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Psychological and psychophysiological differences between different sexual behaviors

Psychologické a fyziologické rozdíly u různých forem sexuálního chování

Komise pro obhajoby doktorských disertací v oboru: Psychologie

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I. Psychological measures

Satisfaction (3 papers)

A basic psychological question is whether there are differences, at a population level, in the satisfaction associated with engaging in various sexual behaviors. The most basic aspect is sexual satisfaction, but given an expectation that engaging in various sexual behaviors has more pervasive connections with one's existence and relationships, the differential associations of various sexual behaviors with satisfaction with intimate relationships, one's own mental health, and overall life also merited investigation. In my paper "*Satisfaction (sexual, life, relationship, and mental health) is associated directly with penile-vaginal intercourse but inversely with other sexual behavior frequencies*" (Brody & Costa, 2009), I made use of a large (N = 2810) dataset (collected for the "Sex in Sweden" study, and provided by the Swedish Public Health Institute) which was representative of the general population of Sweden. Because of the logical concern that, for example, an association between masturbation frequency and lesser satisfaction might be due to lack of a partner (rather than masturbation *per se* being the basis of the association with lesser satisfaction), a multivariate approach was used, in which each of the satisfaction measures (from the Life Satisfaction Questionnaire developed by Fugl-Meyer et al) was statistically predicted (for the sexes separately and combined) from the candidate predictors of frequencies (days in the past 30 days) of penile-vaginal intercourse (PVI), masturbation, oral sex, anal sex, and age. The results were that for both sexes, PVI frequency was positively associated with all measures of satisfaction (e.g., part correlation = 0.50 for sexual satisfaction). In contrast, masturbation frequency was independently negatively correlated with almost all measures of satisfaction. Noncoital partnered sexual behavior frequencies were independently negatively associated with some measures of satisfaction, and uncorrelated with the other measures. Age was not a statistical confounder in the analyses. Thus, when frequency of these major categories of sexual behaviors are considered concurrently, it is specifically PVI frequency – and not frequency of other sexual behaviors – that is favorably associated with satisfaction with one's sex life, intimate relationships, own mental health, and overall life. The negative association of masturbation with satisfaction is not due simply to lack of a partner, and having sexual activities with a partner than exclude PVI leads to less satisfaction than having PVI. An additional analysis indicated that having a rigid attitude toward variety in sexual activities was unrelated to satisfaction. The paper offers a discussion of the implications for sex research and for clinical practice.

One can engage in PVI without having an orgasm, or without having an orgasm triggered directly by PVI *per se*. For women, having an orgasm triggered directly by PVI without concurrent clitoral masturbation is a vaginal orgasm. An important question with major theoretical and clinical implications is whether vaginal orgasm is associated with greater satisfaction than orgasm elicited by means of direct clitoral stimulation. In my paper "*Vaginal orgasm is associated with better psychological function*" (Brody, 2007b), I made use of the same existing nationally representative dataset collected for the "Sex in Sweden" study (N = 1256 women providing complete data for this analysis), to examine whether women who

ever had a vaginal orgasm (a clear majority of the representative sample) had greater satisfaction than women who never had a vaginal orgasm, but had clitoral orgasm. The women who had vaginal orgasm reported greater satisfaction with their sexual life, their own mental health, their intimate relationships, and with their life overall, when compared to the women who had only clitoral orgasm. Of note, the vaginally orgasmic women also reported less masturbation in the past month, and reported experiencing more frequent sexual desire. The investigation also revealed that a history of orgasm from receiving oral sex or from partner masturbation was not associated with a history of vaginal orgasm.

To examine the cross-cultural consistency of the findings from the two studies noted above, I developed a research network in the People's Republic of China. In my paper "*Sexual behavior predictors of satisfaction in a Chinese sample*" (Tao & Brody, 2011), I examined the associations of two measures of sexual satisfaction (a single item measure from the Life Satisfaction Questionnaire used in the Swedish studies, as well as a sexual satisfaction scale from a lengthier validated questionnaire, the Multidimensional Sexuality Questionnaire) with frequencies of engaging in, as well as having an orgasm from, PVI, masturbation, and partnered sexual activity with a partner that excluded PVI the same day. To examine the possibility that responses might be influenced by a tendency toward responding in a socially desirable manner (thus risking biasing responses to sensitive questions), we first translated and validated a short form of the Marlowe-Crowne social desirability responding scale into Mandarin (Tao, Guoying, & Brody, 2009), and then included it in the measures administered in the satisfaction study. In the multivariate analysis of a data from a convenience sample of Chinese industrial workers, I found that for both men and women, the measures of sexual satisfaction (which produced similar results) were associated with frequency of PVI and frequency of the orgasm PVI produces (the latter for women only), but satisfaction was not associated with frequency of other sexual behaviors or their corresponding orgasms. Thus, the results in the Chinese sample were consistent with those obtained in the Swedish sample, indicating cross-cultural similarity of the sexual behaviors associated with sexual satisfaction. Of note, these Swedish and Chinese results were replicated and extended in a large (N = 1570) nationally representative sample of middle-aged (age 35-65 years) Czechs (Brody & Weiss, 2011). The Czech data revealed that sexual satisfaction, life satisfaction, own mental health satisfaction, and intimate relationship satisfaction (from the Life Satisfaction Questionnaire) were all associated with vaginal orgasm consistency. Of note, only 17% of the middle-aged Czech women had never had a vaginal orgasm. In addition, for both sexes, the satisfaction measures were associated with simultaneous PVI orgasm consistency (percentage of PVI occasions resulting in vaginal orgasm overlapping in time with the man's PVI orgasm) and with PVI frequency (except for women's overall life satisfaction). In multivariate analyses, PVI frequency and simultaneous orgasm consistency made independent contributions to the aspects of satisfaction for both sexes.

