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Variance in Mood Symptoms Across Menstrual Cycles: Implications for Premenstrual Dysphoric Disorder

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Abstract

Premenstrual dysphoric disorder (PMDD) remains a controversial diagnosis: Some authors have argued that it pathologizes normal mood changes, and others have questioned the need for daily mood reports across multiple cycles. In the present study, we examined changes in mood among psychologically healthy young participants with regular menstrual cycles. We collected daily reports of negative mood (depression, nervousness, irritability, and fatigue) across two to six consecutive cycles from 27 participants aged 18–35 years, and we used variance decomposition analyses to examine how much of the variance in these daily reports was due to day, cycle, and individual. The majority of variance (79%–98%) was due to daily fluctuations and did not conform to a standard pattern of premenstrual rise/postmenstrual fall. These findings suggest that PMDD is not simply an exaggeration of mood patterns typical for psychologically healthy people. Individual patterns were relatively stable from cycle to cycle; thus tracking deviations from a patient's own normative mood patterns may have greater clinical utility than deviation from a presumptive norm.

Keywords

mood; premenstrual dysphoric disorder; daily diary; menstrual cycle; variance decomposition

The diagnosis of premenstrual dysphoric disorder (PMDD) has been criticized on multiple fronts. Some authors have raised concerns that distress regarding menstrual symptoms is culturally bound (Chrisler & Caplan, 2002; Ogebe et al., 2011). Feminist scholars have

argued that the creation of a diagnostic category that, by definition, will (generally¹) be applied to women is indicative of a biased system that medicalizes (and generally pathologizes) women's experience (Rome, 1986; Ussher, Hunter, & Browne, 2000). The public narrative of premenstrual disturbance may cause people who menstruate to self-monitor mood and other symptoms to a greater extent in the days preceding menses (Cosgrove & Riddle, 2003), potentially amplifying any underlying negative mood (Swinkels & Giuliano, 1995) and misattributing any changes to the menstrual cycle rather than to contextual factors.

On a societal level, misattribution of normative fluctuations in negative mood may contribute to the internalization of sexist norms regarding proper emotionality. Ussher has argued that the characterization of mood fluctuations as mental illness may create a distinction between the premenstrual versus "normal" post-menstrual self (Ussher et al., 2000), thus reinforcing the rejection of even brief episodes of negative emotion as ego-dystonic and further heightening distress when such fluctuations do occur (Cosgrove & Riddle, 2003). Indeed, one study showed that women who identify as experiencing premenstrual syndrome (PMS) report significantly higher concerns about losing control over their emotions, and greater endorsement of a dualistic "normal" versus "PMS" self, than do women who do not identify as experiencing PMS (Chrisler, Gorman, & Streckfuss, 2014). That study also showed significant associations between endorsement of feminine gender norms that enforce strict regulation of external expression of negative mood (if not their outright suppression) and the belief that premenstrual symptoms cannot be controlled by the individual who experiences them (Chrisler et al., 2014). Therein lies a bind: Femininity demands control of one's negative mood, but women are expected to experience premenstrual rises in negative mood as uncontrollable. In sum, these findings suggest that people who perceive cyclic mood changes as non-normative, and thus threatening, are more likely to be harmed by these symptoms.

However, others have noted that the diagnosis offers a means by which patients who have significant cycle-related mood disturbance may understand their symptoms and access health care and other resources (Di Giulio & Reissing, 2006; Figert, 1996). Women who are diagnosed with PMDD do report functional impairment and significantly lowered health-related quality of life (Borenstein et al., 2003; Halbreich, Borenstein, Pearlstein, & Kahn, 2003). In a comparative analysis across different disease conditions, Yang et al. (2008) determined that the health-related quality of life of women who reported PMDD was comparable to or worse than that of women who reported chronic back pain or diabetes. Insurers in the United States must cover care for PMDD under the Affordable Care Act (at least as of this writing); it is argued that this coverage would be revoked without a formal diagnostic code (Robinson & Swindle, 2000).

