Original Article

Dreaming furiously? A sleep laboratory study on the dream content of people with Parkinson's disease and with or without rapid eye movement sleep behavior disorder

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ABSTRACT

Objective: Rapid eye movement (REM) sleep behavior disorder (RBD) has been related to altered, action-filled, vivid, and aggressive dream content, but research comparing the possible differences in dreams of Parkinson's disease (PD) patients with and without RBD is scarce. The dream content of PD patients with and without RBD was analyzed with specific focus on action-filledness, vividness, emotional valence, and threats.
Methods: A total of 69 REM and NREM dream reports were collected in the sleep laboratory, 37 from nine PD patients with RBD and 32 from six PD patients without RBD. A content analysis of (1) action-filledness (actions and environmental events); (2) vividness (emotions and cognitive activity); (3) intensity of actions, events and emotions; (4) emotional valence, and (5) threatening events was performed on the transcripts.
Results: Altogether 563 dream elements expressing action-filledness and vividness were found. There were no significant between-group differences in the number or distribution of elements reflecting action-filledness or vividness, emotional valence or threats. In within-group analyses, PD patients with RBD had significantly more negative compared to positive dreams ($p = 0.012$) and compared to PD patients without RBD, a tendency to have more intense actions in their dreams ($p = 0.066$).
Conclusions: Based on the results of this study, there are no major between-group differences in the action-filledness, vividness, or threat content of dreams of PD patients with and without RBD. However, within-group analyses revealed that dreams were more often negatively than positively toned in PD patients with RBD.

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1. Introduction

Parkinson's disease (PD) is a progressive neurodegenerative disease. Approximately 30–50% of people with PD also suffer from rapid eye movement (REM) sleep behavior disorder (RBD) or REM sleep without atonia (RWA) [1–4]. Rapid eye movement sleep behavior disorder is characterized by loss of muscle tone during rapid eye movement (REM) sleep, leading to motor activity and dream enactment behaviors (DEB) [5,6].

According to previous studies, dream contents are abnormal in both PD [7] and RBD [8,9]. In particular, retrospective patient reports [6,10] and questionnaire studies [9,11] have suggested that dreams of RBD patients are more action-filled, vivid, and aggressive. However,

when dream content is systematically sampled with home dream diaries or laboratory awakenings, the conclusion becomes less clear.

In the very first home dream diary study on RBD patients' dreams [9], it was found that the dreams of patients with PD and RBD had more aggressive content than the dreams of those with PD without RBD. The RBD patients in this study, however, were not diagnosed with polysomnographic recordings according to the International Classification of Sleep Disorders - Second Edition (ICSD-2) [8] criteria. In contrast, a more-recent home dream diary study [12] indicated that there is no evidence of heightened aggressiveness in idiopathic RBD patients' dreams compared to dreams reported by healthy controls. Further, in this study, nine out of the 12 idiopathic RBD (iRBD) patients were medicated with clonazepam, and clonazepam intake has been linked to vivid and intensive dreams [13]. Thus, if dreaming is more vivid and intense in people with RBD, and clonazepam may further amplify these dream features, a difference between the dreams of iRBD patients and healthy controls, if it exists, would probably become more pronounced.

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Polysomnographic (PSG) studies on dreams of people with RBD are scarce [14]. In a very recent study [15], retrospectively recalled dream content was compared to dreams recalled in morning awakenings in a laboratory, and it was noticed that when people with RBD were asked to report any dreams that they recalled over their entire lifespan, these dreams contained more aggression content than those recalled in the sleep laboratory; this was most likely due to memory bias. As the aim of the particular study was to compare mentation related to behaviors in both sleepwalkers and people with RBD, the participants were only woken up when behaviors occurred, or in the morning; this resulted in only nine dreams from the people with RBD. Thus, although memory bias for retrospectively recalled dreams seems to be the most likely explanation for their findings, the laboratory dream sample was extremely small for definitive conclusions.

To conclude, research that systematically collects and analyzes the dream content of people with PD with and without RBD in a sleep laboratory setting is scarce, although at least one laboratory study exists on the dreams of people with PD [16]. In the present sleep laboratory study, the main objective was to test whether people with PD and RBD have more action-filledness and vividness in their dream reports than those without RBD. Whether people with PD and RBD have more aggression, negatively valenced emotions and threats in their dream reports than those with PD without RBD was also studied.

