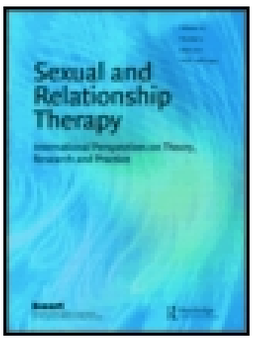

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Gender differences in response to infidelity types and rival attractiveness

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ABSTRACT

Some evolutionary psychologists hypothesize that women are more upset by their partners' emotional infidelity than men, and men are more upset by sexual infidelity than women. In addition, other evolutionary psychologists hypothesize that women are more distressed than men when their partners are unfaithful with a very attractive rival (lover). However, according to the imagination hypothesis, these sexual differences can be explained by gender differences in the "imagination of infidelity." Based on this context, we hypothesized that gender differences would not be observed when controlling for the effects of infidelity imagination. Participants consisted of 288 college students who were in serious committed relationships. Photographs of attractive and unattractive rival were presented, and participants rated how upset they would be by their partner's infidelity with the rival. A 2 (gender) $\times$ 2 (infidelity type) $\times$ 2 (rival attractiveness) factorial design was employed. Analysis of variance for the group who had lower levels of infidelity imagination revealed a significant interaction between gender and infidelity type. However, analyses of covariance with vividness of the partner's infidelity as a covariate revealed that there were no differences between the genders. Therefore, the imagination hypothesis was supported while the evolutionary explanation for gender differences was not.

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Infidelity; jealousy; evolutionary psychology; rival attractiveness; gender difference

Introduction

According to previous research by some evolutionary psychologists (Buss, 2018; Buss, Larsen, Westen, & Semmelroth, 1992; Daly, Wilson, & Weghorst, 1982; Symons, 1979), men are more upset over a mate's sexual infidelity than women, whereas women are more upset over a mate's emotional infidelity than men. In the ancestral history of humankinds, such gender differences have been ascribed to the need for reproductive fitness. As fertilization occurs internally in women, men can never be certain that the reputed offspring is their own. Thus, there is always the risk that a

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man might be cuckolded and would invest—in terms of providing care and resources—in another man's child. This would be very costly to his reproductive fitness, that is, the number of viable offspring he could potentially produce. As a result, men are predicted to be more vigilant and anxious about their female mate's sexual infidelity. Conversely, women are always certain of their genetic contribution to their offspring; therefore, a man's sexual infidelity may be less costly from a woman's perspective. Women invest heavily in reproduction, including nine months of gestation, the lactation period, and ongoing care for a highly dependent child. Based on this substantial parental investment, women tend to enhances their reproductive fitness by seeking and keeping long-term mate. Therefore, emotional infidelity—which may signal that a mate will either abandon the relationship or divert resources to a rival—will be more upsetting to a woman. Such an evolutionary view is referred to as the "jealousy as a specific innate module hypothesis" (JSIM; Harris, 2003a).

Buss et al. (1992) asked participants to imagine their partner's infidelity using brief scenarios and then identify the most distressing of two types of infidelity (a forced-choice paradigm). The results showed that men reported being more upset by sexual infidelity than women, whereas women reported being more upset by emotional infidelity than men. Such differences in infidelity responses have been found repeatedly in studies using a forced-choice paradigm (for reviews, see Easton, Schipper, & Shackelford, 2007; Edlund & Sagarin, 2017; Harris, 2003a). Emotional and sexual infidelity have been defined based on the guidelines used in Buss et al.'s (1992) study after numerous subsequent studies focused on the genuineness of its findings, that is, the formation of a deep emotional attachment to one person while enjoying passionate sexual relations with another.

Imagination hypothesis

Several researchers have questioned the validity of the JSIM due to contradictory findings (e.g. Carpenter, 2012; DeSteno, Bartlett, Braverman, & Salovey, 2002; Harris, 2003a, 2005; Kato, 2014a, 2014b) and alternative interpretations that can account for gender differences in infidelity responses (for review, see Edlund & Sagarin, 2017; Kato, 2017); for example, social cognitive theory (Harris, 2003a, 2003b) and the double-shot hypothesis (DeSteno & Salovey, 1996; Harris, 2003a). The imagination hypothesis on jealousy (Kato, 2014a, 2014b) proposes that gender differences in responses to infidelity are derived from the capacity for imagination which varies between genders, particularly men's explicit sexual imagery and women's explicit romantic imagery. According to the imagination hypothesis, men and women should not differ in response to a partner's sexual and emotional infidelity provided that men and women can imagine emotional and sexual infidelity vividly and realistically. Research on gender differences suggests that men are more likely than women to imagine explicit sexual details (Leitenberg & Henning, 1995; Rupp & Wallen, 2008), whereas women are more likely than men to imagine emotional/romantic storylines (Leitenberg & Henning, 1995). For example, men were faster and more accurate in recognition tasks involving erotic sentences than women (Geer & McGlone, 1990). Compared to men, Harris (2000) stated that women tended to include more