There is a lack of consensus as to whether the disorder represents a significant exaggeration of the same mood symptoms experienced by many individuals in the days preceding menses,

¹As the majority of this article is concerned with the process of menstruation, we use the terms *people who menstruate* or non-gendered *individual* in recognition of the fact that not all people who menstruate identify as women, and not all women menstruate. However, when describing arguments made on the basis of gender (e.g., the characterization of mood cyclicality as "typical of women"), or describing the results of studies that were targeted toward self-identified women, we use the terms *woman* or *women* as appropriate.

or if it is a clinically distinct mood disorder (Endicott et al., 1999). If the former, one may expect that PMDD would share more features (and would be likely to resemble more closely the clinical presentation) of other reproductive disorders than of nonreproductive mood disorders. If the latter, PMDD would share more features with other mood disorders that are temporally bound (e.g., seasonal affective disorder [SAD]) than with reproductive disturbances. However, there are data to support both views: There is high comorbidity between PMDD and non-mood reproductive disorders (Bancroft, Williamson, Warner, Rennie, & Smith, 1993; Ju, Jones, & Mishra, 2014) and between PMDD and other mood disorders (Cohen et al., 2002; Kim, Czarkowski, & Epperson, 2011), particularly SAD (Praschak-Rieder et al., 2001).

Finally, several authors have pointed out that PMDD's diagnostic requirement of "prospective daily ratings of at least two symptomatic cycles" (American Psychiatric Association, 2013, p. 172) is burdensome (Cohen et al., 2002) and is not followed in typical clinical practice (Bosman, Jung, Miloserdov, Schoevers, & aan het Rot, 2016). The admonition for clinicians (and their patients) to collect daily ratings of mood across multiple cycles seems particularly strained given that the majority of the research on mood variability has focused on short timeframes (e.g., comparing the few days prior to menses to a few days after) within one cycle (Bosman et al., 2016).

This line of research is limited by a lack of information on the normal variation in mood in people without mood psychopathology. Many researchers have examined daily diary ratings of mood symptoms, but few have done so prospectively across the entire cycle (Bosman et al., 2016); we cannot know if a rise in mood symptoms is unique to the premenstrual phase if no other phases are considered. Few researchers have examined the patterns of normal variability in mood in healthy people who menstruate (Bosman et al., 2016). Thus it is unclear if a premenstrual rise in mood symptoms is itself unusual or if PMDD is the extreme version of commonly experienced patterns.

What is more, the shape of mood cycles is often assumed rather than tested. For example, Kiesner and colleagues (Kiesner, Mendle, Eisenlohr-Moul, & Pastore, 2016) assessed mood and menstrual cycle-related physical symptoms in 163 women. Unlike in many prior studies, they included all available days across two consecutive cycles and found significant intra-individual variance in all symptoms measured. However, their analysis (cosine regression) tested the assumption that all symptoms fit a consistent pattern of rise and fall. Such an analysis can reveal only whether fluctuations fit the assumed pattern of premenstrual rise/postmenstrual fall with every cycle, not how well each person fits their own individual pattern over time. It is possible that people's mood does consistently rise and fall over the course of the menstrual cycle—but that the timing does not perfectly align across individuals. Indeed, using hierarchical linear modeling in a different sample, the same authors showed that, although 61% of women's negative mood patterns followed a premenstrual rise/postmenstrual fall cycle, 13% consistently showed mid-cycle rise/luteal-phase decline (Kiesner, 2011). However, both of these studies assumed rather than tested whether cyclicity itself predicted variance—that is, whether moods typically follow any kind of monthly patterns (let alone what specific pattern was the best fit). Harvey et al. (2009) examined negative mood across the menstrual cycle in 62 healthy women; their study was

notable for a long monitoring period (1 year) and the consideration of hormonal measures. The results showed higher average negative mood in ovulatory versus anovulatory cycles. However, as the authors themselves noted, they were limited by an analytic method that averaged data across multiple participants and multiple cycles, which would not reveal individual patterns of change. Finally, there is little work that compares the relative contributions to variance in mood across menstrual phases: Are menstrual phases better predictors of mood than individual differences?

