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Nightmare frequency is related to a propensity for mirror behaviors

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ABSTRACT

We previously reported that college students who indicated engaging in frequent dream-enacting behaviors also scored high on a new measure of mirror behaviors, which is the propensity to imitate another person's emotions or actions. Since dream-enacting behaviors are frequently the culmination of nightmares, one explanation for the observed relationship is that individuals who frequently display mirror behaviors are also prone to nightmares. We used the Mirror Behavior Questionnaire (MBQ) and self-reported frequencies of nightmares to assess this possibility.

A sample of 480 students, consisting of 188 males (19.2 ± 1.73 years) and 292 females (19.0 ± 1.55 years) enrolled in a first-year university psychology course, participated for course credit. They completed a battery of questionnaires that included the 16-item MBQ, plus an item about nightmare frequency (NMF) in the past 30 days. NMF scores were split to create low, medium, and high NMF groups.

MBQ total scores were significantly higher for female than for male subjects, but an interaction revealed that this was true only for *Hi-NMF* subjects. MBQ Factor 4, *Motor Skill Imitation*, paralleled this global interaction for females, whereas MBQ Factor 3, *Sleepiness/Anger Contagion*, was elevated only for *Hi-NMF* males. Item analyses indicated that *Hi-* and *Med-NMF* females scored higher than *Lo-NMF females* on the 3 items of Factor 4 that reflect voluntary imitation (*imitating famous/cartoon voices*, *being a physically active spectator*, and *learning new skills by observing*), as well as on 2 other items that reflect involuntary imitation (*contagious yawning* and *self-rated empathy*). *Although Hi-* and *Lo-NMF* males differed most clearly on the *sleepiness* item of Factor 3, all 3 items on this factor (including *anger contagion* and *contagious yawning*) are plausibly associated with perception of and response to social threat.

Results provide evidence that among females nightmares are associated with voluntary and involuntary mirror behaviors during wakefulness, while among males nightmares are associated with threat-related mirror behaviors during wakefulness. They thus support the possibility that the association between mirror behaviors and dream-enacting behaviors is due to a common mirror neuron mechanism that underlies mirror behaviors and nightmares and that involves motor, rather than emotional, resonance. These results have implications for understanding the comorbidity of nightmares and other pathological symptoms such as imitative suicidal behaviors, the influence of observational learning on dissociative symptomatology, and the predominance of threat and aggression in the dream enacting behaviors of REM sleep behavior disorder.

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1. Introduction

Mirror behaviors, such as empathizing with another's emotions or imitating their actions or speech, are more frequent among individuals who act out fictive behaviors in their dreams than they are among individuals who do not (Nielsen & Kuiken, 2013). Dream-enacting behaviors are frequently the culmination of highly disturbing dreams, including the typical nightmares of college students (Nielsen, Svob, & Kuiken, 2009), the unpleasant 'baby-in-peril' dreams of postpartum mothers (Nielsen & Paquette, 2007), and the violence-filled nightmares of patients with REM sleep behavior disorder (RBD) (Schenck, Bundlie, Ettinger, & Mahowald, 1986; Schenck, Lee, Bornemann, & Mahowald, 2009). However, it is unknown whether a propensity for mirroring others' emotions and behaviors while awake is associated specifically with self-reported nightmare frequency.

The possibility of an association between mirror behaviors and disturbing dreams is pertinent both for clarification of nightmares as a clinical problem and for a coherent theory of nightmares. Clinically, nightmares are associated with several pathologies (see Levin & Nielsen, 2007 for review) whose relationship to mirror behaviors and the mirror neuron system is under investigation. For example, nightmares are symptomatic of affective disorders, such as bipolar disorder (Beauchemin & Hays, 1996; Mehl et al., 2006) and alexithymia, both of which are linked to anomalies in the mirror neuron system (Kim et al., 2009; Moriguchi et al., 2009). Similarly, nightmares are predictive of suicidal and self-harm behaviors (Li, Lam, Yu, Zhang, & Wing, 2010; Nadorff, Nazem, & Fiske, 2011; Sjostrom, Hetta, & Waern, 2009), which may be linked to mirror processes to the extent that they are influenced by similar behaviors in others, e.g., contagious suicides (Hagihara & Abe, 2012; Jeong et al., 2012; Yang et al., 2012). Nightmares also commonly accompany dissociative disorders (e.g., Watson, 2001), the symptoms of which can be influenced by observational learning, including media portrayals of the disorder (e.g., Lilienfeld et al., 1999).