emotional details and had greater experience with romantic fantasy or daydreaming. For these reasons, gender differences in infidelity responses found by previous studies might be attributed to these hypothetical infidelity scenarios.

The imagination hypothesis on sexual infidelity has been supported by several studies (e.g. Harris, 2000; Kato, 2014a). For example, Kato (2014a) had participants imagine sexual infidelity in a laboratory setting using explicit infidelity scenarios and photographs to induce detailed sexual imagery of a partner infidelity. Women reported sexual infidelity as more upsetting when explicit infidelity scenarios were presented than when presented with fictitious infidelity scenarios wherein their partner's dalliance was with a famous Hollywood star. Interestingly, there were no gender differences in jealousy when presenting vivid infidelity scenarios. Another study (Harris, 2003b) showed that, for women, a greater number of committed sexual relationships were associated with higher levels of focus on the sexual aspects of their partner's infidelity but not the emotional aspects of infidelity. No studies have directly tested the imagination hypothesis with regard to emotional infidelity. However, the imagination hypothesis on emotional infidelity may also be valid for the reasons described above.

To test the imagination hypothesis, the current study focused on two factors that affect imagination for partner infidelity: relationship status and method to stimulate imagination.

Relationship status

In the present study, we tested the JSIM and imagination hypothesis using individuals who were or had been in a serious committed relationship because reports show they can imagine aspects of infidelity easier than individuals who have not been in a committed relationship (e.g. Becker, Sagarin, Guadagno, Millevoi, & Nicastle, 2004). Kato's (2014b) analysis using Becker et al.'s (2004) data showed that the difference in imagining partner infidelity between individuals who were or were not in a committed relationship had a large effect size (Cohen's $d = 1.14$). This relationship status was a predictor of gender differences in jealousy (e.g. Becker et al., 2004; Burchell & Ward, 2011; Guadagno & Sagarin, 2010; Kato, 2014a; Voracek, 2001). For example, in a study with a large sample of college students who were not in a committed relationship (Kato, 2014b), men reported to be more distressed by sexual infidelity than women, while women reported to be more distressed by emotional infidelity than men. Conversely, no significant interaction between gender and infidelity type was found in participants who were in serious committed relationships. For the latter sample, the Type II error probability of falsely accepting an incorrect null hypothesis was low ($1–\beta = .959$, effect size partial $\eta^2 = .005$). As the conclusions in the previous study suggested, the findings on relationship status indirectly supported the imagination hypothesis on infidelity responses because no significant gender differences in jealousy were found for a sample of individuals who were in committed relationships (e.g. Guadagno & Sagarin, 2010; Kato, 2014a, 2014b; Voracek, 2001). However, a few studies (e.g. Becker et al., 2004; Murphy, Vallacher, Shackelford, Bjorklund, & Yunger, 2006) with individuals in relationships support the JSIM on infidelity type.

A method to stimulate imagination

In existing methods for assessing gender disparities related to in jealousy (e.g. Buss et al., 1992), individuals imagine hypothetical infidelity scenarios and are asked to decide if sexual or emotional infidelity is more upsetting, and then they rate the degree of distress caused by the imagined infidelity (Kato, 2014a). In other words, when testing gender differences in jealousy, previous researchers had participants imagine their partner's infidelity using only hypothetical infidelity scenarios without proposing a specific rival (Kato, 2014a). Such methods lacked the realistic appraisal of possible incidents of infidelity (Harris, 2000; Kato, 2014a). Therefore, we provided participants with photographs of rivals (attractive and unattractive) in the current study to induce detailed imagery of a partner's infidelity.