2. Methods

2.1. Participants

Twenty-four people with PD were enrolled into the present study. They were recruited by neurologists from the Innsbruck University Hospital's Clinical Department of Neurology to participate in a sleep laboratory research on dreaming in people with PD. All were monitored with video PSG for one night before inclusion to the study. Exclusion criteria were those with: a Mini Mental State Examination (MMSE) <24 points; only subclinical RWA who did not meet history or video criteria for RBD ($n = 1$); psychiatric symptoms ($n = 1$); advanced Parkinson-related hallucinations ($n = 2$); and no dreams being recalled during the research ($n = 2$). One of the patients who recalled no dreams had PD only, and the other had PD with RBD. Dream recall frequency was not an inclusion criterion as such, but only patients that recalled at least one dream during the experimental nights were included in the study. In addition, three withdrew from the study prior to its conclusion. The remaining 15 patients had a mean age of 62 years (Table 1) and consisted of 11 men (mean age 60.5, SD 10.75, range 45–76 years) and four women (mean age 67.5, SD 3.51, range 64–71 years).

The participants were divided into two groups: one comprising PD with RBD ($n = 9$; seven males, two females) and the other PD without RBD ($n = 6$; four males, two females). Of the nine participants with PD and RBD, six participated simultaneously in another study investigating the relationship between dream content and observed behaviors during REM sleep [14]. All but one participant (RBD group) were receiving dopaminergic treatment, and four participants in both groups were taking dopamine agonists (cabergoline, pergolide, pramipexole,

ropinirole, rotigotine). Catechol O-methyltransferase (COMT) inhibitors were prescribed to three participants with PD and RBD and to one with PD without RBD. Amantadine was prescribed to three participants in the RBD group and to two in the PD without RBD group. None of the participants with PD without RBD, but five with PD and RBD were prescribed hypnotics (zolpidem) and/or antipsychotics (quetiapine) in small doses, and two in the PD with RBD group had antidepressants. None of them used beta-blockers, which are known to induce nightmares in some users. The two groups did not differ from each other in relation to age, disease duration, years from diagnosis, or L-Dopa dose per day ($p > 0.05$) (Table 1). The Ethics Committee of Innsbruck Medical University approved the study, and the participants' written informed consent was obtained according to the Declaration of Helsinki.

2.2. Procedure

2.2.1. Interview

A brief, semi-structured interview addressing self-perceived changes in dream recall and nightmare frequency, as well as changes in dream and nightmare content since the onset of PD, was conducted before the first experimental night. The participants were asked whether they had noticed that their dream recall or nightmare frequency had increased or decreased since the onset of Parkinson's symptoms, whether they had not observed any change, or whether they did not typically remember or pay attention to their dreams and nightmares enough to answer the question. Similarly, the participants were asked whether they had noticed an increase or decrease in vividness or change in the emotional valence of their dreams and nightmares, whether they had not observed any change, or whether they did not remember their dreams and nightmares to the extent that they could assess whether any change had taken place.

2.2.2. Dream report acquisition in the sleep laboratory

The participants underwent video-polysomnographic recording in the sleep laboratory for two ($n = 7$) or three nights ($n = 8$). The first night was a diagnostic night for some of the participants who were suspected as having RBD but who had not been previously diagnosed (if the diagnosis was verified, they were enrolled to the study) and/or an adaptation night for those who were unfamiliar with the sleep laboratory setting. The adaptation night was omitted for those who had previously been monitored in a laboratory setting and/or whose RBD diagnosis had been previously confirmed. Two trained professionals scored the sleep stages according to standard criteria [17], with allowance for RBD-related muscle tone variation in REM sleep scoring [18].

Prior to the investigation, the participants were given oral and written instructions on how to report dreams in as much detail as possible. During the experimental nights, the participants were awoken from the third, fourth, and the following REM sleep stages, 10 min after the onset of the stage, and twice from the non-REM (NREM) sleep stage N2, once during the first half and once during the second half of the night. In addition, the participants with RBD were always awoken when typical RBD behaviors appeared (including the adaptation night). Of note, the behaviors were allowed

Table 1
Age, disease duration, years with diagnosis and mean L-Dopa dose in participants with Parkinson's disease with and without RBD.