A related question concerns the types of mirror behaviors that might be associated with nightmares. Factor analysis of the Mirror Behavior Questionnaire (MBQ) revealed four types of mirror behaviors (Nielsen & Kuiken, 2013): *Empathy/Emotional Contagion*, *Behavioral Imitation*, *Sleepiness/Anger Contagion*, and *Motor Skill Imitation*. This pattern is broadly consistent with other research that supports a distinction between cognitive and emotional empathy (Reniers, Corcoran, Drake, Shryane, & Vollm, 2011), the multidimensionality of empathy (Derntl et al., 2010), and the existence of different forms of motor resonance (Gazzola, ziz-Zadeh, & Keysers, 2006) and emotional contagion (Lundqvist, 2006). There is also a substantial literature on sex differences in (1) empathy, with females being more empathic; (2) contagious behaviors, with females exhibiting more emotion-congruent facial responses and higher self-reported contagion (Sonnby-Borgstrom, Jonsson, & Svensson, 2008; Wakabayashi, Sasaki, & Ogawa, 2012): and (3) the early developmental origins of emotional contagion (Geangu, Benga, Stahl, & Striano, 2010). Both sex and age are important factors in the etiology of nightmares as well.

The goal of the present study was therefore to assess possible relationships between nightmares and mirror behaviors in a college student population. The MBQ (Nielsen & Kuiken, 2013) permitted us to examine the specific types of mirror behaviors that might characterize subjects who frequently report nightmares.

2. Methods

Subjects were 480 students enrolled in a first-year university psychology course who received partial course credit for participation. Of these, 188 were male (19.2 ± 1.73 years; range: 17–27) and 292 were female (19.0 ± 1.55 years; range: 17–29). They gave informed consent and participated voluntarily; they were also free to choose an alternative educational activity for course credit. The male and female groups did not differ in age ($p = .18$).

All subjects completed an extensive battery of questionnaires as part of a larger research program on personality and dreaming. Details about the battery and results from some of the questionnaires are published elsewhere (Nielsen & Kuiken, 2013; Nielsen et al., 2009), and only some of the findings are described here. Subjects responded to questionnaires on optically scored answer sheets; these were subsequently scanned and verified by an assistant to remove cases with incorrectly coded or out of range responses. Following participation, subjects were given a thorough written debriefing.

2.1. Questionnaire measures

2.1.1. Nightmare frequency (NMF)

Subjects were given written definitions of nightmares, bad dreams, sleep terrors, and sleep paralysis to allow them to discriminate among these different phenomena. Nightmares were defined as *disturbing dreams* (*usually in the second half of the night*) *that awaken you from sleep and that are clearly recalled*. Subjects were then asked: *How often have you experienced* ***nightmares*** *during the* ***last 30 days***? A 7-point (0–6) response scale was provided where 0 = *Not at all*; 1 = *Once*; 2 = 2–5 *times*; 3 = 6–10 *times*; 4 = 11–15 *times*; 5 = 16–20 *times*; 6 = 21 *or more times*. The *NMF* measure was used to create three groups: *Lo-NMF* (score = 0; $n = 271$), *Med-NMF* (score = 1; $n = 109$); and *Hi-NMF* (score > 1; $n = 100$).