This method of using a rival's facial photograph has been used to test gender differences in rival attractiveness by some previous studies (e.g. Buunk & Dijkstra, 2004; Dijkstra & Buunk, 1998). Some evolutionary psychologists (e.g. Buss, Shackelford, Choe, Buunk, & Dijkstra, 2000) suggest that women would be more distressed than men if their partners were unfaithful with a very attractive rival. Evidence for this hypothesis has been provided by several studies (e.g. Buss et al., 2000; Dijkstra & Buunk, 1998; for a review, see Buunk, Massar, & Dijkstra, 2007). Such gender difference was explicated by the following interpretation. In the ancestral history of humankinds, men value a potential mate's physical attractiveness more highly than women because physical attractiveness represents an important clue to a woman's fertility; therefore, rival attractiveness is more central to a mate's value for men than it is for women.

We used a facial photograph instead of a body photograph because the previous studies (e.g. Buunk & Dijkstra, 2004; Dijkstra & Buunk, 1998) also used facial photographs rather than body photographs to examine gender differences in the jealousy-evoking effects of rival attractiveness. Additionally, another previous study (Buss et al., 2000) showed gender differences in distress regarding the rival's facial as well as body attractiveness in an Asian culture (Korean sample) and Western cultures (Dutch and American samples).

Gender differences in jealousy in Japanese samples

Four studies have examined gender differences in jealously in a Japanese sample (i.e. Buss et al., 1999; Kato, 2014a, 2014b; Takahashi, Matsuura, Yahata, Koeda, Suhara, & Okubo, 2006). Two of them (Kato, 2014a, 2014b) supported the imagination hypothesis while the others did not test for it. Three studies (Kato, 2014a, 2014b, Takahashi et al., 2006) found no gender differences in jealousy among individuals who were in committed relationships; therefore, these findings were inconsistent with the JSIM. Another study (Buss et al., 1999), one that did not provide information regarding the relationship status of participants, supported the JSIM. Therefore, testing the JSIM among Japanese people is imperative because the JSIM has been tested primarily in Western cultures to date.

Only one study (Buss et al., 1999) that included a Japanese sample examined cross-cultural differences in responses to partner infidelity. The study showed that

men (76%) and women (32%) college students in the United States (and) chose sexual infidelity as more distressing in the first dilemma scenario utilized by Buss et al. (1992) compared to their counterparts in Japan (38% and 13%). These unmistakable cultural differences in attitudes toward extramarital sex also influenced responses in infidelity. Individuals who were more permissive of uncommitted sexual relations were less upset over sexual infidelity (IJzerman et al., 2014). There results tend to indicate, relatively speaking, that Japanese people may have more relaxed attitudes about extramarital sex. For example, 40–50% of the Japanese population unequivocally disapprove of extramarital sex, whereas that figure is as high as 70–80% in the United States population (Kato, 2009). Another cross-cultural study of responses to infidelity (Buunk, Angleitner, Oubaid, & Buss, 1996), one that did not include a Japanese sample, suggested that individuals in cultures that have more relaxed attitudes about extramarital sex might be less concerned over their partners' sexual infidelity, at least in men, compared to emotional infidelity.

Hypothesis in the present study

The present study tested the imagination hypothesis and the JSIM. If the imagination hypothesis was correct, no gender differences in jealousy would be found at least when controlling for the effects of infidelity imagination. Additionally, this phenomenon would be observed independent of rival attractiveness. On the other hand, if the JSIM was valid, gender differences in jealousy would be observed even among Japanese participants in a committed relationship because the differences would be derived from a specific innate module. Additionally, the differences would be observed even when controlling for the effects of infidelity imagination. Moreover, if the interpretations of some evolutionary psychologists (e.g. Buss et al., 2000; Dijkstra & Buunk, 1998) are valid, women would be more upset over their partner's infidelity when providing an attractive rival's photograph compared to an unattractive rival's photograph.

Methods

Participants

Potential participants aged 24 years or younger were recruited from several Japanese colleges to equalize the participants' age-group with the purported rivals' (lovers') ages (20 years) in the photographs used for this experiment. Of the 497 potential participants, 297 students reported that they had been in the past or were currently in a serious committed romantic relationship. For the present study, a committed relationship referred to a serious and potentially long-lasting romantic heterosexual relationship that was not confined to casual dating. The final sample for data analyses included 288 participants (109 men and 179 women; $M = 19.66$, SD $= 1.17$ year). Of these, 111 reported having a current committed relationship (current CR) while the remaining 177 participants had a serious committed relationship in the past (past CR). Nine participants were eliminated from the initial sample of 297 for reasons to be explained in the Results section under Manipulation Checks. The mean

relationship duration in the current CR group was 12.32 months (SD = 10.26) and 10.08 months (SD = 10.27) in the past CR group. A *t*-test revealed no significant difference in relationship duration between groups. None of the 288 participants were married.