The present study was designed to address these issues by examining mood reports across two to six consecutive cycles in 27 psychologically and physically healthy young women,² who provided a total of 2,534 daily reports. We asked the following questions: (1) How well does the assumption of cyclicity of symptoms fit the data (i.e., is there a consistent premenstrual rise in symptoms or any other consistent pattern across all individuals)?; (2) What is the level of variation in symptom reports explained by cycle (i.e., were women's own individual patterns of variation in mood relatively stable from cycle to cycle)?; and (3) To what degree did the PMDD diagnostic criteria identify these healthy women's cycles as pathological? Given that meta-analyses of daily diary studies suggest significant variance in mood among both healthy and clinical populations over short time periods (Houben, Van Den Noortgate, & Kuppens, 2015), we predicted that the variance in mood symptoms would be significant. However, as there has been a lack of consistency in the literature on mood cyclicity across the menstrual cycle (with different reports showing higher negative mood in the premenstrual phase, postmenses, and even at ovulation (Harris & Vitzthum, 2013; Kiesner, 2011; Romans, Clarkson, Einstein, Petrovic, & Stewart, 2012), we hypothesized that daily fluctuations would account for a greater proportion of the variance than cycle-level fluctuations.

Method

This study was approved and overseen by the Institutional Review Board at Indiana University; all participants provided written informed consent. The present study was a secondary analysis of data collected for a larger study of changes in mood when women start hormonal contraceptives; the data presented here were taken from the control group of participants who were neither taking nor intending to start taking hormonal contraceptives.

Participants

Participants were recruited via flyers posted in the community and on a study website. Inclusion criteria were: self-identifies as a woman who is physically healthy, no pregnancies or lactation in the last 6 months, no hormonal medication use currently or in the last 6 months, 18–35 years of age, and regular access to the Internet. Screening and informed consent procedures were conducted via e-mail and online chat with the head researcher. Thirty-one women were enrolled, and they completed entrance surveys including questions about their psychiatric history. Approximately one third (29%) of these 31 women reported a lifetime history of diagnosis and/or treatment for depression. This is in keeping with

²All recruitment materials specified “women”—thus we use the gendered term here.

epidemiologic estimates of depression history among currently healthy women (Weissman et al., 1996), and thus we retained these reports. However, four women indicated that their depression was current or untreated, and they were dropped from the present analysis.

Thus the final sample included 27 women who self-identified as “currently healthy,” with an average age of 23.85 years ($SD = 5.37$). The majority of participants were European American (89%); 7% were African American, 7% mixed race, and 3% Asian American. Most (68%) were in an exclusive, committed relationship; 26% were single; 3% were casually dating, and 4% were in an unidentified type of relationship. Most (90%) did not have children. Of the women who reported being in a committed relationship, five reported using condoms, two reported a nonhormonal IUD, one reported use of contraceptive sponges with spermicides, one reported an unspecified contraceptive method, and 10 reported no current contraceptive use.

Procedure

Participants enrolled in the study completed entrance, weekly, and daily surveys. Entrance surveys were completed with a researcher—in person or in an online chat session—to provide informed consent and to ensure that participants understood survey instructions. The current analysis includes only data from the entrance and daily surveys. Data were collected during a span of 16 months, from August 2013 through November 2014. Participants were followed for at least two and up to six consecutive cycles: one person (4%) completed daily reporting of two cycles, four (15%) completed three cycles, three (11%) completed four cycles, 16 (59%) completed five cycles, and three (11%) completed six. To reduce missing data and dropout, each participant received a daily (and a weekly) e-mail prompt with a personalized link to a personalized daily (and weekly) survey, each with an opt-out link. Participants received \$20 upon their completion of the study.

Measures

In the daily surveys, participants reported how much they had experienced nervousness, sadness, irritability, and fatigue and how much each symptom had bothered them that day. Reports were made on a 5-point scales that ranged from *not at all* (1) to *severely* (5) for both ratings. The parent study (from which these secondary analyses were derived) was designed to evaluate whether side effects of hormonal contraceptives matched symptoms commonly associated with the menses. Thus these variables were chosen to represent commonly reported symptoms of both hormonal contraceptive use and premenstrual syndrome. The mood survey, which was created for the present study, was intentionally short to improve daily reporting rates. Indeed, the amount of missing data was low for each symptom (2.56% for nervousness, 1.72% for sadness, 1.65% for irritability, 1.12% for fatigue), which resulted in an average of 1.76% of the data coded as missing. Because this amount was so low, we assume that those data are missing at random. Symptom scores were calculated as symptom distress (how much they were bothered) multiplied by its frequency (adjusted by the range of possible answers). See Table 1 for descriptive statistics and correlations.