2.1.2. Mirror Behavior Questionnaire (MBQ)

Mirror behaviors were assessed with a 16-item self-report scale containing items that represent empathy as well as contagious emotions (*Empathy/Emotional Contagion*: e.g., smiling, laughing, crying), mirroring of body postures and speech patterns (*Behavioral Imitation*: e.g., speech and motor tics, accents, body movements), imitative learning of motor skills

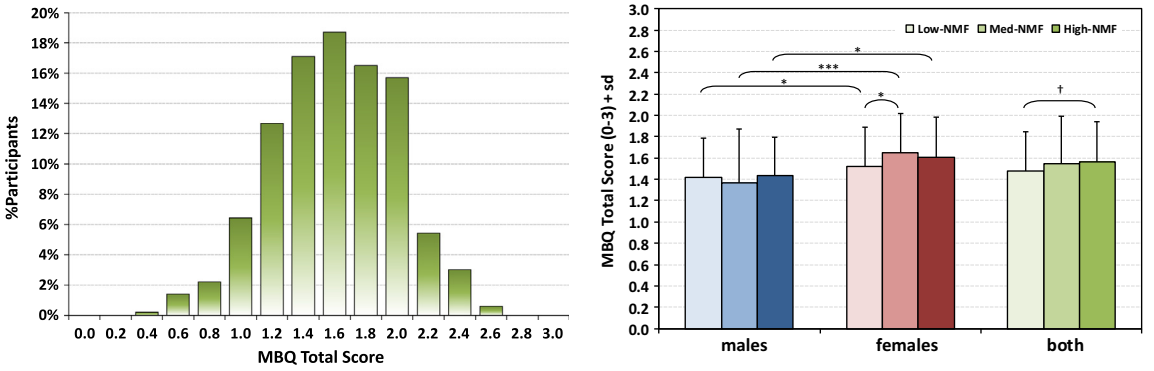

Fig. 1. Left panel: distribution of MBQ total scores is relatively normal; scores are 16-item averages. Right panel: MBQ total scores (+sd) for groups low, medium and high in Nightmare Recall Frequency (NMF) over the last 30 days. $^{***}p < .001$; $^{*}p < .05$; $^{\dagger}p = .057$.

(*Motor Skill Imitation*: e.g., learning new skills by observation, imitating voices), and contagious sleepiness, yawning, and anger (*Sleepiness/Anger Contagion*). Previous analyses validated these 4 independent MBQ factors (Nielsen & Kuiken, 2013). Responses to each item were made on 4-point scales: 0 = never; 1 = rarely; 2 = sometimes; 3 = often. The global MBQ measure was calculated as the average rating on the 16 items of the questionnaire. The 4 MBQ factor scores were available from the previous factor analytic study and were examined as secondary endpoints. Finally, the 16 items of the MBQ were examined individually to assess more specifically the types of mirror behaviors associated with nightmares.

2.2. Statistics

Distributions of the MBQ measures did not significantly depart from normality (Fig. 1, left panel), thereby allowing group comparisons using parametric statistics, including ANOVA/ANCOVA, MANOVA/MANCOVA, and *t*-tests. The NM frequency ratings had a skewed distribution and group comparisons were assessed using the non-parametric Mann–Whitney *U*.

3. Results

3.1. Nightmare frequency (NMF)

Mean *NMF* for the entire sample was 0.72 ± 1.02 (range: 0–6; median: 0) or the recall of slightly less than 1 nightmare in the last 30 days. Distributions of recall by group (*Lo-NMF*, *Med-NMF*, *Hi-NMF*) and sex are shown in Table 1. Females reported a higher *NMF* (.84 ± 1.09) than did males (.53±.87; Mann–Whitney $U = 3.40$, $p = .001$).

3.2. Mirror Behavior Questionnaire

3.2.1. MBQ total score

Mean MBQ score was 1.51 ± 0.39 with a median of 1.5, mode of 1.38, and range of 0.44–2.50 (out of 3.00). The distribution of scores was relatively normal (Fig. 1, left panel). A 3 × 2 ANOVA with *NMF group* (*Lo-NMF*, *Med-NMF*, *Hi-NMF*) and *sex* as independent variables and MBQ total score as the dependent measure revealed no main effect for *NMF group* ($F_{2,474} = 0.67$, $p = .513$; Cohen's $d = 0.03$), although, as shown in Fig. 1, the *Hi-NMF* group had a marginally higher MBQ total score ($M = 1.56 \pm 0.38$) than did the *Lo-NMF* group ($M = 1.48 \pm 0.37$; $t_{369} = 1.91$, $p = .057$). There was also a main effect for *sex* ($F_{1,474} = 19.65$, $p < .0001$; Cohen's $d = 0.40$); females had higher MBQ scores ($M = 1.57 \pm 0.37$) than did males

Table 1
Nightmare frequency of recall in the last 30 days by nightmare frequency (NMF) group and sex.