Measures

All instructions, questions, and measures were provided in Japanese.

Response to infidelity

Infidelity responses (response score) were assessed using continuous measures instead of forced-choice questions for the following two reasons. First, previous studies by evolutionary psychologists employed these scales to demonstrate gender differences in jealousy (for reviews, Harris, 2005; Sagarin et al., 2012). Second, there are serious methodological issues with hypothetical forced-choice findings (Harris, 2005); for example, all previous attempts to show converging validity for the forced-choice measure have failed. Thus, participants rated how upset or distressed they would be by their partner's sexual or emotional infidelity on a scale ranging from 1 (*not at all upset or distressed*) to 6 (*extremely upset or distressed*) using the following infidelity scenarios adapted from Buss et al. (1992). The emotional infidelity scenario was to *imagine your partner forming a deep emotional attachment to that person.* The sexual infidelity scenario was to *imagine your partner enjoying passionate sexual intercourse with that other person.*

Imagination of infidelity

To assess vividness of partner infidelity (imagination score), participants rated the extent to which they could imagine their partner's infidelity with the potential rival depicted in a photograph from 1 (*not at all imaginable*) to 6 (*very vividly imaginable*). The validity for this single-item measure was established by Kato (2014a). Specifically, participants who were allowed to imagine an act of infidelity using real scenarios and screen images reported that they found it easier to imagine their partner's infidelity with images of people than with images invoking fictitious or unfathomable infidelity scenarios, in which the partner's dalliance was with a famous Hollywood star.

Stimuli

Four facial photographs were used for this experiment to represent attractive and unattractive men and women considered to be rivals to the participants. All were 20-year-old Japanese people who matched the participants' age group. Four college students familiar with the JSIM collected sixteen portraits taken with a digital camera, and then they selected the four most appropriate photographs based on their discussions. Specific rival photographs were used to allow participants to imagine their partner's infidelity.

In a preliminary unpublished experiment administered by the four students, they presented the following two questions regarding two same-gender photographs

matching the participants' gender to 128 participants (64 men and 64 women) who did not take part in the current experiment. First, the participants selected one photograph of the person who they perceived as more attractive out of the two same-gender photographs. Three participants chose an unattractive rival as an attractive rival, that is, they gave unexpected responses. Second, the participants rated each photograph as either more attractive or less attractive than average. One participant reported that the photograph depicting an attractive rival was less attractive than average, and three participants reported that the photograph of a face purportedly depicting an unattractive rival was more attractive than average. There were also categorized as unexpected responses.

Procedure

After providing informed consent, an assistant handed participants a set of questionnaires that assessed infidelity responses, infidelity imagination, and other questions. An experimenter instructed participants to look at a photograph of a rival displayed on a monitor. The participants were provided with two photographs of attractive and unattractive faces, and their responses and imagination regarding sexual and emotional infidelity for each were assessed. More specifically, the following procedure was conducted. A photograph of an attractive or unattractive individual, either of whom were the same gender as the participant, was presented for 120 seconds. The participants were asked to imagine a situation (sexual or emotional infidelity scenario) where their partner (current CR group) or ex-partner (past CR group) was unfaithful with the rival in the photograph, where after they would answer a question regarding their responses to their partner's infidelity. Sixty seconds after the photograph was presented, the participants were asked to imagine the other infidelity type and to answer a question on their infidelity responses. Thirty seconds after the photograph had disappeared, the other type of photograph was presented. The participants were again asked to imagine sexual or emotional infidelity, after which the same procedure was repeated. The two infidelity scenarios and the two types of photographs were presented in random order.

After the screen image had disappeared, the participants were instructed to complete additional questions regarding the vividness of each infidelity type and to select which rival they found more attractive. The experiment was administered in small groups to allow several assistants to monitor the participants to prevent conversations among them.

Experimental design and data analyses

The experimental design included a between-subjects variable (the participant's gender) and two within-subjects variables: infidelity type (sexual or emotional infidelity) and rival attractiveness (attractive or unattractive).