	PD with RBD ($n = 9$) M (SD, range)	PD without RBD ($n = 6$) M (SD, range)	Total ($n = 15$) M (SD, range)
Age/years	61.2 (9.86, 45–76)	64.0 (10.32, 45–74)	62.3 (9.77, 45–76)
Disease duration	8.0 (6.10, 1–21)	13.5 (7.12, 7–26)	10.2 (6.87, 1–26)
Years with diagnosis	6.4 (6.01, 1–20)	9.7 (3.33, 5–13)	7.3 (5.22, 0–20)
Levodopa equivalent dose mg/day	527.8 (317.32, 0–1000)	800.0 (517.69, 300–1800)	636.7 (415.10, 0–1800)

There were no significant differences between groups ($p > 0.05$).

to evolve for as long as possible (up to the 10 min deadline). The aim was to wake the participants exactly 10 min after the onset of the REM sleep stage, but due to spontaneous arousals, the mean REM sleep duration prior to awakenings was slightly less than 10 min (mean 8 min 8 s, SD 7 min 43 s; no between-group differences $p > 0.05$) (Table 3).

After forced and spontaneous awakenings the participants were asked to immediately report the dreams that they recalled. In addition to the free recall report, questions were asked regarding characters, settings, actions, and emotions in the dream if any of these elements was not spontaneously reported. The dream reports were collected and recorded in German, which was the participants' native language. A research assistant (IM) and the principal researcher (KV) translated the reports into English and a third party then reviewed the translations (BF).

2.2.3. Dream report analysis

The data consisted of systematically collected and randomized dream reports from 15 participants. The English translations of the reports were used in the analyses of the data. First, dream report length was assessed according to the Total Word Frequency (TWF) method [19]. In this method, repetition is ignored, and non-words (hmm, mmm) and asides (clarifying the relationship between dream features and waking life) produced by the participants are not included. Then, the dreams were content analyzed with the focus on: (1) action-filledness; (2) vividness; (3) intensity of actions, events and emotions; (4) emotional valence; and (5) threatening events.

Although the concepts action filled and vivid have often been used to describe the assumed RBD-related changes in dream content, these concepts have not been previously precisely defined. To allow for detailed content analysis, action-filledness was defined as the number of: (1) any dream characters' outwardly expressed and, thus, observable activity; and (2) environmental events caused either by natural forces or by unspecified agents. Vividness was defined as the activity taking place within the mind of the dream characters, which refers to: (1) cognition and (2) specific emotions. The intensity of an action, an event or an emotion was quantified with a three-point Likert scale (low, moderate, intense), while the intensity of thoughts could not be coded. Dream reports were further categorized by emotional valence into positive, negative, balanced, or non-emotional dreams.

The threatening events in dreams were identified and categorized by using the Dream Threat Scale (DTS) [20]. A threat refers to an event in a dream where, if the event were real, the physical or mental well being of any person would be endangered or where any person's physical resources or territory would be jeopardized. The nature of threat, the target of threat, the severity of threat, the participation and reaction of the dream self, and the realism of the threat were coded. The definitions and the coding scales are described in more detail in Table 2. Dream and content coding examples can be found in the Appendix.

2.2.4. Interrater agreement

Two independent judges, who were blind to whether the reports originated from people with PD and with or without RBD and from REM or NREM sleep, assessed the action-filledness, vividness, intensity, and emotional tone of the dreams; three judges were used to assess the threat content. Cases that were initially identified by only one rater were resolved through discussion, and discussed elements were either discarded from or included in the analyses.

Two independent judges identified a total of 611 dream elements that expressed action-filledness and vividness. Of these, 563 dream elements (92.1%) were accepted for further analysis. The elements describing action-filledness were further categorized into actions ($n = 294$) and environmental events ($n = 42$), and the interrater agreement was 90.4% for actions, and 65.9% for environmental events.