#In last 30 days	Group	Males		Females		Both	
		N	%	*N*	%	*N*	%
Not at all	Lo-NMF	123	65.4	148	50.7	271	56.5
Once	Med-NMF	38	20.2	71	24.3	109	22.7
2–5	Hi-NMF	23	12.2	59	20.2	82	17.1
6–10	Hi-NMF	1	0.5	7	2.4	8	1.7
11–15	Hi-NMF	2	1.1	2	0.7	4	0.8
16–20	Hi-NMF	1	0.5	3	1.0	4	0.8
21+	Hi-NMF	0	0.0	2	0.7	2	0.4
Total		188	100	292	100	480	100

($M = 1.41 \pm 0.39$) (Fig. 1, right panel). However, these effects should be interpreted in light of a marginally significant *NMF group* x *sex* interaction ($F_{2,474} = 1.99$, $p = .138$) indicating that the female *Lo-NMF* group reported significantly fewer mirror behaviors than the female *Med-NMF* group ($t_{217} = -2.34$, $p = .020$; $d = .30$) and marginally fewer mirror behaviors than the *Hi-NMF group* ($t_{219} = -1.54$, $p = .126$; $d = .30$). In contrast, the male groups did not differ from each other on the MBQ total score (all $p > .470$) (Fig. 1, right panel).

3.2.2. MBQ factor scores

A 3 × 2 MANOVA with *NMF groups* (*Lo-NMF*, *Med-NMF*, *Hi-NMF*) and *sex* as independent variables and the 4 MBQ Factor scores as dependent measures clarify these findings. It revealed a main effect for *sex* (Hotelling's Trace (T) = .278; $F_{4,468} = 32.56$, $p < .0001$), which should be interpreted in light of a significant *NMF group* × *sex* interaction ($T = .042$; $F_{8,934} = 2.44$, $p = .013$). As shown in Fig. 2 (lower right panel), the multivariate interaction was explained primarily by two effects. First, a univariate interaction specifically for Factor 4 *Motor Skill Imitation* ($F_{2,472} = 4.34$, $p = .014$) revealed that both *Hi-NMF* ($M = 0.051 \pm 0.95$) and *Med-NMF* ($M = -0.13 \pm 0.95$) females reported more mirror behaviors than did *Lo-NMF* females ($M = -0.45 \pm 0.95$; $t_{218} = -3.67$, $p = .0004$; $d = .36$ and $t_{216} = -2.33$, $p = .021$; $d = .32$ respectively; *Hi-* and *Med-NMF* groups did not differ). In contrast, among males, the *Hi-NMF* ($M = 0.31 \pm 0.78$), *Med-NMF* ($M = 0.27 \pm 0.81$) and *Lo-NMF* groups ($M = 0.44 \pm .99$) did not differ on this factor (all $p > .336$). Second, for Factor 3 *Sleepiness/Anger Contagion*, the male *Hi-NMF* group reported more mirror behaviors ($M = 0.29 \pm 0.95$) than did the *Lo-NMF* group ($M = -0.16 \pm 1.10$; $t_{147} = -1.95$, $p = .052$; $d = .32$); also, the female *NMF* groups did not differ on this factor (Fig. 2, upper right panel). In sum, among women, medium and high nightmare frequency was associated with MBQ *Motor Skill Imitation* (Factor 4); among men, high nightmare frequency was associated with MBQ *Sleepiness/Anger Contagion* (Factor 3).

