43	3.74/2.14	3.92/1.82	.23
My RM and I have spent more time together than usual.	4.96/1/94	4.27/2.18	5.09/1.90	5.00/2.14	.23
My RM and I have been kissing more than we normally do.	6.30/1.66	3.58/1.84	6.30/1.55	4.80/1.61	.50**
I have exercised more often than usual.	5.22/2.19	3.31/2.06	4.74/2.30	4.20/2.55	.25
My RM and I have had difficulty communicating with each other.	2.52/1.41	3.58/2.50	2.39/1.47	3.68/2.39	.54**
My health has been better than normal.	4.89/1.69	4.73/1.71	5.22/2.15	4.40/2.12	.19
My RM and I have expressed our love for each other verbally more often than normal.	5.74/1.86	4.08/1.38	5.48/2.04	5.16/1.89	.18
My RM and I have fought more than we typically do.	2.39/1.41	3.31/2.36	2.48/1.41	3.44/2.20	.34*
I haven't been as healthy as I usually am.	3.26/1.60	3.65/2.43	3.87/2.16	4.20/2.63	.06

Note. Participants were instructed to “think back over the last 2 weeks” and to indicate their level of agreement with each statement. RM = romantic partner (this was spelled out in the measure but is abbreviated here.) Scores ranged from 1 (“strongly disagree”) to 7 (“strongly agree”). T₁-T₂ correlations are averaged across conditions. Significance tests for correlation coefficients are two-tailed.
*p < .05. **p < .01.

affection would also produce increased verbal affection were assuaged by a nonsignificant group difference on the item, "My romantic partner and I have expressed our love for each other verbally more often than normal."

The experimental and control groups differed in their average scores to four other items measured during the manipulation checks, according to two-tailed tests. One related to exercise ("I have exercised more often than usual"), wherein the experimental group reported greater agreement than did the control group, $t(48) = 2.13$, $p = .038$, $d = .61$. They also differed on all three items related to relational conflict. For the item, "My romantic partner and I have had more conflict than we typically do," the control group exceeded the experimental group, $t(48) = -2.08$, $p = .043$, $d = .60$. Likewise, for the item, "My romantic partner and I have had difficulty communicating with each other," the control group exceeded the experimental group, $t(48) = -2.31$, $p = .025$, $d = .67$. Finally, for the item, "My romantic partner and I have fought more than we typically do," the control group exceeded the experimental group, $t(48) = -2.12$, $p = .040$, $d = .61$. Since all 3 conflict items showed a significant group difference, we aggregated the scores ($\alpha = .91$) to create an index of conflict change, and we used this index, along with the item indicating change in exercise (described above), as potential covariates.

Descriptive Analyses

T_1 values for all outcome variables (total cholesterol, relationship satisfaction, depression, and stress) were assessed in sex-by-experimental condition ANOVAs to establish T_1 equivalency of the experimental conditions. The ANOVAs revealed no main effects of experimental condition and no sex-by-condition interaction effects for any of the outcomes (all p 's $> .05$), indicating equivalency between the experimental and control conditions. Means and standard deviations for all outcomes, separated by time and condition, appear in Table 2. There were no significant sex differences in any of these variables (all p 's $> .05$).

Table 2 Means and Standard Deviations for Biochemical and Self-Report Outcomes

Variable	Condition	T_1 M	T_1 SD	T_2 M	T_2 SD
Total cholesterol	Experimental	182.56	24.95	176.80	24.46
	Control	181.54	26.31	180.69	27.49
Relationship satisfaction	Experimental	5.57	1.16	6.18	0.70
	Control	6.21	0.78	5.99	0.97
Depression	Experimental	2.92	1.36	2.81	0.99
	Control	2.30	0.88	2.36	0.84
Stress	Experimental	3.57	1.00	2.87	0.81
	Control	3.10	1.04	3.15	0.96

Note. Total cholesterol was measured in mg/dL. All self-report outcomes were measured on 7-point scales wherein higher scores correspond to greater values.

Hypotheses

Analyses and control variables

The hypotheses predicted an increase over time in relationship satisfaction, and decreases over time in total cholesterol, depression, and stress, in the experimental condition that are not also observed in the control group. Before testing the hypotheses, we investigated a number of variables as potential covariates, each of which has been demonstrated to exert independent effects on blood lipids, relationship satisfaction, depression, and/or stress. These potential control variables included: 1) sex; 2) age; 3) ethnicity; 4) education level; 5) average weekly alcohol consumption; 6) average weekly caffeine consumption; 7) average number of times per week participant exercises for at least 30 consecutive minutes; 8) T₁ body mass index; 9) change in body mass index from T₁ to T₂; 10) whether or not participant smokes; 11) change in exercise habits, as measured in manipulation check; and 12) change in conflict behavior, as measured in manipulation check. All of these variables failed to exert significant influence on total cholesterol, relationship satisfaction, depression, and stress (all p 's > .05). Tests on the remaining outcome variables—since there were no significant sources of error variance to control—were conducted using ANCOVA with one-tailed pairwise mean comparisons by condition. Means and standard deviations for all outcomes, separated by time and condition, appear in Table 2.