Vividness included cognition ($n = 168$) and emotions ($n = 59$), and the respective agreement percentages between raters were 71.8% and 85.7%. Actions, environmental events, and emotions were also coded for intensity with a three-point Likert scale, with an interrater agreement of 92.0%. The intensity of cognitive processes could not be coded for. Further, the dream narratives were categorized based on their emotional valence into four different categories: (1) predominantly positive dreams, (2) predominantly negative dreams, (3) balanced dreams, and (4) non-emotional dreams without emotional content. The agreement between raters for emotional valence was 94.3%.

Three blinded judges identified and categorized the threatening events in the dream transcripts. A total of 36 threatening events were identified, and the judges agreed on 32 (88.9%), which were further analyzed, while four (11.1%) were omitted. The mean identification interrater agreement between the three judges was 88.9%. The agreement percentages in coding the events into specific threat categories were: the nature of threat (79.1%), target of threat (88.5%), severity of threat (62.5%), participation and reaction of dream self (80.2%), and realism of threat (78.1%).

2.3. Statistical analysis

The statistical analyses were performed with IBM SPSS version 21.0. Non-parametric tests were used due to violation of normal distribution assumption, and small sample size. The between-group differences in age, disease duration, years from diagnosis, L-Dopa dose per day, number of awakenings (REM/NREM, spontaneous/forced), number of dreams (from REM/NREM and spontaneous/forced awakenings) and their length, and recall percentage from REM/NREM were tested with Mann–Whitney U test (U), which can be used as a non-parametric equivalent to the independent samples t-test. The between-group differences in the self-reported changes in dream recall, nightmare frequency and content were analyzed with Fisher's exact test suitable for small data. The between-group differences in the nominally scaled dream content variables were first analyzed with Pearson's Chi-squared (χ^2) test (Fisher's exact (F) test for threat content) by using dream content raw scores. Then, to control for unequal contribution of data by different participants (some reported many dreams which included plenty of elements, while others reported few dreams with less elements), the between-group comparisons were repeated with Mann–Whitney U test by using averaged dream content scores. The averaged scores were calculated by dividing the number of specific elements, such as actions in the participant's dreams, by the number of dreams reported by the participant. Within-group comparisons, such as the ratio of positive and negative dreams, were conducted with Related Samples Wilcoxon Signed Rank (Z) test.

3. Results

3.1. Dream recall in people with PD and with or without RBD

Based on the interviews, the self-estimated changes in dream recall frequency did not differ between groups ($p > 0.05$). In the interview, 46.7% of participants reported that after the onset of PD they recalled fewer dreams, 26.7% said that they recalled more dreams, 20.0% had not noticed any change, and one could not give an estimate. In contrast, the groups differed in self-assessed changes in nightmare frequency ($n = 15$, $F = 10.36$, $p = 0.008$). Of the nine participants with PD and RBD, six approximated that the frequency of nightmares had increased since the onset of PD, while those with PD without RBD said that they had either not observed any change or did not have nightmares at all; none reported an increase in nightmares.

Table 2
Dream content analysis: definitions and content categories and subcategories.

Definition of action-filledness: all observable activities and events in the dream report. Includes:
(1) Outwardly expressed activity: all voluntary physical movement of the body or body part (eg, walking, running, reaching) or any expressive communication (talking, shouting, crying) of any dream character.
(2) Environmental events: events that indicate activity of an agent (eg, car is moving, the bus stopped) or events that occur without the control of any dream character, for example, are caused by natural forces (building is falling, boat is turning up side down).
Definition of vividness: all activities taking place within the mind of the dream self or any other dream character. Includes:
(1) Cognition: all non-emotional mental information processing such as thinking, wondering, forgetting, remembering, attention, and learning.
(2) Emotions: all positive or negative mental experiences, such as feeling fear, joy, and happiness.
Definition of intensity: used for scoring the intensity of actions, environmental events and emotions:
(1) Low: no physical exertion (talking, sitting), or low physiological arousal in conjunction with emotion.
(2) Moderate: increased physical effort (jogging, crying), or moderate physiological arousal in conjunction with emotion.
(3) Intense: strong physical exertion (running, shouting), or strong physiological arousal in conjunction with emotion.