3.2.3. MBQ items

To explore further the preceding patterns, we conducted separate univariate ANOVAs for males and females using the individual MBQ items as dependent variables. Because female *Lo-NMF* differed from both *Med-* and *Hi-NMF* groups on Factor

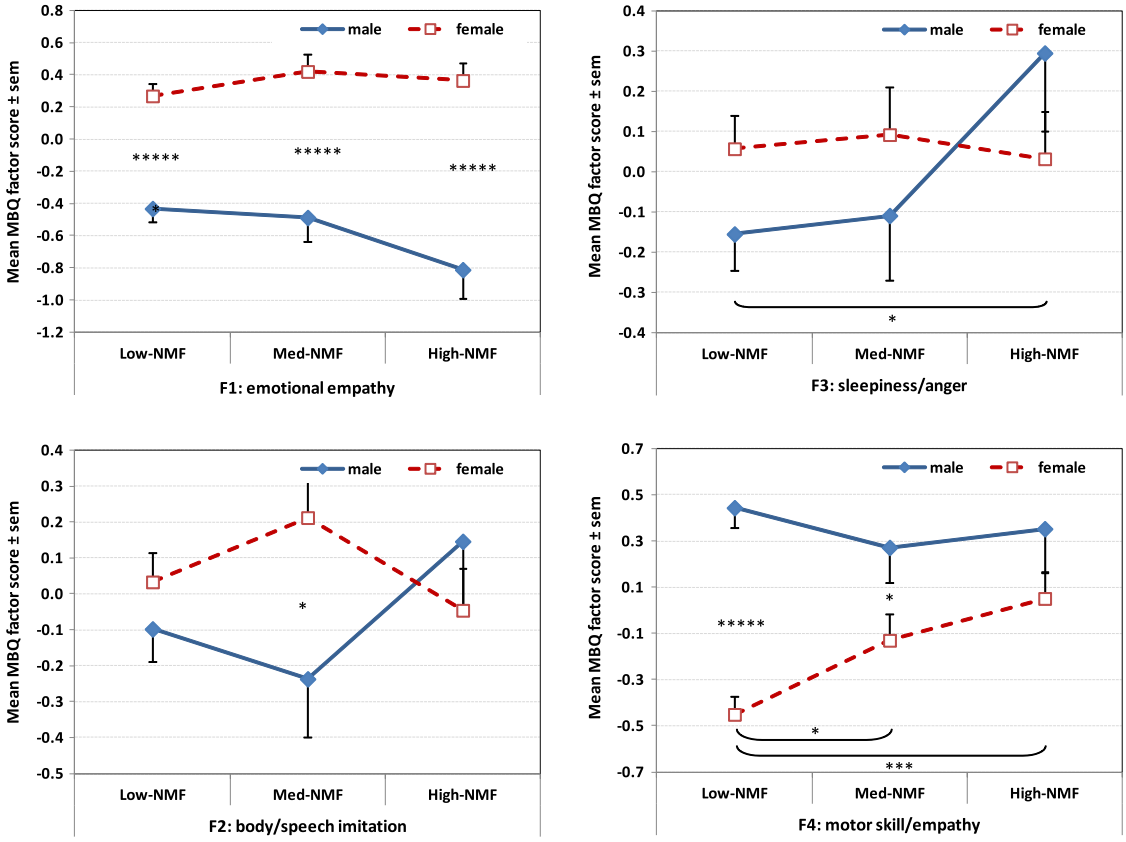

Fig. 2. Mean (±sem) MBQ factor scores by Nightmare Recall Frequency (NMF) category and sex. Relationships were observed between higher NMF and higher Factor 3 (sleepiness/anger contagion) scores for males and higher Factor 4 (motor skill/empathy) scores for females. A large sex difference was observed at all levels of NMF for Factor 1 (empathy/emotional contagion). *****$p < .000006$; ***$p < .0005$; *$p < .05$.