Intimate relationship quality

Related to the concept of intimate relationship satisfaction are the various specific components that contribute to overall intimate relationship quality. In my paper "*Women's relationship quality is associated with specifically penile-vaginal intercourse orgasm and*

frequency” (Costa & Brody, 2007), we examined in a convenience sample of Portuguese women the associations of frequencies of PVI, masturbation, and partnered sexual behaviors excluding PVI the same day (and the corresponding orgasm frequencies) with dimensions of the Perceived Relationship Quality Components (PRQC) Inventory. Consistent with the satisfaction studies, PVI frequency correlated directly with the dimensions of Satisfaction, Intimacy, Trust, Passion, Love (all $r \geq .40$) and with summary Global Relationship Quality ($r = .55$). The PRQC dimensions were uncorrelated with partnered sexual behaviors excluding PVI the same day. Of note, frequency of masturbation correlated inversely associated with the Love dimension ($r = -.38$). Frequency of PVI orgasm correlated directly with the dimensions of Satisfaction, Intimacy, Passion, Love (all $r \geq .44$) and with summary Global Relationship Quality ($r = .52$). Frequency of masturbation was also found to be inversely correlated with PVI orgasmic consistency. The analyses included a measure of social desirability responding, and the results indicated that the observed associations were not confounded by social desirability responding tendencies.

Sex education, attention to sensations, and male partner characteristics

Given the observed associations of greater satisfaction (sexual, own mental health, intimate relationship) and relationship quality with specifically PVI and the orgasm that it directly produces, an important question is what the correlates and antecedents of vaginal orgasm are. In my paper “*Vaginal orgasm is associated with vaginal (not clitoral) sex education, focusing mental attention on vaginal sensations, intercourse duration, and a preference for a longer penis*” (Brody & Weiss, 2010), we surveyed a nationally representative sample of Czech women ($N = 1000$; only 21.9% never had a vaginal orgasm), and found that vaginal orgasm consistency was associated with 1) having being educated in her youth that the vagina was a source of women’s orgasm, 2) greater mental focus on vaginal sensations during PVI, 3) greater duration of PVI, and 4) a preference for an above-average penis length. The findings suggest that educating women about their vagina (rather than only their clitoris) being a source of their orgasm increases their likelihood of having a vaginal orgasm. Similarly, actual mental attention to specifically vaginal sensations during PVI (as opposed to distraction and/or attention elsewhere) is an important part of being able to have vaginal orgasm. Penis length, and in many cases, PVI duration, are male partner characteristics, which are significant in addition to the woman’s own characteristics and experience. The PVI duration finding replicates an earlier finding of ours with a Czech sample (Weiss & Brody, 2009), which was that in multivariate analysis, foreplay duration was not a significant predictor of women’s partnered orgasm consistency, but PVI duration was. The penis length finding was subsequently replicated in my investigation in a primarily Scottish sample of women (Costa, Miller, & Brody, 2012).

Alexithymia

In addition to male partner characteristics, and whether the woman was educated in her youth that the vagina was a source of women’s orgasm, the woman’s emotional development, psychological and interpersonal function and processing of sensory input are of interest in research on PVI frequency and orgasm from PVI per se. As noted in the study above, not having adequate mental focus on vaginal sensations during PVI is associated with less

likelihood of vaginal orgasm. More subtle and detailed psychological processes might also undermine appreciation for PVI and readiness to experience the orgasm PVI directly produces. Alexithymia consists of impairments in the abilities to recognize, identify, and communicate specific emotions. Alexithymia is associated with increased risk of psychological, psychosomatic and interpersonal problems. In my paper "*Alexithymia is inversely associated with women's frequency of vaginal intercourse*" (Brody, 2003), I examined the relationship between alexithymia scores (Toronto Alexithymia Scale) and frequencies of PVI, masturbation, and partnered sexual activity which excludes PVI, in a sample of healthy young German adults. To reduce the risk of social desirability response bias distorting the results, participants with high social desirability responding scale scores were excluded. For women (but not men), alexithymia was inversely associated with both recall and diary measures of PVI frequency but not frequency of other sexual behaviors. Therefore, for normal young women (but not men), lower frequency of specifically PVI is associated with impairments in the abilities to recognize, identify, and communicate specific emotions. The paper discussed the related issue of emotional integration and its relation to PVI but not other sexual behaviors, and also speculated on a possible evolutionary basis for this being more of an issue for women than for men.