Category	Action-filledness	Vividness	Intensity	Emotional valence[b]
Subcategory	1. Outwardly expressed activity 2. Environmental events	1. Cognition[a] 2. Specific emotions	1. Low 2. Moderate 3. Intense	1. Positive 2. Negative 3. Balanced 4. Non-emotional

Definition of threatening event: Event in a dream in which the dream self or any other dream character is threatened physically or mentally, or the dream self subjectively experiences being threatened.

Category	I. Nature of threat	II. Target of threat	III. Severity of threat	IV. Participation of dream self	V. Realism of threat
Subcategory	1. Escapes and pursuits 2. Accidents and misfortunes 3. Failures 4. Catastrophes 5. Illnesses 6.1 Verbal aggression 6.2 Threat of physical aggression 6.3 Direct physical aggression 7. Cannot be scored	1. Self 2. Significant others 3. Territory 4. Significant resources 5. Non-significant others 6. Non-significant resources	1. Life-threatening 2. Social, psychological or financial 3. Physical 4. Minor	1. Possibility to react, appropriate reaction 2. Possibility to react, but no reaction 3. No possibility to react 4. Cannot be scored	1. Realistic 2. Realistic but improbable 3. Fictitious 4. Cannot be scored

[a] The intensity of cognition could not be assessed.
[b] Emotional valence was coded for the whole dream report.

Table 3
Distribution of awakenings in people with Parkinson's disease with and without RBD.

	PD with RBD (n = 9) N (M, SD, range)	PD without RBD (n = 6) N (M, SD, range)	Total (n = 15) N (M, SD, range)
Awakenings	81 (9.00, 2.45, 6–14)	49 (8.33, 2.50, 6–12)	130 (8.73, 2.40, 6–14)
REM awakenings	52 (5.78, 2.39, 1–9)	30 (5.50, 2.26, 2–9)	82 (5.67, 2.26, 1–9)
NREM awakenings	29 (3.22, 1.56, 1–5)	19 (3.00, 2.19, 1–7)	48 (3.13, 1.77, 1–7)
Spontaneous	30 (3.44, 2.13, 0–6)	22 (3.67, 2.25, 1–6)	52 (3.53, 2.10, 0–6)
Forced	51 (5.56, 2.79, 2–10)	27 (4.67, 2.07, 1–7)	78 (5.20, 2.48, 1–10)
Time from onset of REM stage (min)	7.89 (7.32, 0–30)	8.56 (8.41, 0–42)	8.14 (7.72, 0–42)
Dreams[a]	37 (4.11, 2.57, 1–7)	32 (5.33, 2.66, 1–9)	69 (4.60, 2.59, 1–9)
REM dreams	30[b] (3.33, 2.45, 0–7)	23 (3.83, 2.71, 1–8)	53 (3.53, 2.48, 0–8)
NREM dreams	7 (0.78, 0.83, 0–2)	9 (1.50, 1.52, 0–4)	16 (1.07, 1.16, 0–4)

There were no significant differences between groups.
[a] Recall from REM stage was higher than from NREM stage.
[b] Of these dreams, 17 were also included in another study [14].

A total of 130 awakenings were performed, and of these awakenings, 82 were performed from REM, and 48 from NREM N2 sleep. On average, 3.7 awakenings per night per participant (SD 1.14, range 2–7) were conducted (Table 3). There were no significant differences between groups in the total number of awakenings, awakenings from REM or NREM sleep, or awakenings per night. The participants with RBD were awakened from REM sleep (or spontaneously aroused), 36 times (out of 52) in conjunction with behaviors, and dreams were recalled in 23 of these awakenings. The behavior was allowed to unfold for as long as possible before the awakening, and the majority of the behaviors were minor, consisting of stereotypical twitching, jerking, jaw movements, and vocalizations. Complex behaviors, typically leading to spontaneous arousal, were quite infrequent. Although participants with RBD were awakened or might have spontaneously aroused when behaviors occurred during REM sleep, the length of REM sleep before awakenings was not significantly different between the groups (Table 3).