To test the JSIM, a $2 \times 2 \times 2$ analysis of variance (ANOVA) was conducted with infidelity response scores as the dependent variable. Moreover, to control for the influence of infidelity imagination, a 2 (gender) $\times$ 2 (infidelity type) $\times$ 2 (rival

attractiveness) analysis of covariance (ANCOVA) on the infidelity response scores was conducted with infidelity imagination scores as a covariate. Regarding the JSIM on infidelity type, Sagarin (2005) suggested that evidence of an interaction between gender and infidelity type, one that does not need to show a crossover pattern, would confirm the hypothesis when participants used continuous rating scales to estimate their distress over the two types of infidelity (see Harris, 2005). However, Harris (2005) stated that the slopes for men and women should be in opposite directions or show a crossover interaction to validate the JSIM. We tested the evolutionary explanation for gender differences using Sagarin's approach, because he is an advocate of the JSIM. Partial eta square (η^2) was estimated as the effect size of interactions. Cohen's *f*, that was estimated on the basis of partial η^2, was used because of unclear criteria for the interpretion of partial η^2. According to Cohen's (1988) benchmark for interpreting *f*, small, medium, and large were .10, .25, and .40, respectively.

In this design, infidelity type and rival attractiveness formed a within-subjects design because the differences within gender have been generally compared using a within-subjects design in previous research on gender differences in jealousy (see Harris, 2003a, 2005; Sagarin et al., 2012). This may be because Buss et al. (1992) is generally considered to be the seminal study in this area, and that used a similar within-subjects design for comparison.

Results

Manipulation checks and order effects

To assess the attractiveness of the faces in the four photographs, participants were asked to select the more attractive of the two same-gender rivals. Only nine participants chose the previously rated unattractive rival as more attractive, indicating that almost all participants perceived the attractive rival as more attractive than the unattractive rival. These nine participants were eliminated, resulting in a sample of 288 participants for data analyses.

The effects for the presentation order of rival photographs were tested. All interactions between the order of the photographs and other variables, including gender, infidelity type, and rival attractiveness on infidelity responses scores were not significant at $p < .05$.

Infidelity responses

The mean and standard deviations for infidelity responses and imagination scores are shown in Tables 1 and 2, respectively.

Past CR group

For the past CR group, a $2 \times 2 \times 2$ ANOVA revealed a significant interaction between gender and infidelity type ($F(1,109) = 3.94$, $p < .05$, partial $\eta^2 = .022$, $f = .15$) but no other significant interactions, including the interaction between attractiveness and gender ($F(1,109) = .87$, $p = .352$, partial $\eta^2 = .005$, $f = .07$) and the effect of attractiveness ($F(1,109) = .29$, $p = .591$, partial $\eta^2 = .002$, $f = .04$). The interaction

Table 1. Means and standard deviations (SD) for infidelity response scores.

	Men			Women		
Variable	*n*	Mean	SD	*n*	Mean	SD
Current CR group						
Sexual infidelity						
Attractive rival	30	4.37	1.45	81	4.37	1.30
Unattractive rival	30	4.40	1.13	81	4.60	1.23
Emotional infidelity						
Attractive rival	30	4.07	1.34	81	4.20	1.28
Unattractive rival	30	3.97	1.03	81	4.51	1.16
Past CR group						
Sexual infidelity						
Attractive rival	79	4.05	1.35	98	4.12	1.30
Unattractive rival	79	3.92	1.16	98	4.04	1.27
Emotional infidelity						
Attractive rival	79	3.76	1.28	98	3.90	1.25
Unattractive rival	79	3.62	1.15	98	4.05	1.28

Note: Possible range of infidelity response scores is 1 to 6. CR is a serious committed relationship.

Table 2. Means and standard deviations (SD) for infidelity imagination scores.

	Men			Women		
Variable	*n*	Mean	SD	*n*	Mean	SD
Current CR group						
Emotional infidelity	30	2.65	1.21	81	2.87	1.04
Sexual infidelity	30	3.77	1.09	81	3.94	1.09
Past CR group						
Emotional infidelity	79	2.67	1.32	98	2.17	1.18
Sexual infidelity	79	3.67	1.21	98	3.60	1.13

Note: Possible range of imagination scores is 1 to 6. CR is a serious committed relationship.

between gender and infidelity type indicated that women were more upset than men were over their partner's emotional infidelity. The effect of infidelity type showed that response scores of sexual infidelity were higher than those of emotional infidelity.

Further, the $2 \times 2 \times 2$ ANCOVA revealed that all interactions—including the interactions between gender and infidelity type ($F(1,173) = 3.32$, $p = .070$, partial $\eta^2 = .019$, $f = .14$) and between gender and attractiveness ($F(1,173) = 0.96$, $p = .328$, partial $\eta^2 = .006$, $f = .08$)—were not significant. A significant effect of infidelity type was found ($F(1,173) = 4.07$, $p = .045$, partial $\eta^2 = .023$, $f = .15$) as response scores of sexual infidelity were higher than those of emotional infidelity. However, nonsignificant effects were also found, including the effect of attractiveness ($F(1,173) = 0.36$, $p = .550$, partial $\eta^2 = .002$, $f = .04$). A statistical power analysis revealed powers of .525 for the interaction between gender and infidelity type, .544 for the interaction between gender and attractiveness, and .615 for the effect of attractiveness.