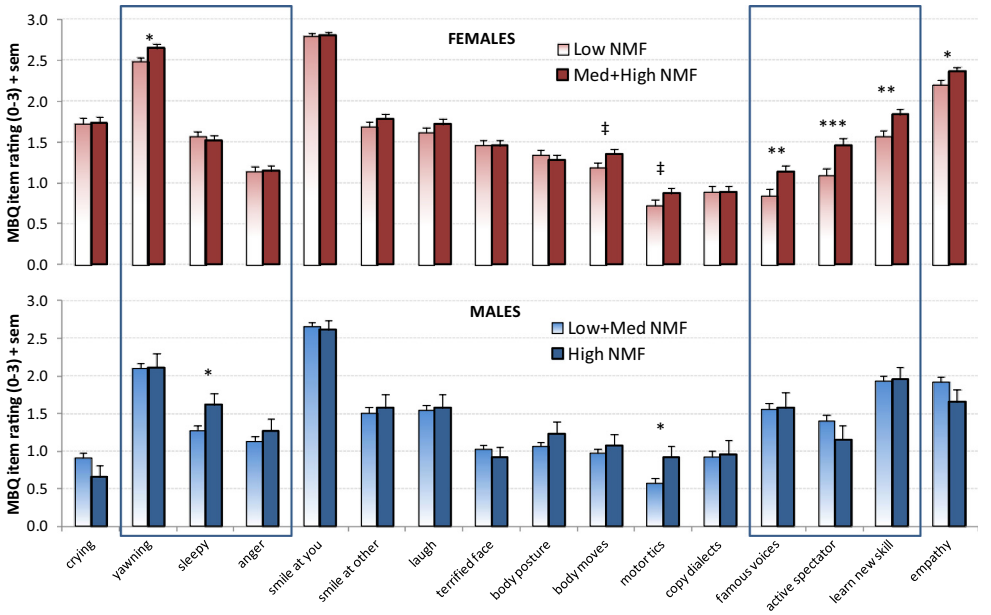

Fig. 3. Mean (+sem) ratings for 16 MBQ items for female and male subjects in self-reported nightmare frequency (NMF) groups. Females in the Med + High-NMF group more strongly endorsed the three MBQ Factor 4 *Motor Skill Imitation* items as well as the 'contagious yawning' and 'empathy' items than did females in the Low NMF group. Males in the High NMF group more strongly endorsed the *Sleepiness* item of the Factor 3 *Sleepiness/Anger contagion* items as well as the 'copy motor tics' item than did males in the Low + Med NMF group. $^{***}p < .001$; $^{**}p < .01$; $^{*}p < .05$; $^{‡}p < .110$.

4, the latter were combined into one (*Med + Hi-NMF*) group and compared with the *Lo-NMF group*. Because male *Lo-* and *Hi-NMF* groups differed on Factor 3, they were compared.

As indicated in Fig. 3 (top panel), among females, we found higher MBQ scores in the *Med + Hi-NMF* group than in the *Lo-NMF* group on all three Factor 4 items (*imitating famous/cartoon voices*, *being a physically active spectator*, *learning new skills by observing*). However, these voluntary imitative behaviors do not tell the entire story. Some MBQ items associated with involuntary imitative behaviors showed the same pattern. Specifically, there were significant *Med + Hi-NMF* vs. *Lo-NMF* differences among females for items that assess contagious yawning and self-reported empathy. There also were marginally significant differences between *Med + Hi-NMF* vs. *Lo-NMF* differences among females for *copying body movements* ($p = .083$) and *copying motor tics* ($p = .110$). When the ratings on these voluntary and involuntary motor mimicry items were averaged to create a composite measure of motor mimicry, univariate ANOVA indicated that *Med + Hi-NMF* females and *Lo-NMF* females clearly differ ($F_{1,290} = 19.14$, $p < .00002$). On the other hand, *Med + Hi-NMF* and *Lo-NMF* males did not differ from each other on this composite measure ($F_{1,186} = 0.33$, $p = .567$).

In contrast, as shown in Fig. 3 (bottom panel), among males we found higher MBQ scores specifically for the *sleep contagion* item of Factor 3; for females, no such difference was observed. Beyond that item, we also found a difference between *Hi-* and *Lo + Med-NMF* males on *copying motor tics* ($p = .022$).