Attachment

One approach to understanding disturbances in intimate relationships is through the examination of attachment style. According to attachment theory, adequate interactions with the primary caregiver (usually mother) in early childhood lead to a secure attachment style, but disturbed interactions in early childhood can lead to an insecure attachment style in later adult relationships, involving anxious attachment (involving preoccupations with abandonment fears) and avoidant attachment (involving avoidance of emotional closeness in relationships). Both forms of insecure attachment have been found to be associated with intimate relationship difficulties (including nonspecific measures of sexual problems), as well as with other measures of poorer physical and mental health. In my paper "*Anxious and avoidant attachment, vibrator use, anal sex, and impaired vaginal orgasm*" (Costa & Brody, 2011), I report on the study of a sample consisting primarily of Scottish women. Upon multivariate analysis, anxious attachment (measured with the Revised Experiences in Close Relationships scale) was found to be associated with lesser past month vaginal orgasm consistency, but with higher frequency of vibrator and anal sex orgasms. In addition, avoidant attachment was found to be associated with higher past month frequency of vibrator orgasms. Lifetime number of PVI partners was uncorrelated with attachment scores. The paper considers various explanations for the findings, especially that insecure attachment might lead to women having difficulties in attaining vaginal orgasms and thus be more inclined to sexual activities that involve more emotional and physical detachment. In addition, there is the possibility that specifically vaginal orgasm might help to maintain more secure attachment.

Psychological defense mechanisms (3 papers)

Given the aforementioned cross-cultural empirical findings that lesser vaginal orgasm consistency (or never having had a vaginal orgasm) is associated with less satisfaction with one's own mental health (as well as less satisfaction with intimate relationships and with

sexual life), with multiple aspects of poorer relationship satisfaction, with poorer mental focus on vaginal sensations during PVI, and with more anxious attachment, an important question is whether poorer psychological functioning is characteristic of women who have lesser vaginal orgasm consistency, even if they have clitorally-induced orgasm. Such a finding would be probably the first empirical test of one aspect of the Freudian theory (Freud, 1953) that with maturity, females transfer importance and sensitivity from the clitoris to the vagina. One earlier Czechoslovak study found that women diagnosed with neurotic disorders were less likely to have orgasms produced by PVI (compared to women without neurotic disorders), but they did not differ in their ability to have orgasms from direct clitoral stimulation (Kratochvil, 1993). However, a general population study linking measures of psychological maturity to ability to have vaginal orgasm (as opposed to only clitoral orgasm) had been lacking. In my paper "*Vaginal orgasm is associated with less use of immature psychological defense mechanisms*" (Brody & Costa, 2008), I report on the association between Portuguese women's past month frequency of different sexual behaviors and corresponding orgasm rates, and their scores on the Defense Style Questionnaire (DSQ-40), a validated measure of various immature, neurotic, and mature defense mechanisms. The immature defense mechanisms are termed such because they are both associated with various forms of psychopathology, as well as some of them being normal for some small children (Bond, 2004). My study found that vaginal orgasm was associated with less overall use of immature defense mechanisms, as well as with less use of the component immature defenses of somatization, dissociation, displacement, autistic fantasy, devaluation, and isolation of affect. Orgasm induced by direct clitoral stimulation (including clitoral masturbation during PVI) was not associated with less use of immature defenses, but was associated with more use of some immature defenses. In addition, multivariate analysis revealed that more frequent masturbation and less vaginal orgasm consistency made independent statistical contributions to the prediction of immature defenses scores. Women who had not had vaginal orgasm had immature defense mechanism scores comparable to those of women with diagnoses of depression, social anxiety disorder, panic disorder, and obsessive-compulsive disorder (reported in other studies). I also found that the observed associations were not confounded by either social desirability responding or self-reported relationship quality.

I conducted a replication (with data collected by other researchers working with me) and extension of the defenses study, entitled: "*Greater tactile sensitivity and less use of immature psychological defense mechanisms predict women's penile-vaginal intercourse orgasm*" (Brody, Houde, & Hess, 2010). In this study, French-Canadian women university students completed the Defense Style Questionnaire and a short form of the Marlowe-Crowne social desirability scale, and provided details of their past month (and ever) frequencies of engaging in, and having an orgasm from, PVI, masturbation, and specific noncoital partnered sexual behaviors. They also had their finger sensitivity (a noninvasive proxy for general tactile sensitivity) measured with von Frey type microfilaments. In multivariate analyses, PVI orgasm in the past month was associated with greater tactile sensitivity (odds ratio = 4.0 for each filament point) as well as lower immature defense mechanisms scores (odds ratio = 5.1 for each scale point). Ever having a PVI orgasm was associated only with lower immature defense mechanisms scores and lower social desirability responding score. Clitorally induced

orgasm was not associated with either tactile sensitivity or immature defense mechanisms. Greater tactile sensitivity was also associated with greater past month PVI frequency (inclusion of PVI frequency in a logistic regression model displaced tactile sensitivity from the significant predictors). Lower immature defense mechanisms scores were associated with greater past month PVI and PVI orgasm frequencies. Thus, both lesser physical sensitivity (and the various factors that can determine poorer sensitivity) and the use of immature psychological defense mechanisms might decrease the likelihood of women's orgasm from specifically PVI, but not from other sexual activities. These results largely replicate and extend the previous findings, in a sample from another culture.