In total, 69 dreams were acquired, 37 from participants with PD and RBD, and 32 from participants with PD without RBD (Table 3). The majority of the reports was obtained from REM sleep awakenings (n = 53). The mean dream recall rate from REM sleep (ie, the number of recalled dreams divided by the number of awakenings from REM sleep) was 68.3% (SD 37.46, range 0–100). The NREM sleep recall rate was 34.8% (SD 34.71, range 0–100). Thus, for both groups, dream recall was better from REM than NREM sleep awakenings ($Z = 13.0$, $p = 0.023$), but there were no significant between-group differences in recalling dreams from REM or NREM stages ($p > 0.05$). The number of spontaneous and forced awakenings did not differ between groups ($p > 0.05$), and dream recall was equally frequent after spontaneous (50%) and forced awakenings (55%) in both groups ($p > 0.05$).

Dream report length, calculated from the English transcripts, ranged from 23 to 376 words (mean 122 words, SD 91.40). The NREM dream reports (mean 101.93, SD 87.94, range 26–379) were not

significantly shorter than REM dream reports (mean 127.89, SD 79.43, range 27–368) ($p > 0.05$). There were no significant between-group differences in the length of dream reports ($p > 0.05$).

3.2. Dream content analysis

3.2.1. Interview
In the interview, five of the nine participants with PD and RBD (55.6%) indicated that both their dream content in general and also their nightmares had become more vivid and more negatively toned. In contrast, only one participant with PD without RBD reported increased negative dreaming (but not more vivid or negative nightmares), and the rest had not observed any changes. The between-group differences, however, were not significant ($p > 0.05$).

3.2.2. Nature and intensity of action-filledness and vividness
In the 69 dreams, there were no significant between-group differences in the total number of elements categorized as action-filledness (actions and environmental events) or vividness (cognition and specific emotions) ($n = 297$ for PD with RBD; $n = 266$ PD without RBD) ($p > 0.05$) (Table 4). These results replicated when averaged scores (number of elements divided by the number of dreams per participant) were used instead of raw scores. Regarding action-filledness, in both groups, outwardly expressed action elements were more prevalent than environmental events. Similarly, in the vividness category, elements describing cognitive activity outnumbered specific emotions in both groups (Table 4).

The intensity of actions, environmental events, and specific emotions was further assessed with a three-point Likert scale (low–moderate–intense), while the intensity of cognitive activity could not be evaluated. Low intensity was conceptualized as no physical exertion or arousal (such as talking, walking, or smiling), moderate as increased physical effort or arousal (such as jogging or crying), and intense as strong physical exertion or arousal (such as running or shouting). The intensity of the elements describing

Table 4
Number of action-filledness and vividness elements, and threatening events in dream reports (n = 69) of participants with Parkinson's disease with and without RBD.

	PD with RBD n (M, SD, range)	PD without RBD n (M, SD, range)	Total n (M, SD, range)
Action-filledness	171 (19.00, 13.20, 3–39)	165 (27.67, 22.87, 3–62)	336 (22.47, 17.48, 3–62)
Actions	151 (16.78, 12.30, 1–34)	143 (23.83, 20.76, 3–58)	294 (19.60, 15.91, 1–58)
Environmental events	20 (2.2, 1.48, 1–5)	22 (3.67, 3.27, 0–8)	42 (2.80, 2.37, 0–8)
Vividness	126 (14.00, 13.51, 0–34)	101 (16.83, 14.84, 1–42)	227 (15.13, 13.60, 0–42)
Cognition	94 (10.44, 9.79, 0–25)	74 (12.33, 11.96, 0–34)	168 (11.20, 10.33, 0–34)
Emotions	32 (3.56, 4.13, 0–12)	27 (4.50, 3.45, 1–9)	59 (3.93, 3.77, 0–12)
Threatening events	18 (2.00, 1.58, 0–5)	14 (2.33, 2.42, 0–7)	32 (2.13, 1.89, 0–7)
REM threats	16 (1.89, 1.76, 0–5)	11 (1.83, 2.56, 0–7)	27 (1.87, 2.03, 0–7)
NREM threats	2 (0.22, 0.44, 0–1)	3 (0.50, 0.55, 0–1)	5 (0.33, 0.49, 0–1)

There were no significant differences between groups.

action-filledness (actions and environmental events) and vividness (emotions) was most often evaluated as low (59.2%, $n = 234$), then as moderate (25.3%, $n = 100$), and least often as intense (15.4%, $n = 61$).