In each daily survey, participants indicated whether they had experienced menstrual bleeding that day and, if so, to what degree (no bleeding, spotting, low, medium, or high menstrual

flow). Menses was defined as at least 2 consecutive days of any reported menstrual bleeding, or (if there were missing data) at least 1 day of high menstrual flow. To standardize the time variable across participants with different cycle lengths, cycle day was defined with respect to the start of the next menses.

We additionally classified all complete cycles according to the diagnostic criteria for PMDD as per the *DSM-5*. We examined whether cycles met Criteria A and B (marked affective lability, irritability, depressed mood, or anxiety/nervousness in the seven days before the onset of menses but absent or minimal in the seven days after the last day in which the participant reported menstrual bleeding that cycle). We defined “marked” symptoms as frequency* distress >1, which corresponds to a report of a symptom that was experienced at least “somewhat” that day with “severe” distress. To be classified as “potentially meeting criteria,” the cycle had to meet both Criterion B (reporting marked levels of these core PMDD symptoms) and Criterion A (symptoms appeared in the week prior to menses but were absent in the week following menses).

Results

To assess whether there is a consistent premenstrual rise in symptoms across healthy women, we conducted a multiple regression model in MPlus v. 7.3 (Muthén & Muthén, 1998–2012). Because these data are nested, we clustered our analyses by ID number to examine days until next menses (i.e., day in the cycle) as a predictor of the four symptoms. There was no significant effect of day on nervousness ($b = 0.008$, $t_{25} = 1.55$, $p = 0.12$), sadness ($b = -0.004$, $t_{25} = -0.60$, $p = 0.55$), irritability ($b = 0.002$, $t_{25} = 0.27$, $p = 0.79$), or fatigue ($b = 0.001$, $t_{25} = 0.29$, $p = 0.77$), which suggests that there is no consistent premenstrual rise in any of the symptoms.

Next, we assessed the level of variation in symptom reports at the day and cycle level within individuals and at the between-individuals level. We conducted variance decomposition analyses in HLM v. 7.01 (Raudenbush, Bryk, & Congdon, 2010). These analyses break down the proportion of variance found at each level, which allows researchers to see whether most variance is due to differences between participants or to fluctuations within a participant, and whether the amount of variance is significant. A significant amount of variance in each of the four symptoms existed at each level (i.e., at the daily level, the cycle level, and between individuals); however, most variance occurred at the daily level with a relatively low amount of variance from cycle to cycle or between individuals. Sadness and irritability were the most variable symptoms. See Table 2 for variance statistics, and Figures 1 and 2 for examples of the most (sadness) and least (fatigue) variable symptoms.

Twenty-three (19%) of the 124 complete cycles analyzed met Criteria A and B as defined above. The majority of these (18 cycles) were repeated across multiple cycles within the same individual. Only five of the 23 cycles that met criteria occurred in individuals for whom that was the only cycle that met the criteria across multiple months of reports. In other words, it was rare for a participant who met diagnostic criteria to do so in only one cycle; if she met it once, she was very likely to meet it in subsequent cycles.

Discussion

In the present study, we examined daily reports in psychologically healthy young women to answer three main questions: Do symptoms follow consistent cyclic patterns? Insofar as there are consistent patterns across menstrual cycles, to what extent do these differ between individuals? And do the criteria for PMDD as outlined in the *DSM-5* characterize symptom fluctuations as pathology in women who self-identify as free from mental illness? We found significant variation in mood symptoms over time in healthy young women; however, this variance was predominantly explained not by consistent patterns of premenstrual rise and postmenstrual fall but by day-to-day fluctuations. Individual patterns of change in mood symptoms were relatively stable from cycle to cycle; similarly, participants' likelihood of inconsistently meeting PMDD criteria from cycle to cycle was low. Finally, of the mood symptoms surveyed, fatigue and nervousness were relatively more stable than sadness and irritability.