In a second replication and extension of the defenses findings, entitled “*Immature psychological defense mechanisms are associated with lesser vaginal orgasm consistency and greater alcohol consumption before sex*” (Costa & Brody, 2010), I reported on the associations (in a predominantly Scottish sample) between frequency of various sexual activities (and corresponding orgasms), Defense Style Questionnaire scores, and degree of alcohol consumption before sex (ACBS). Both higher levels of ACBS and higher immature defenses scores were associated with lesser vaginal orgasm consistency, but they were uncorrelated or directly correlated with frequency of other sexual behaviors (including clitoral masturbation during PVI). Immature defenses scores were also associated with more ACBS, and a further analysis revealed that immature defenses scores explained the associations between ACBS and both lack of vaginal orgasm and greater frequency of other sexual behaviors. Thus, in addition to yet another general replication of the association between lack of vaginal orgasm and more use of immature defenses (in yet another country), it was found that ACBS might impair vaginal orgasm or increase the likelihood of choosing other sexual activities, but this effect might be largely contingent on immature defenses (rather than on alcohol *per se*).

II. Psychophysiological measures

Concordance of genital and subjective sexual arousal

Several psychophysiological studies have reported poor concordance between women's genital (vaginal pulse amplitude) and subjective sexual arousal responses to erotica. This contrasts with the generally good concordance observed between genital and subjective arousal in men (men have the additional visual cue of erection, in addition to the other more subtle processes underlying genital-subjective concordance in both sexes). However, the studies of women had not examined key specific aspects of the research participants' real-life sexual responses. Given the aforementioned psychological findings, I hypothesized that the concordance between women's genital and subjective arousal would be very good for women with greater orgasmic consistency from PVI, but not for women with poor PVI orgasmic consistency, regardless of their orgasmic consistency from masturbation or noncoital partnered sexual activities. In my paper “*Intercourse orgasm consistency, concordance of women's genital and subjective sexual arousal, and erotic stimulus presentation sequence*”

(Brody, 2007a), I replicated my findings obtained with a sample of post-menopausal Dutch women (Brody, Laan, & van Lunsen, 2003), as I confirmed my specific hypotheses in a sample of young Dutch women. The present study also replicated the previous study's finding that PVI orgasmic consistency was uncorrelated with masturbation orgasmic consistency. My psychophysiological genital-subjective arousal concordance studies indicate that women with good PVI orgasmic consistency (but not women with only good orgasmic consistency from other sources) have a better integration of vaginal and subjective sexual arousal. These psychophysiological results can be seen as consistent with the aforementioned findings that women who are more vaginally orgasmic have better mental focus on vaginal sensations during PVI, and also make less use of immature defenses (including maladaptive processes that decrease awareness of sensation and emotion).

Heart rate variability (2 papers)

In my paper "*Vaginal intercourse frequency and heart rate variability*" (Brody & Preut, 2003), I examined the relationship between frequency of PVI (both recalled and diary recorded measures) and both resting heart rate variability (HRV; an index of cardiac autonomic control and parasympathetic tone associated with better cardiovascular health outcomes and with emotion regulation) and resting diastolic blood pressure in 120 healthy German adults. Participants with high social desirability responding scores were excluded from analyses. Replicating my findings in a previous smaller study of German adults (Brody, Veit, & Rau, 2000), greater HRV was found to be associated with greater frequency of PVI (but not of masturbation or noncoital partnered sexual activity) and with greater rated importance of PVI. There were no sex differences in the HRV-PVI frequency relationship, and the relationship was not explained by examining measures of Extraversion, Neuroticism, Depression, Trait Anxiety, or partnership satisfaction in analyses. However, the previously obtained inverse association of PVI frequency with DBP was not replicated.

In my more recent study "*Greater resting heart rate variability is associated with orgasms through penile-vaginal intercourse, but not with orgasms from other sources*" (Costa & Brody, 2012), I examined the hypotheses that greater frequency of orgasms from PVI (for women, without additional simultaneous clitoral stimulation; thus, vaginal orgasm) are associated with greater resting HRV. A differential hypothesis was that HRV measures would be unrelated to orgasmic frequency from noncoital sexual activities. Men and women (N = 143) had their heart rate measured for 5 minutes at rest, and reported their frequencies of specific sexual behaviors and corresponding orgasms in a recent representative month. Controlling for social desirability responding scores, I found that for men, greater resting HRV was associated with greater PVI orgasm frequency. Similarly, for women, greater resting HRV was associated with any vaginal orgasm in the month. These findings persisted after further statistical control for cohabitation with a sexual partner. Another finding was that lifetime number of PVI partners was unrelated to resting HRV. The findings were discussed in the contexts of both 1) orgasms through specifically PVI enhancing HRV (and perhaps its many favorable health correlates), 2) greater parasympathetic tone favoring the capacity to engage in specifically PVI, and in the case of women, to reach vaginal orgasm, and 3) the possibility of healthier people having greater resting HRV and also more frequent orgasms

through specifically PVI. As noted, resting HRV is also an index of emotion regulation (Appelhans & Luecken, 2006; Thayer & Lane, 2007), and thus the HRV results are consistent with the aforementioned psychological findings of greater PVI frequency and greater vaginal orgasm consistency being associated with better psychological functioning.