Current CR group

A $2 \times 2 \times 2$ ANOVA revealed that all interactions—including the interactions between gender and infidelity type ($F(1,109) = 3.03$, $p = .085$, partial $\eta^2 = .027$, $f = .17$) and between gender and attractiveness ($F(1,109) = 1.58$, $p = .212$, partial $\eta^2 = .014$, $f = .12$)—were not significant. A significant effect of infidelity type was found ($F(1,173) = 14.35$, $p < .001$, partial $\eta^2 = .116$, $f = .36$) as response scores for sexual infidelity were higher than those for emotional infidelity. However, other

nonsignificant effects were also found in this group, including the effect of attractiveness ($F(1,173) = 0.96$, $p = .328$, partial $\eta^2 = .009$, $f = .10$).

Moreover, the $2 \times 2 \times 2$ ANCOVA revealed that all effects—including the interactions between gender and infidelity type ($F(1,107) = 3.14$, $p = .079$, partial $\eta^2 = .029$, $f = .17$), between gender and attractiveness ($F(1,107) = 1.28$, $p = .261$, partial $\eta^2 = .012$, $f = .11$), and the effect of attractiveness ($F(1,107) = .07$, $p = .797$, partial $\eta^2 = .001$, $f = .03$)—were not significant. A statistical power analysis revealed powers of .520 for the interaction between gender and infidelity type, .524 for the interaction between gender and attractiveness, and .808 for the effect of attractiveness.

Infidelity imagination

Finally, to examine gender differences in infidelity imagination, a 2 (gender) $\times$ 2 (group: current relationship or not) $\times$ 2 (infidelity type) ANOVA was conducted with imagination scores of infidelity as a dependent variable. The ANOVA with the imagination scores of emotional infidelity revealed a significant interaction between gender and group ($F(1, 284) = 3.94$, $p < .05$, partial $\eta^2 = .014$, $f = .12$), as well as significant effects of group ($F(1, 284) = 5.47$, $p < .05$, partial $\eta^2 = .019$, $f = .14$) and infidelity type ($F(1, 284) = 167.88$, $p < .001$, partial $\eta^2 = .372$, $f = .77$). Other interactions and effects were not significant. The interaction showed that women in the current CR group ($M = 2.87$, SD = 1.04) imagined emotional infidelity more vividly than did women in the past CR group ($M = 2.17$, SD = 1.04). The effect of infidelity type revealed that infidelity imagination scores for sexual infidelity ($M = 3.31$, SD = .07) were higher than those for emotional infidelity ($M = 3.03$, SD = 0.10).

Discussion

According to the JSIM, men would be more upset than women about their partner's sexual infidelity, whereas women would be more upset than men over emotional infidelity. Also women would be more distressed than men if their partners were unfaithful with an attractive rival. In contrast, according to the imagination hypothesis, such gender differences in jealousy would not be observed if infidelity imagination was controlled. We used a within-subjects design that has been used previously in this area to compare responses to infidelity. No carryover effects, wherein the first test influenced the other in a within-subjects design, were found in the current study.

Imagination hypothesis

As predicted, we found that there were no gender differences in both groups after controlling for the effects of infidelity imagination, thereby indicating that the imagination hypothesis was supported in our sample. Additionally, the imagination hypothesis was supported independently of rival attractiveness in our sample.

The imagination hypothesis and our findings explain the following inconsistency regarding gender differences in jealousy found in previous studies using individuals in a committed relationship. Some studies (e.g. Guadagno & Sagarin, 2010; Kato,

2014a, 2014b; Voracek, 2001) found no significant gender differences in jealousy among individuals in a committed relationship, whereas another study (Becker et al., 2004) showed significant interaction between gender and infidelity type. The ANOVAs in our study that did not take into account infidelity imagination were also inconsistent between the past and current CR groups. More specifically, the ANOVAs revealed no significant gender differences in jealousy in the current CR group and a significant interaction between gender and infidelity type in the past CR group. The latter showed that women in the past CR group were more distressed by emotional infidelity than women in the current CR group. Additionally, our findings on infidelity imagination showed that women in the current CR group could imagine emotional infidelity (but not sexual infidelity) more vividly than could those in the past CR group. The inconsistency among previous studies and between the past and current CR groups in the present study might result from differences in infidelity imagination. In fact, gender differences in jealousy disappeared in the past CR group after controlling for the effects of infidelity imagination.