These findings question the assumptions that there is a consistent pattern of premenstrual rise in mood symptoms among healthy individuals and that significant variation in mood is uncommon. Despite having requested daily reports, most prior studies of mood symptoms across a menstrual cycle presented averaged reports across days that fall into a defined phase (e.g., forward cycle days 24–28 that represent the premenstrual phase; Bosman et al., 2016); however, given that healthy individuals exhibit considerable variability in cycle length, day of ovulation, and hormonal patterns (Fehring, Schneider, & Raviele, 2006; Vitzthum, 2009), it is unlikely that these set phases capture the same biological phenomenon across individuals. For example, although days 13–15 are often considered the “ovulatory” phase, less than 40% of cycles actually have evidence of ovulation during this window (Howards et al., 2009). In the present study, we standardized timing to the start of the next cycle; this method has been shown to align better to reproductively relevant events (such as the rise in luteal-phase progesterone) than the more typically used forward counting (Gangestad et al., 2016; Vitzthum, 2009). Thus our failure to find stable premenstrual rise in negative moods was less likely to be due to misalignment with reproductively relevant events within the menstrual cycle.

If patients do exhibit consistent premenstrual rises in mood symptoms without fluctuation in mood at other times, they would be exhibiting a highly unusual pattern—at least, one not often seen in our sample of 124 cycles. In other words, the patterns of change in mood described in the PMDD diagnostic criteria do suggest psychopathology. However, the truly unusual aspect of the patterns of mood described by PMDD diagnostic criteria is not the variability in premenstrual mood but, rather, the remarkably stable mood at non-premenstrual times. In the present study, we found that the majority of variance in mood symptoms was explained by daily fluctuations. Our findings suggest the possibility that some individuals are inappropriately excluded from the PMDD diagnosis on the basis of fluctuations in mood in the week after the menses (i.e., because their cycles do not fit the assumption of stability during non-menstrual phases). Because most studies have used short timeframes (e.g., 3–4 days) to characterize different phases of the cycle (Bosman et al., 2016), the assumption that mood symptoms are stable at non-premenstrual times has been largely untested.

The cycle-to-cycle variance was relatively low, accounting for only ~1%–6% of the total variance in mood symptoms, whereas individual differences accounted for up to 16% of variance in mood symptoms. Each person's pattern of change in mood was relatively consistent across cycles and could not reliably be compared to other people's patterns of change. Other researchers have similarly found that individual patterns of change across the menstrual cycle are more reliable in predicting significant discrepancies than attempts to fit people to an "average" pattern of change (Kiesner et al., 2016). Thus patients should be encouraged to track their own patterns and to note changes as potentially worth clinical follow-up, but not to try to compare themselves to others (or to an assumed standardized norm).

The *DSM-5* (and other consensus documents on the diagnosis of PMDD) states that at least two cycles are necessary to establish a consistent pattern (American Psychiatric Association, 2013; O'Brien et al., 2011). However, our findings suggest that one cycle is highly predictive of the next. If it is not, this inconsistency itself would be highly unusual. As in previous studies, about 16% of cycles were identified as potentially indicative of Criterion A for PMDD (Freeman, DeRubeis, & Rickels, 1996), but it was rare for patients to have one and only one cycle that met Criterion A within the study's span (Bosman et al., 2016).

It should also be noted that close to one fifth of participants in this nonclinical sample had at least one month of mood patterns indicative of Criterion A of PMDD. That such a sizeable portion of a self-identified "healthy" sample would have patterns of symptoms that mimic those described by the PMDD diagnostic criteria further reinforces the need to consider not only presence of symptoms (or even their cyclicity) but also functional impairment in making a diagnosis. As with all disorders listed in the *DSM-5*, the diagnosis of PMDD requires that the symptoms reported must represent a significant disruption in quality of life. Our findings suggest that the existence of cyclic symptoms such as sadness or fatigue does not intrinsically lead to life disruptions, as none of our participants identified as being notably impaired by their symptoms. It is likely that severity of symptoms moderates the degree to which cyclicity leads to functional impairment; that is, people who have fluctuations in very intense symptoms will be more likely to experience these fluctuations as disabling than people who have the same patterns of change in less severe symptoms. However, given that clinicians often must rely on patients' self-report regarding the degree to which a symptom is disabling, it is also possible that patients' interpretations of the acceptability of such fluctuations may contribute to their ultimate diagnosis (Nash & Chrisler, 1997; Ussher, 2008). As such, it may be worth exploring patients' perceptions of their need for control over their bodies and emotions, and reassuring them that cycle-related changes can be normative in healthy people.