Blood pressure reactivity to stress

Consistent with the hypothesis that specifically greater PVI frequency is associated with indices of better health, I examined the association between healthy young German adults' diary recorded past two-week sexual behavior frequencies and the magnitude of their blood pressure increases (reactivity) and subsequent recovery following a validated laboratory stressor (Trier Social Stress Test) in my paper "*Blood pressure reactivity to stress is better for people who recently had penile-vaginal intercourse than for people who had other or no sexual activity*" (Brody, 2006). Participants who reported any PVI (but no other sexual activities) in the two-week period before the stressor had better stress response (less reactivity, and in some analyses faster recovery) than persons reporting other or no sexual behaviors. Persons who only masturbated or only had partnered sex without PVI had 14 mmHg more systolic BP reactivity than those who had PVI but not the other behaviors, which was an effect of great magnitude compared to other correlates obtained in healthy samples (in the sizable blood pressure reactivity literature at the time). Many nonsexual candidate variables were examined but failed to confound the observed relationships. These findings are not only consistent with the pattern of specifically PVI being associated with indices of better health (and perhaps some other sexual behaviors being associated with indices of poorer health), but they are also consistent with a role of the Vagus nerve (the major determinant of HRV, a variable in the studies noted above) in both limiting cardiovascular stress responses and being related to aspects of sexual function, emotion regulation, and relatedness.

Brain imaging (fMRI) of clitoris, vagina and cervix

A common assertion in sexology has been that if vaginal eroticism (including vaginal orgasm) exists, then it must be attributable to indirect stimulation of the clitoris. In addition to the different psychological and psychophysiological correlates of PVI (and vaginal orgasm) when compared to clitorally-based activities already noted, there is the ultimate issue of whether stimulation of different genital regions activates different parts of a woman's brain. In our paper "*Women's clitoris, vagina and cervix mapped on the sensory cortex: fMRI evidence*" (Komisaruk et al., 2011), my colleagues and I used functional magnetic resonance imaging (fMRI) to determine the brain's somatosensory cortex projections of clitoris, vagina, uterine cervix, and nipple self-stimulation. Consistent with my previous differential psychological and psychophysiological findings, stimulation of the clitoris, lower vagina, and cervix activated differentiable sensory cortical regions, all clustered in the medial cortex (medial paracentral lobule), in addition to a region activated by all genital regions. An additional finding was that nipple stimulation activated both a thoracic region and part of the genital sensory cortex, consistent with erotic aspects of nipple stimulation. In developing the classic somatosensory homunculus, Penfield examined men only, so our brain mapping added several important points. The differentiable vaginal, clitoral, and cervical regions of activation

are consistent with innervation by different afferent nerves, and with different behavioral correlates noted above.

Anatomical indicator of prenatal influence

In addition to the likely experiential influences on experiencing vaginal orgasm implied by the historical educational and current emotional functioning findings noted above, there might be prenatal factors as well. Although two twin studies reported significant heritabilities of women's coital orgasm consistency, they did not provide any manifest markers (Dawood, Kirk, Bailey, Andrews, & Martin, 2005; Dunn, Cherkas, & Spector, 2005). A clinical observation of mine inspired my empirical study of the association between a more prominent tubercle of the upper lip (determined primarily by prenatal factors, and likely related to more complete prenatal development of the forebrain) and greater likelihood of experiencing vaginal orgasm. In my paper "*Vaginal orgasm is more prevalent among women with a prominent tubercle of the upper lip*" (Brody & Costa, 2011), I report on findings from a predominantly Scottish sample of 258 women. Online, they reported their frequencies of various sexual activities and corresponding orgasms, age, and the prominence of the tubercle of their upper lip. Social desirability response bias was also assessed. In multivariate analysis, it was revealed that a prominent and sharply raised lip tubercle was associated with a much greater odds ratio of ever having a vaginal orgasm, compared to women with less prominent, flat, or concave lip tubercle area categories. Lip tubercle was not associated with social desirability scores, or with orgasms triggered by clitoral masturbation during PVI, solitary or partner clitoral or vaginal masturbation, vibrator use, or cunnilingus.

Nutritional and metabolic aspects (2 papers)

In my paper "*Slimness is associated with greater intercourse and lesser masturbation frequency*" (Brody, 2004), I report on the relationship between frequencies (recalled and diary recorded) of PVI, noncoital partnered sexual activities, and masturbation to measured waist and hip circumference in 120 healthy German adults aged 19-38 years. I found that slimmer waist (in men and in the sexes combined) and slimmer hips (in men and women) were both associated with greater PVI frequency. Slimmer waist and hips were also associated with greater rated importance of intercourse for men. Noncoital partnered sexual activity frequency had a less consistent association with slimness. Slimmer waist and hips were also found to be associated with lesser frequency of masturbation (in men and in the sexes combined). The associations were independent of the effects of cohabitation with a partner (so the effects are not simply due to slimmer people having potentially greater access to a partner). The results are discussed in the contexts of differences between different sexual behaviors with regard to attractiveness, emotional relatedness, sexual dysfunction, sociobiology, and psychopharmacological aspects of excess fat and carbohydrate consumption.

Other than the brain imaging study, the studies which I have discussed so far have been correlational (risk-factor epidemiologic). This is generally the case for human sexuality studies. However, I also conducted some experimental studies. Given the association between various indices of health and specifically PVI (and orgasmic response to PVI), one question is whether improving health status (in a nominally healthy young population) might improve