Gender differences in infidelity imagination can be explained by other factors such as sociocultural influences (Murnen and Stockton, 1997; Rupp & Wallen, 2008). For example, Western culture has historically allowed men greater sexual freedom and has placed constraints on women regarding the display of sexual motivation or interest in sexual material, and gender differences in jealousy may result in different levels of arousal (Rupp & Wallen, 2008). Additionally, Western cultures emphasize sexual equality, especially in the sexual domain, more than Asian cultures. As described earlier, more college students in the United States, compared to those in Japan, chose sexual infidelity instead of emotional infidelity as more upsetting regarding their partner's infidelity (Buss et al., 1999). Similarly, another study (Geary, Rumsey, Bow-Thomas, & Hoard, 1995) showed that the percentages selecting sexual infidelity instead of emotional infidelity among college students in the United States were higher than those in China. Further, the experience of personal infidelity or a partner's infidelity may also influence infidelity imagination; in other words, whether or not individuals had experienced partner infidelity affected their responses regarding their partner's infidelity (e.g. Harris, 2003b; Tagler, 2010; Varga, Gee, & Munro, 2011). The experience rates of partner infidelity in Western cultures are generally higher than in Asian cultures. For example, experience rates of Japanese partner infidelity in male and female university students were only 15.9% and 15.6%, respectively (Funaya, Tanaka, Hashimoto, & Takagi, 2006), compared to dating couples in American college students with 39% (Varga et al., 2011), 52.7% (Tagler, 2010), and 33–37% (Harris, 2003b). Experience rates of partner infidelity might also be low in our sample; in fact, the mean scores of sexual infidelity imagination were found to be relatively low in our sample.

Our sample was comprised of only Japanese students, and our findings were consistent with previous results using homogeneous Japanese samples (e.g. Kato, 2014a, 2014b; Takahashi et al., 2006). Future studies should test the imagination hypothesis using our method with other populations—especially participants from in Western cultures who can most likely imagine sexual infidelity vividly—to help illuminate the sociocultural factors that affect infidelity imagination and also to test the imagination hypothesis.

Jealousy as a specific innate module hypothesis

The JSIM predicts gender differences in response to partner infidelity despite samples and the participants' infidelity imagination. However, our findings were inconsistent with the predictions of the JSIM in both past and current CR groups. Nevertheless, the predictions of the JSIM were consistent with the results in the past CR group only when not controlling the effects of infidelity imagination. Additionally, the effect sizes for the JSIM were small. However, our data cannot reject the possibility of an evolutionary explanation for gender differences in jealousy because the statistical powers found in the past and current CR groups could indicate a false acceptance of an incorrect null hypothesis (i.e. Type II error probability).

Compared with research based in Western cultures, few studies have tested the JSIM in Asia, including China (Geary et al., 1995), Korea (Buss et al., 1999), and Japan (Buss et al., 1999; Kato, 2014a, 2014b; Takahashi et al., 2006). The findings among Asian sample were inconsistent; more specifically, only one study (Buss et al., 1999) supported the JSIM, whereas the other studies provided evidence that was inconsistent with the JSIM prediction. Our findings were consistent with most of the results in the previous studies conducted Asia. According to the JSIM, gender differences in jealousy should be observed regardless of ethnic or cultural groups, although the JSIM does not deny sociocultural influences on gender differences in jealousy. However, the previous studies in Asian cultures, including our findings, have provided insufficient evidence for the JSIM.

Rival attractiveness

No significant gender differences in rival attractiveness and rival attractiveness differences were found in either the current or past CR groups. These results were consistent with the prediction of the imagination hypothesis and a recent previous study (e.g. Buunk & Dijkstra, 2015), but they were inconsistent with other previous studies (e.g. Buss et al., 2000; Dijkstra & Buunk, 1998) that supported the gender differences in rival attractiveness. Although responses to jealousy have been found to be affected by relationship status (e.g. Guadagno & Sagarin, 2010; Kato, 2014a, 2014b; Voracek, 2001), all but one (i.e. Buss et al., 2000) of the studies supporting the JSIM did not account for relationship status. Therefore, this inconsistency may have resulted in the difference in relationship status. Further, Buunk and Dijkstra's (2015) sample and ours differ from samples in other studies (e.g. Buss et al., 2000; Dijkstra & Buunk, 1998) that supported the gender differences in rival attractiveness. Buunk and Dijkstra's sample was from the Kurdistan region of Iraq while ours was from Japan. All other samples in the studies that supported the gender differences were from Western cultures. Without doubt, the impact of rival attractiveness on distress related to partner infidelity differs among ethnic and cultural groups (e.g. Buss et al., 2000; Buunk & Dijkstra, 2015).