In regard to the mood symptoms measured, there was relatively greater stability in fatigue and nervousness and relatively greater variance in sadness and irritability. Studies of daily mood fluctuations in healthy college students have shown that sadness is more variable and less tied to environmental factors (e.g., daily stressors) than is anxiety (Gunthert et al., 2007). Similarly, although significant variation in fatigue is common among women with chronic pain (Zautra, Fasman, Parish, & Davis, 2007) and women receiving cancer treatments (Schwartz, 2000), among healthy individuals, it is tied primarily to either poor

sleep or acute illness (Akerstedt, Axelsson, Lekander, Orsini, & Kecklund, 2014). Taken together with these previous studies, our findings suggest that changes in sadness may be relatively less reliable as a prognostic indicator than fluctuations in fatigue or anxiety, particularly if those changes cannot be explained by environmental factors.

Although we were able to capture a large sample of daily reports across 2–6 cycles, our study is not without limitations. First, we examined a sample of predominantly White, young, heterosexual women who were not using hormonal contraceptives. Second, we measured symptoms with single-item assessments, which do not allow for robust psychometric testing. Much more work is needed to replicate these effects in more diverse samples of people who menstruate with stronger measurement tools. As this was a secondary analysis, we had to use the items available, which did not include a complete assessment of all possible PMDD symptoms (e.g., changes in food cravings, difficulty concentrating). Similarly, although the survey asked participants the degree to which different symptoms bothered them, it did not assess why these symptoms were distressing. It is possible that certain symptoms (such as fatigue) may be more disruptive to daily functioning than others (such as sadness), and thus people who menstruate pay more attention to their fluctuations. It is also possible that certain symptoms (such as negative mood) may carry a deeper meaning, particularly for people who experience these symptoms as PMDD. Prior research has suggested that women who report experiencing PMS/PMDD are more likely to interpret mood changes as a threat to self-control (Chrisler et al., 2014), or the expression of negative mood as unfeminine and thus incongruent with the “normal” (presumptively feminine) self (Ussher, 2003).

Finally, we did not measure hormones directly. Even though reproductive hormones do follow an infradian rhythm in people who menstruate, there is considerable variability from cycle to cycle; moreover, the amplitude of hormonal variations does not always correspond to the degree of behavioral or emotional changes across a cycle (Hamilton, Parry, & Blumenthal, 1988; Harvey et al., 2009). Hormonal measures are necessary to have complete confidence in the assessment of menstrual cycle phase, as well as the reproductively relevant events therein (e.g., ovulation). If we are to make sense of how an ostensibly hormonal cycle could influence mood or cognition, we must tie these analyses back to the hormones in question.

Nevertheless, our data do suggest that there is significant variability in mood across the menstrual cycle even in healthy young women and that there are consistent patterns across cycles within individuals. As the use of mobile apps to track menstrual symptoms (and these apps’ computational capacity) increases, it is becoming increasingly possible to track and evaluate complex patterns of variance. Assessments that examine patients’ individualized mood patterns—rather than attempts to examine deviations from a presumptive norm—may prove to be a very powerful tool in identifying patients at risk of reproductive mood disorders.

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Figure 1.
Variation in sadness at the day level for each individual, within a single cycle.

Figure 2.
Variation in fatigue at the day level for each individual, within a single cycle.

Table 1

Descriptive statistics and zero-order correlations.

Variable	Mean	SD	1	2	3	4
1. Nervousness	0.09	0.22	–			
2. Sadness	0.11	0.28	.16**	–		
3. Irritability	0.09	0.27	.13**	.24**	–	
4. Fatigue	0.03	0.15	.14**	.45**	.53**	–

**
 $p < .01$.

Table 2

Variance decomposition for level 1, 2, and 3 variables.

Variable	Variance			Proportion	
	Day (L1)	Cycle (L2)	Individual (L3)	Day b(L1)	Individual (L3)
Nervousness	0.0350	0.0025	0.0070	78.5%	15.8%
Sadness	0.0563	0.0028	0.0093	82.4%	13.6%
Irritability	0.0580	0.0036	0.0043	88.0%	6.5%
Fatigue	0.0161	0.0002	0.0002	97.5%	1.4%

Note. N = 27 women with 2,534 daily assessments.