specifically PVI frequency. In my paper *“High-dose ascorbic acid increases intercourse frequency and improves mood: A randomized controlled clinical trial”* (Brody, 2002), I report on a double-blind placebo-controlled randomized clinical trial of 14 days of 3000 mg/day sustained-release ascorbic acid (AA; vitamin C) compared to placebo in healthy young adults. In addition to this essential nutrient likely being consumed in suboptimal doses by the general population, supplemental AA has been shown in animal studies to have a role in modulating central catecholaminergic activity and to decrease approach anxiety and to increase oxytocin release. These processes are relevant to sexual behavior and mood. In addition, I previously demonstrated that the AA dose used in this trial improves human responses to stress (Brody, Preut, Schommer, & Schurmeyer, 2002). In the present study, participants with partners recorded frequencies of PVI, noncoital partnered sexual activities, and masturbation in daily diaries, and also completed the Beck Depression Inventory before and after the trial. The results indicated that relative to the placebo group, at the end of the trial the AA group reported greater frequency of PVI (but, as hypothesized, not of the other sexual behaviors). Exploratory subgroup analyses revealed that the effect was most prominent in subjects not cohabiting with their sexual partner, and in women. The AA but not placebo group also experienced a decrease in Beck Depression Inventory scores (which were already in the normal range at baseline). The differential benefit to noncohabitants suggests that there might be an analogy to the increased approach behavior noted in animal studies. Thus, improved nutritional status (and perhaps improved approach behavior, less stress, and greater oxytocin levels) led to an increase in specifically PVI (but not other sexual activities), the one sexual behavior consistently associated with better psychological and physical health.

Neurohormonal response

In my paper *“The post-orgasmic prolactin increase following intercourse is greater than following masturbation and suggests greater satiety”* (Brody & Kruger, 2006), I report on further experimental research, this time involving examining the neurohormonal response of participants engaging in, and having an orgasm from PVI or masturbation in the laboratory (as compared to a control condition on another day). Previous research indicated that the neurohormone prolactin increases sharply following orgasm, and that this prolactin increase is involved in a feedback loop which decreases arousal by inhibitory central dopaminergic and perhaps peripheral processes. Thus, the magnitude of the post-orgasmic prolactin surge is a neurohormonal index of sexual satiety. The results of the current study indicate that for both sexes (adjusted for prolactin changes in the non-sexual control condition), the magnitude of prolactin increase following PVI is 400% greater than that following masturbation. The results are discussed as being an objective physiological indicator of PVI being more physiologically satisfying than masturbation. Given that prolactin has a key role in modulating central dopamine activity, the differential prolactin responses to PVI and to masturbation might account for some of the many psychological and psychophysiological differential correlates of PVI as compared to other sexual activities.

A review of differential health aspects

In my paper *“The relative health benefits of different sexual activities”* (Brody, 2010), I present a review of the associations of favorable physical and psychological health benefits

associated with specific sexual activities. The topics include life expectancy (experimental studies in animals and correlational studies in humans), cardiovascular disease and function, cancers, semen biochemistry, muscle function, pre-eclampsia, immune function, and a range of psychological variables including satisfaction, relationship quality, depression and other psychiatric disorders. The results indicate that a broad range of better psychological and physiological health indices are associated specifically with PVI. In contrast, other sexual activities have weaker, no, or (in the cases of masturbation and anal intercourse) inverse associations with indices of psychological and physical health. Implications of the findings for evidence-based sex education and therapy are discussed, as are the consistency of the findings with evolutionary explanations that would favor the one potentially reproductive sexual behavior.

III. Summary

The twenty papers of the thesis use a variety of methods to examine the issue of psychological and psychophysiological (including psychopharmacological and behavioral neurophysiological) differences between different sexual behaviors in humans. Given the subject, it is not surprising that most of the studies are correlational in nature. However, there are also a few experimental studies of mine that are included. Some of the studies involve a small or medium sized convenience sample, but a few of the survey studies make use of the “gold standard” of large nationally (Czech Republic and Sweden) representative samples. One of the papers is my review of the related issue of health differences between different sexual behaviors.

The main variables examined in the twenty papers under the heading of differences between sexual behaviors include: satisfaction (with one’s sexual life, intimate relationships, mental health, and life in general); dimensions of intimate relationship quality; alexithymia (impairments in the abilities to recognize, identify, and communicate specific emotions); attachment styles; history of sex education received; mental attention to vaginal sensations; types of psychological defense mechanisms that are used; male partner characteristics (with regard to women’s orgasmic response); alcohol use before sex; tactile sensitivity; psychophysiological concordance of genital and subjective sexual arousal; heart rate variability; blood pressure reactivity to stress; brain imaging (fMRI) of various female genital sites; an anatomical indicator of likely prenatal influences; nutritional and metabolic aspects; and neurohormonal responses.

Given the benefits of examining cross-cultural similarity of associations of specific sexual behaviors and responses, I have published studies based on participants from the Czech Republic, Sweden, United Kingdom, People’s Republic of China, Netherlands, Germany, Switzerland, Canada, Portugal, and United States of America.

The results of these multi-method, multi-national, multi-level studies are quite consistent in demonstrating that one specific sexual behavior (and orgasmic response to that one specific sexual behavior) -- but not other sexual behaviors (nor their corresponding orgasmic responses) – is associated with better psychological and psychophysiological function for both sexes. That one sexual behavior is penile-vaginal intercourse (PVI), the one sexual

behavior directly related to gene transmission. The results are consistent with, and help to expand, aspects of both evolutionary psychological and psychoanalytic theories. However, the results also stand on their own, at behavioral and psychophysiological levels.