4. Discussion

These results provide preliminary evidence that nightmare frequency is associated with a tendency to express waking mirror behaviors. They support the notion that a previously observed association between mirror behaviors and dream-enacting behaviors (Nielsen & Kuiken, 2013) reflects a mirror neuron mechanism that underlies both waking mirror behaviors and nightmares. Nightmares may not be the only source of dream-enacting behaviors, but they appear to be a notable one.

The precise mechanisms influencing both mirror behaviors and nightmares nonetheless remain unclear. We previously suggested (Nielsen, 2007) that mechanisms such as motor resonance and the central mirror neuron system may underlie the production of both mirror behaviors and dream content in which the self and other characters are depicted as intensely engaged in so-called character-self interactions (CSIs; for review see Nielsen & Lara-Carrasco, 2007). The present findings suggest that the CSIs that lead to dream-enacting behaviors are particularly likely to depict the self as threatened, fearful, anxious or terrified—that is, to be nightmarish in character. Moreover, the findings point to the likelihood that one type of mirror behavior, *Motor Skill Imitation*, is most closely related to nightmares in females, and another type, *Sleepiness/Anger Contagion* is related to nightmares in males. This selectivity raises the possibility that the underlying mirror mechanism involved for females is related to processes that primarily involve *motor* resonance rather than *emotional* resonance, whereas for males it is related to mechanisms common to detection of and response to threat.

Examination of the results for individual MBQ items bears out this interpretation most clearly for females. All three Factor 4 items—*imitating famous/cartoon voices*, *learning new skills by observing*, and *being a physically active spectator*—received significantly higher ratings in the female *Med + Hi-NMF* group than in the female *Lo-NMF* group. Additionally, the female *Med + Hi-NMF* group received somewhat higher ratings on the *copy body movements*, *copy motor tics* and *contagious yawning* items. Results for a composite measure that includes both voluntary (e.g., imitating voices) and involuntary (e.g., contagious yawning) motor mimicry suggest that the underlying process in question implicates a motor rather than an emotional resonance system. It is noteworthy that the self-rated *empathy* item—but not the other emotional mimicry items from MBQ Factor 1, (e.g., *contagious crying*, *contagious laughter*)—contributed to this pattern. Thus, empathy, as rated on the MBQ, may reflect motoric resonance that is the substrate of emotion, e.g., the dynamics of expressive movement and postural bearing (Platek, 2010; Stern, 2010), rather than emotion per se; it may reflect motor-affective resonance rather than cognitive perspective-taking (Reniers et al., 2011).

The results for males suggest (less decisively) that for them the mirror mechanism is more closely related to detection of and response to threat. The item aggregate that comprises MBQ Factor 4 is compatible with this interpretation, although item by item analyses did not provide corroboration comparable to that provided for Factor 3. Nonetheless, feeling anger when seeing someone else expressing anger (*contagious anger*) quite directly reflects mechanisms involved in response to threat. Moreover, there is evidence that *contagious yawning* is a form of behavioral mimicry that facilitates recognition of threat in non-human primates (Anderson, 2010; Vick & Paukner, 2010) and, similarly, the recognition of danger during periods of stress or anxiety in humans (Greco, Baenninger, & Govern, 1993). As for *sleepiness contagion*, studies are lacking on the mirror features of this behavior, but sleep deprivation is associated with aggressive tendencies in both animals and humans (Berry, Steel, Mastin, & Pezska, 2011; Kamphuis, Meerlo, Koolhaas, & Lancel, 2012). Perhaps, then, the association of sleep contagion and contagious yawning with nightmares in the present study belies perturbation of a mechanism responsible for processing social threat. Thus, attempts to specify the underlying mechanism of nightmares across gender should consider whether contagious yawning and sleepiness marks behavioral mimicry that facilitates threat recognition and response—and that underlies the imagery of social threat in nightmares (Schredl, 2010).