Although our results were inconsistent with the interpretation of evolutionary psychology regarding gender differences in rival attractiveness, our findings and the imagination hypothesis neither confirm nor deny the interpretation of certain evolutionary psychologists regarding gender differences in rival attractiveness (e.g. Buss

et al., 2000). This is because we cannot provide the alternative hypothesis, the theoretical models, or the rationale for denying the interpretation of evolutionary psychology in the current study, and also because the gender differences in rival attractiveness have been previously supported by evolutionary psychologists (for a review, see Buunk et al., 2007).

Relationships between the imagination hypothesis and the JSIM

Although the origins of sexually differentiated responses to sexual stimuli are unknown (Rupp & Wallen, 2008), there are several possible theories that might explain why women picture less graphic sexual content than men when imagining infidelity. One explanation is an evolutionary psychological perspective (Cross, Copping, & Campbell, 2011). Therefore, it may seem that gender differences in the imagination of infidelity parallel those of the JSIM. For example, from the perspective of some evolutionary psychologists, it has been suggested that men have more vivid sexual infidelity imagery to prevent being cuckolded. However, in this study, we found a significant interaction between gender and infidelity type in the past CR group and a nonsignificant interaction in the current CR group. These findings are inconsistent with the JSIM. Evolutionary psychologists who have supported the JSIM assume gender differences in response to the present partner's infidelity but not a former partner's infidelity. However, our data showed that gender differences were observed in the past CR group but not in the current CR group. Therefore, although an evolutionary explanation of gender differences in sexually graphic imagination may be appropriate, its interpretation may differ from the explanation offered by the JSIM. Our data cannot address the possibility of an evolutionary explanation for gender differences in sexually graphic imagination; indeed, examining this evolutionary explanation may provide a comprehensive understanding of gender differences in jealousy.

Limitations

Several limitations of the current study need to be addressed. First, the generalizability of our findings regarding the imagination hypothesis may be limited by our Japanese sample. A discussed previously, gender differences in infidelity imagination can also be explained by other factors such as sociocultural influences. Moreover, our sample consisted of college students who were currently in committed relationships or had been in the past, and they were unmarried. As discussed, previous experience with partner infidelity and marital status may be important factors when imagining partner infidelity. Future studies should test the imagination hypothesis using other samples, such as individuals who had experienced a partner's infidelity, or infidelity among married individuals. It would also help to use samples from other populations, especially Westerners.

Second, our participants in the current study we able to imagine sexual infidelity rather than emotional infidelity when photographs of rival faces were provided. This finding may be consistent with our findings wherein participants were more upset over sexual infidelity than emotional infidelity before controlling for the effects of

infidelity imagination. Findings related to infidelity imagination may suggest the need for providing another method that can be used for imagining a partner's emotional infidelity.

Additionally, findings related to infidelity imagination need to be interpreted with caution because other methods to imagine partner infidelity may result in different findings. For example, if we used body photographs instead of facial photographs, especially images of people in sexually suggestive poses or clothing, participants might imagine sexual infidelity more vividly. Kato's (2014a) study showed that when pictorial stimuli (e.g. a bathroom, a double bed, and a naked couple having sexual intercourse) was provided as a hypothetical depiction of a partner's sexual infidelity, the percentage of those who responded that they were more upset with a partner's sexual infidelity (vs. emotional infidelity) was higher in both women (67.19% vs. 46.88%) and men (73.44% vs. 60.94%) compared to when they were presented only with a rival's facial photograph.

Conclusions

No significant gender differences in jealousy were found in the current and past CR groups after controlling for the effects of infidelity imagination. This finding was consistent regardless of rival attractiveness. Additionally, high levels of infidelity imagination were positively associated with high responses to partner infidelity. These findings are consistent with the predictions of the imagination hypothesis, and they support this hypothesis in our sample. Conversely, our findings are inconsistent with the JSIM even though they are consistent with previous studies featuring Asian samples.

Compliance with ethical standards

The author declare that I have no conflict of interest. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all participants for being included in the current study. The participants did not receive any compensation for their participation.

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