Previous research on sexual psychology has more often than not failed to make adequate distinctions between specific sexual behaviors and orgasm triggers. My research has been original in making this crucial distinction, and in using a broad range of measures and research techniques. The findings provide a new evidence base that contradicts the assertions (e.g., by Kinsey and his followers, that all sexual outlets are roughly equivalent) that have guided many aspects of sexual psychology. The new evidence can inform not only sexology, clinical sex therapy and sex education, but also aspects of clinical and personality psychology, biological (including evolutionary) psychology, and a broader understanding of the different aspects of specific sexual behaviors and orgasmic responses to those specific sexual behaviors.

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- Costa, R. M., & Brody, S. (2011). Anxious and avoidant attachment, vibrator use, anal sex, and impaired vaginal orgasm. *Journal of Sexual Medicine*, 8(9), 2493-2500. doi: 10.1111/j.1743-6109.2011.02332.x
- Costa, R. M., & Brody, S. (2012). Greater resting heart rate variability is associated with orgasms through penile-vaginal intercourse, but not with orgasms from other sources. *Journal of Sexual Medicine*, 9(1), 188-197. doi: 10.1111/j.1743-6109.2011.02541.x

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Appendix 1: The 20 publications (with citation details and specification of the candidate's own scientific contribution and share if scientific results mentioned in the submitted thesis were obtained with co-authors), in reverse chronological sequence

Costa, R.M., & Brody, S. (2012). Greater resting heart rate variability is associated with orgasms through penile-vaginal intercourse, but not with orgasms from other sources. *Journal of Sexual Medicine*, 9, 188-197.

2011 ISI JOURNAL IMPACT FACTOR: 3.55

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 0

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 0

Candidate's own scientific contribution and share: I generated the hypotheses and designed the study. I supervised the co-author's (my then PhD student) data collection, and we jointly analyzed the data. I wrote the draft, and we co-authored the final version. Estimate of my share of scientific work: 65%

Brody, S., & Costa, R.M. (2011). Vaginal orgasm is more prevalent among women with a prominent tubercle of the upper lip. *Journal of Sexual Medicine*, 8, 2793-2799.

2011 ISI JOURNAL IMPACT FACTOR: 3.55

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 0

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 0

Candidate's own scientific contribution and share: I generated the hypotheses and designed the study. My co-author (my then PhD student) assisted in data collection, and we jointly analyzed the data. I wrote the draft, and we co-authored the final version. Estimate of my share of scientific work: 85%

Costa, R.M., & Brody, S. (2011). Anxious and avoidant attachment, vibrator use, anal sex, and impaired vaginal orgasm. *Journal of Sexual Medicine*, 8, 2493-2500.

2011 ISI JOURNAL IMPACT FACTOR: 3.55

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 0

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 1

Candidate's own scientific contribution and share: I generated the hypotheses and designed the study. I supervised the co-author's (my then PhD student) data collection, and we jointly analyzed the data. I wrote the draft, and we co-authored the final version. Estimate of my share of scientific work: 65%

Komisaruk, B.R., Wise, N., Frangos, E., Liu, W-C., Allen, K., & Brody, S. (2011). Women's clitoris, vagina and cervix mapped on the sensory cortex: fMRI evidence. *Journal of Sexual Medicine*, 8, 2822-2830.

2011 ISI JOURNAL IMPACT FACTOR: 3.55

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 6

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 6

Candidate's own scientific contribution and share: I generated the primary hypothesis and contributed to the design of the study. I participated in data collection. I co-authored the final version. Estimate of my share of scientific work: 30%

Tao, P., & Brody, S. (2011). Sexual behavior predictors of satisfaction in a Chinese sample. *Journal of Sexual Medicine*, 8, 455-460.

2011 ISI JOURNAL IMPACT FACTOR: 3.55

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 2

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 2

Candidate's own scientific contribution and share: I generated the hypotheses and designed the study. We jointly analyzed the data. I wrote the draft, and we co-authored the final version. Estimate of my share of scientific work: 60%

Brody, S. (2010). The relative health benefits of different sexual activities. *Journal of Sexual Medicine*, 7, 1336-1361.

2011 ISI JOURNAL IMPACT FACTOR: 3.55

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 15

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 17

Candidate's own scientific contribution and share: Entirely my work.

Brody, S., Houde, S., & Hess, U. (2010). Greater tactile sensitivity and less use of immature psychological defense mechanisms predict women's penile-vaginal intercourse orgasm. *Journal of Sexual Medicine*, 7, 3057-3065.

2011 ISI JOURNAL IMPACT FACTOR: 3.55

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 0

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 0

Candidate's own scientific contribution and share: I generated the hypotheses and designed the study. We jointly analyzed the data. I wrote the draft, and we co-authored the final version. Estimate of my share of scientific work: 60%

Brody, S., & Weiss, P. (2010). Vaginal orgasm is associated with vaginal (not clitoral) sex education, focusing mental attention on vaginal sensations, intercourse duration, and a preference for a longer penis. *Journal of Sexual Medicine*, 7, 2774-2781.

2011 ISI JOURNAL IMPACT FACTOR: 3.55

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 3

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 4

Candidate's own scientific contribution and share: I generated the hypotheses and jointly designed the study. I analyzed the data. I wrote the draft, and we co-authored the final version. Estimate of my share of scientific work: 70%

Costa, R. M., & Brody, S. (2010). Immature psychological defense mechanisms are associated with lesser vaginal orgasm consistency and greater alcohol consumption before sex. *Journal of Sexual Medicine*, 7, 775-786.