Total cholesterol

We examined the effects of the kissing intervention on total cholesterol using ANCOVA with condition (experimental vs. control) as the fixed factor, T₁ cholesterol as the covariate, and T₂ cholesterol as the dependent measure. Consistent with the hypothesis, the ANCOVA produced a significant main effect for condition, $F(1, 48) = 4.13, p = .048$, partial $\eta^2 = .08$. As expected, the experimental condition experienced a significant decrease in total cholesterol, $t(24) = 3.34, p = .001, d = .64$. (Effect size d reported here and below represents d for repeated measures, not independent groups.) Total cholesterol scores in the control group did not differ significantly over time, $t(25) = -.09, p = .93$.

Relationship satisfaction

An ANCOVA with condition as the fixed factor, T₁ relationship satisfaction as the covariate, and T₂ relationship satisfaction as the dependent measure produced a significant main effect for condition, $F(1,31) = 5.53, p = .025$, partial $\eta^2 = .15$. As hypothesized, the experimental condition experienced a significant increase in relationship satisfaction, $t(15) = -3.28, p = .003, d = .80$.² Relationship satisfaction scores in the control group did not differ significantly over time, $t(18) = 1.18, p = .13$.

Depression

An ANCOVA with condition as the fixed factor, T₁ depression as the covariate, and T₂ depression as the dependent measure produced a nonsignificant main effect for

condition, $F(1,31) = 0.25$, $p = .62$. Contrary to the prediction, scores for depression did not differ significantly over time for either the experimental group, $t(15) = .63$, $p = .27$, or the control group, $t(18) = -.59$, $p = .28$.

Stress

An ANCOVA with condition as the fixed factor, T_1 stress as the covariate, and T_2 stress as the dependent measure produced a significant main effect for condition, $F(1,31) = 9.47$, $p = .004$, partial $\eta^2 = .23$. The experimental condition experienced a significant decrease in stress, $t(15) = 3.13$, $p = .004$, $d = .78$. Stress scores in the control group did not differ significantly over time, $t(18) = -.28$, $p = .39$.

Discussion

Theory and previous research suggest that affectionate behavior in personal relationships has stress-ameliorating physiological effects. On this basis, we hypothesized that increasing affectionate behavior would lead to improvements in physical and mental health outcomes known to be exacerbated by stress. The present experiment tested the efficacy of a romantic kissing intervention for improving total cholesterol, depression, perceived stress, and assessments of relationship satisfaction within cohabiting marriages and romantic relationships.

As predicted, increased kissing during the 6-week trial preceded statistically significant decreases in total cholesterol and perceived stress, and a statistically significant increase in relationship satisfaction, that were not also experienced by those in the control group. Importantly, these changes cannot be attributed to increased verbal affection and/or decreased conflict in the experimental group, two additional communicative changes that one might logically expect to accompany increased non-verbal affection. It appears, rather, that the parasympathetic effects of kissing in established, positive-affect relationships account for the observed improvements in physical, psychological, and relational well-being.

The reduction in total cholesterol is potentially beneficial given that elevated cholesterol is a primary risk factor for cardiovascular disease (Mader, 2005; Shier et al., 2004), which is currently the number one cause of mortality for women and men in the United States (NHLBI, 2008). Previous research by Floyd, Mikkelsen, Hesse, et al. (2007) demonstrated that an affectionate writing exercise was effective in reducing total cholesterol levels among healthy adults, and the present experiment replicates this outcome with a nonverbal affection intervention. Considered in concert, these findings support the contention of affection exchange theory that affectionate communication has stress-ameliorating physiological effects, one benefit of which is their ability to improve blood lipid levels.

The experimental condition experienced a significant decrease in perceived stress and a significant increase in relationship satisfaction not mirrored by the control group. These results support our theoretic speculation that, whereas low-stress, high-satisfaction relational environments may increase affectionate behavior among romantic partners, the obverse causal model is also operative, with increased

affectionate behavior leading to improvements in stress and satisfaction. The instruction to kiss more frequently has been used as a component of marital therapy (Brezsnyak & Whisman, 2004), and the present results provide experimental evidence that such a prescription can enhance relationship satisfaction. The predicted decrease in depression for the experimental group did not achieve significance, although the difference was in the hypothesized direction. Previous studies have identified a significant inverse correlation between affectionate behavior and depression (Floyd, 2002; Floyd et al., 2005); it may be, however, that depression exerts a stronger causal effect on affectionate behavior (if there is a causal connection at all) than affectionate behavior exerts on depression. It may also be the case that assessments of depression are more complex, and therefore subject to a wider range of potential influences, than are assessments of satisfaction or stress (which may approximate more general evaluative judgments). These possibilities await examination in future investigations.