4.1. Mirror behaviors, disturbed dreaming and psychopathology

The results of the present study suggest explanations for some conditions often comorbid with nightmares. Frequent nightmares are a risk factor for suicidal thoughts and behaviors (Li et al., 2010; Pigeon, Pinquart, & Conner, 2012; Sjostrom et al., 2009), and suicidal thoughts and behaviors are also sometimes contagious, e.g., in 'copycat' suicides (Jeong et al., 2012; Yang et al., 2012). Self-injurious behaviors are similarly associated with both nightmares (Wong, Brower, & Zucker, 2011) and contagion (Jarvi, Jackson, Swenson, & Crawford, 2013). Thus, there may be an underlying tendency to imitate others among self-harming individuals, which is consistent with the possibility that there is an underlying voluntary and involuntary tendency to imitate others' behaviors among suicidal individuals. This hypothesis could readily be tested by administering the MBQ to subjects at risk for self-harm and suicide.

Similarly, the present results may help explain relationships between dissociative disorders and nightmares (Koffel, 2011; Watson, 2001). According to a post-traumatic model of dissociation (e.g., Gleaves, 1996; Ross, 1997), sleep disturbances such as nightmares, which often accompany dissociative disorders, are symptomatic of the trauma that instigated the dissociation. However, it may be useful to consider the motor resonance that could underlie dissociative tendencies. The most common measure of dissociation (the Dissociative Experiences Questionnaire; Carlson & Putnam, 1993) involves three components: (1) memory gaps and confusions; (2) de-realization or depersonalization; and (3) and readiness to become absorbed in imaginal events. All three may derive from the same sources that are responsible for sleep-disturbing nightmares. For example, accentuated motor resonance may underlie the conflation of "self" and "other" that characterizes depersonalization, and the readiness to become absorbed in imaginal events may reflect imitative suggestibility (Merckelbach, Muris, Rassin, & Horselenberg, 2000; van der Kloet, Merckelbach, Biesbrecht, & Lynn, 2012). The latter may underlie the often noted imitation of portrayals of dissociative symptoms (especially dissociative identity disorder) in movies and the media (Lilienfeld et al., 1999).

Finally, the results may begin to provide an explanation for the dream imagery that is enacted by those diagnosed with REM sleep behavior disorder (RBD). Studies of the behavior enacted during RBD episodes indicates that it is consistently aggressive/defensive—and comparable in that respect to nightmares (see Nielsen, 2010, for a review). Significantly, individuals diagnosed with RBD are most commonly men, which converges with the present observation that the MBQ *Sleepiness/Anger Contagion* factor predicts nightmare frequency specifically for males. Thus, REM sleep parasomnias may constitute a significant expression of mirror neuron dysregulation during sleep.

4.2. Sex differences

The finding of higher NMF in females than in males replicates a large body of work demonstrating a sex difference in NMF, especially for subjects in their twenties (Nielsen, Stenstrom, & Levin, 2006; Schredl & Reinhard, 2011). That mirror behaviors were more strongly associated with nightmares for females than for males also parallels other nightmare-related findings that are specific to females, such as an association between nightmares and the evening chronotype (Nielsen, 2010). Further

study is needed to determine if the observed effects are attributable to acquired sex differences in motor mimicry (observational conditioning; Kelly & Forsyth, 2007) or to the basic anatomy of the mirror neuron system (Cheng et al., 2009).

4.3. Conclusions

In summary, the present results provide evidence that nightmare frequency is associated with a tendency to express mirror behaviors during waking, especially voluntary and involuntary motor mimicry in women and imitative response to threat in men. The mirror neuron hypothesis suggests explanations for not only the association between mirror behaviors and the dream-enacting behaviors of nightmares, but also for the comorbidity of nightmares and other pathological symptoms such as imitative suicidal behaviors, alterations in dissociative symptomatology, and the aggressive/defensive character of dream-enacting behaviors in RBD episodes.

4.4. Limits of the study

These results call for replication. Although the overall study cohort was large, sample size for the male *Hi-NMF* condition was relatively small ($N = 27$); thus, conclusions about a link between NMF and mirror behaviors for this group should be considered tentative. Also, the fact that subjects were given other questionnaires in the context of the larger study raises the possibility of Type 1 errors. While a valid concern, this possibility was minimized by limiting analyses to the questionnaires for which a priori hypotheses had been established.

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