2011 ISI JOURNAL IMPACT FACTOR: 3.55

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 2

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 2

Candidate's own scientific contribution and share: I generated the hypotheses and designed the study. I supervised the co-author's (my then PhD student) data collection, and we jointly analyzed the data. I wrote the draft, and we co-authored the final version. Estimate of my share of scientific work: 65%

Brody, S., & Costa, R. M. (2009). Satisfaction (sexual, life, relationship, and mental health) is associated directly with penile-vaginal intercourse but inversely with other sexual behavior frequencies. *Journal of Sexual Medicine*, 6, 1947-1954.

2011 ISI JOURNAL IMPACT FACTOR: 3.55

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 10

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 13

Candidate's own scientific contribution and share: I generated the hypotheses and I analyzed the data in an existing database. I wrote the draft, and we co-authored the final version. Estimate of my share of scientific work: 75%

Brody, S., & Costa, R. M. (2008). Vaginal orgasm is associated with less use of immature psychological defense mechanisms. *Journal of Sexual Medicine*, 5, 1167-1176.

2011 ISI JOURNAL IMPACT FACTOR: 3.55

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 7

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 12

Candidate's own scientific contribution and share: I generated the hypotheses and designed the study. I supervised the co-author's (my then PhD student) data collection, and we jointly analyzed the data. I wrote the draft, and we co-authored the final version. Estimate of my share of scientific work: 75%

Brody, S. (2007). Vaginal orgasm is associated with better psychological function. *Sexual and Relationship Therapy*, 22, 173-191.

2011 ISI JOURNAL IMPACT FACTOR: 0.51

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): data not available; 27 with self-citations

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 3

Candidate's own scientific contribution and share: Entirely my work (but using an existing database).

Brody, S. (2007). Intercourse orgasm consistency, concordance of women's genital and subjective sexual arousal, and erotic stimulus presentation sequence. *Journal of Sex & Marital Therapy*, 33, 31-39.

2011 ISI JOURNAL IMPACT FACTOR: 1.27

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 9

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 10

Candidate's own scientific contribution and share: Entirely my work (but using data provided by a colleague).

Costa, R. M. & Brody, S. (2007). Women's relationship quality is associated with specifically penile-vaginal intercourse orgasm and frequency. *Journal of Sex & Marital Therapy*, 33, 319-327.

2011 ISI JOURNAL IMPACT FACTOR: 1.27

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 17

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 18

Candidate's own scientific contribution and share: I generated the hypotheses and co-designed the study. We jointly analyzed the data. I wrote the draft, and we co-authored the final version. Estimate of my share of scientific work: 60%

Brody, S. (2006). Blood pressure reactivity to stress is better for people who recently had penile-vaginal intercourse than for people who had other or no sexual activity. *Biological Psychology*, 71, 214-222.

2011 ISI JOURNAL IMPACT FACTOR: 3.22

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 12

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 16

Candidate's own scientific contribution and share: Entirely my work (but data collected by research assistants).

Brody, S., & Krüger, T.H.C. (2006). The post-orgasmic prolactin increase following intercourse is greater than following masturbation and suggests greater satiety. *Biological Psychology*, 71, 312-315.

2011 ISI JOURNAL IMPACT FACTOR: 3.22

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 14

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 18

Candidate's own scientific contribution and share: I generated the hypotheses and co-designed the study, which involved re-analysis of existing data. I analyzed the data. I wrote the draft, and we co-authored the final version. Estimate of my share of scientific work: 65%

Brody, S. (2004). Slimness is associated with greater intercourse and lesser masturbation frequency. *Journal of Sex & Marital Therapy*, 30, 251-261.

2011 ISI JOURNAL IMPACT FACTOR: 1.27

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 18

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 21

Candidate's own scientific contribution and share: Entirely my work (but data collected by research assistants).

Brody, S. (2003). Alexithymia is inversely associated with women's frequency of vaginal intercourse. *Archives of Sexual Behavior*, 32, 73-77.

2011 ISI JOURNAL IMPACT FACTOR: 3.52

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 15

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 23

Candidate's own scientific contribution and share: Entirely my work.

Brody, S., & Preut, R. (2003). Vaginal intercourse frequency and heart rate variability. *Journal of Sex & Marital Therapy*, 29, 371-380.

2011 ISI JOURNAL IMPACT FACTOR: 1.27

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 5

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 8

Candidate's own scientific contribution and share: I generated the hypotheses and designed the study. I supervised the co-author's (an abortive PhD student) data collection, and I analyzed the data. I wrote the draft, and we co-authored the final version. Estimate of my share of scientific work: 85%

Brody, S. (2002). High-dose ascorbic acid increases intercourse frequency and improves mood: A randomized controlled clinical trial. *Biological Psychiatry*, 52, 371-374.

2011 ISI JOURNAL IMPACT FACTOR: 8.28

WEB OF KNOWLEDGE (ISI) CITATIONS (EXCLUDING SELF-CITATIONS): 14

SCOPUS CITATIONS (EXCLUDING SELF-CITATIONS): 18

Candidate's own scientific contribution and share: Entirely my work (but data collected by research assistants).

**Total citations (excluding self-citations) to these 20 papers (as of 9 November 2012):
WEB OF KNOWLEDGE (ISI) 149, SCOPUS 186**

**Total citations (excluding self-citations) to all of my papers (as of 9 November 2012):
WEB OF KNOWLEDGE (ISI) 1261, SCOPUS 1268**