Considered collectively, the present findings suggest that, within the context of established marital and cohabiting romantic relationships, kissing is a communicative behavior that effects improvements in some parameters of physical, mental, and relational well-being. Further, the observed improvements were independent of multiple potential sources of variance relevant for these outcomes, including body mass index, exercise and dietary behavior, tobacco use, and caffeine and alcohol consumption. Along with recent studies by Floyd, Hesse, et al. (2007), Floyd, Mikkelsen, Hesse, et al. (2007), and Floyd, Mikkelsen, Tafoya, et al. (2007), this study contributes to a growing understanding of how interpersonal communication patterns related to the expression of affection can improve not only self-reported psychological well-being but also objectively measured markers of physical health, such as blood lipids. To the extent that increased kissing improves lipid values, it may have utility as an ancillary nonpharmacological option for treating mild hypercholesterolemia, in concert with traditional interventions, although additional experimental work is warranted before such a course could be recommended.

Limitations and Extensions

Due to the prescreening process and the imposition of multiple inclusion and exclusion criteria, the current sample was probably healthier than a comparably sized sample drawn at random from the same population would be. This was indicated by average lipid values that, in both study conditions, were within the range of normal test values, according to American Heart Association (2007) guidelines. One consequence is that the lipid improvements observed in the experimental group may have marginal clinical significance for a nonclinical sample such as ours. The extent to which the observed lipid changes would replicate in a non-laboratory setting is unknown, but this would be a worthy topic for future field research, given the potential utility of this intervention as a complementary therapy.

The sample size was small relative to those typically seen in mainstream interpersonal communication research. It was, however, within the norm both for psychophysiological studies (e.g., Kurup & Kurup, 2003; Marazziti & Canale, 2004;

van Niekerk, Huppert, & Herbert, 2001), including those conducted within the field of interpersonal communication (e.g., Tardy, Thompson, & Allen, 1989). The controlled, longitudinal nature of the current trial, the relative inability of participants to introduce error variance (at least, in their hematological outcomes) via social desirability or memory biases, and the emergence of several significant effects all argue for the adequacy of the sample size.

The items used in the manipulation check measure allowed us to ascertain whether observed effects might have been attributable to changes in other behaviors besides kissing, including verbal affection, conflict, and changes in diet or exercise. We were able to rule out these alternative explanations, but one alternative left unscrutinized is that increased kissing led to an increase in sexual activity, which could have stress-alleviating effects on its own and therefore account (at least partially) for the observed effects. Changes in the frequency of sexual behavior should be ascertained in future experiments to rule out this alternative explanation.

Future research could extend the present findings in at least four profitable ways. One would be to test, in a controlled manner, the physiological mechanisms responsible for the observed lipid changes. As we noted in the literature review, the specific mechanisms via which stress elevates cholesterol are as yet unidentified, but glucocorticoid elevation is one suspect, given that it results directly from arousal of the hypothalamic-pituitary-adrenal axis, one of the body's primary physiological responses to stressors. Future studies should carefully examine this and other potential mediators of the stress-cholesterol association and as mechanisms through which reductions in stress can lead to improved lipid values.

Second, the benefits of kissing on physiological, mental, and relational well-being should be tested within a range of relationship types, including other romantic relationships (such as lesbian and gay relationships or noncohabiting dyads) and platonic relationships (such as familial dyads). It is possible that the health benefits of kissing are limited to romantic kissing, for instance, or that they manifest differently in romantic and platonic relationships. These and other possibilities await investigation.

Third, although lipids, depression, perceived stress, and relationship satisfaction are all theoretically influenced by the experience of stress, they are not the only health outcomes that are. To the extent that a stress-ameliorating intervention such as affectionate behavior can effect improvements in these outcomes, it may also produce clinically relevant improvements in other health parameters, such as T lymphocyte count, natural killer cell cytotoxicity, resting blood pressure, diurnal cortisol variation, happiness, optimism, and other markers of physical and psychological well-being. Due to the growing evidence that affectionate behavior has stress-mitigating effects, future research on these potential outcomes would be warranted.

Finally, given the current intervention's efficacy with a nonclinical sample, future research should test its effects in a sample with hypercholesterolemia. To the extent that it proves effective at improving lipid values for those with chronic high cholesterol, it may demonstrate clinical as well as statistical significance, further suggesting its potential utility as a complementary therapy.

Notes

- [1] Readers should note that the manipulation check items were scored along a scale of 1 (meaning “strongly disagree”) to 7 (meaning “strongly agree”), making 4 the theoretic point at which the participant neither agrees nor disagrees with the statement. Interpreted within this context, scores on the conflict items (which appear in Table 1) do not indicate increased conflict – but rather, decreased conflict – for both the experimental and control groups. Neither group scored even at the midpoint of the scale, on average (i.e., all means were below 4). Thus, it was not the case that people in the control group fought more often than usual – indeed, their scores indicate that they fought less often than usual – but simply that they did not decrease their conflict as much as the experimental group did.
- [2] Analyses involving the self-report measures of relationship satisfaction, depression, and stress have fewer degrees of freedom due to missing data at Time 2, when not all participants completed and returned the questionnaire. We had complete data for these variables at both time points from 16 experimental participants and 19 control participants, so analyses are based on these cases only.

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