When identifying the intensity differences between the PD with RBD and PD without RBD groups with the three-point scale, a statistically significant difference was observed in actions when raw scores were used (total number of intense actions in both groups). The participants with PD and RBD dream reports contained a greater proportion of intense actions, compared to the actions in the dreams of participants with PD without RBD (15.2% vs 5.6%) ($\chi^2 = (2, n = 294) = 7.396, p = 0.025$). However, the significance disappeared ($U = 11.0, p = 0.066$) when averaged participant scores were compared across groups (intense actions divided by all actions per participant). There were no between-group differences in the intensity of environmental events or specific emotions ($p > 0.05$) whether computed from raw or averaged scores.

Based on their overall emotional valence, the dream reports were classified as predominantly positive, predominantly negative, balanced or non-emotional. In both groups, dreams with negative emotional tone were more often reported (PD with RBD 43.2%; PD without RBD 40.6%) than positive (PD with RBD 13.5%; PD without RBD 28.1%) or balanced dreams (PD with RBD 16.2%; PD without RBD 12.5%), or dreams lacking emotional valence (PD with RBD 27.1%; PD without RBD 18.8%). There were no between-group differences in the distribution of emotional valence of dream reports ($p > 0.05$). However, within-group analyses revealed that participants with PD and RBD had significantly more negative than positive dreams ($Z = 36.0, p = 0.012$), while the difference was not significant in the PD without RBD group ($p > 0.05$).

3.2.3. Threatening events and their quality

The participants reported, on average, 4.6 dreams, and had, on average, 0.46 threatening events per dream (Table 4). Thus, less than every other dream contained a threatening event. The between-group differences in the number of threatening events were not statistically significant, whether calculated from raw or averaged scores ($p > 0.05$). Dreams reported from REM stage did not include more threats than dreams reported from NREM stage ($p > 0.05$).

The threat was categorized as a failure to achieve a set goal in 37.5%, as an aggression in 25.0%, an accident in 15.6%, an illness in 15.6%, a catastrophe in 3.1% of the cases, and one event could not be categorized. The target of threat was the dreamer himself in 71.9% of the cases, a significant other in 18.6%, significant resources in 18.6%, a non-significant other in 15.6%, non-significant resources in 9.4%, and in one case, it was territory of the dream self (note that a single threat can have several targets, thus percentages do not add up to 100%). The severity of threat: was minor in 50.0% of events; endangered the dream self's social, psychological or financial well being in 28.1%; was life-threatening in 15.5%; and threatened the physical well-being of the dream self in 6.3% of the cases. In 65.6% of the cases, the dream self participated and reacted to the threat in a reasonable and appropriate manner, while in 34.4% of the cases the reaction could not be scored due to interruption of the dream situation. The nature of the threat was realistic in 78.1% of the cases and realistic but improbable in 21.9% of the cases, while no fictional threats were observed. There were no between-group differences in any of the threat content ratings ($p > 0.05$). As the number of threats in the sample was low, the results need to be interpreted with caution.

4. Discussion

Although in questionnaire and interview studies [6,9,11] where dream content is assessed retrospectively, as well as in one dream diary study with systematically collected dreams [9], the participants with PD and RBD reported altered dreaming, the content analysis of dream reports of participants with PD with and without RBD collected with systematic laboratory awakenings showed no major differences in action-filledness (actions, environmental events), vividness (cognition, emotions), and threat content (including aggression). The only statistically significant between-group differences found in the present study were that participants with PD and RBD retrospectively estimated that their nightmare frequency had increased since the onset of PD symptoms, and that there was a tendency for a slightly higher number of intense actions in the PD with RBD dream reports. However, this result was not confirmed when the number of dreams reported by each participant was controlled for.

Further, there were no between-group differences in the self-estimated increase in the vividness or negativity of dream content, and the content analysis did not reveal any between-group differences in the number or intensity of emotions in the dream reports of participants with PD and with or without RBD. However, the participants with PD and RBD retrospectively estimated that their nightmare frequency had increased, and when the overall emotional valence of the whole dream report was assessed by external judges, within-group analyses indicated that negative dreams were significantly more often than positive dreams reported in the PD with RBD group, whereas the ratio of negative to positive dreams was balanced in the PD without RBD group. Regardless, the distribution of negative, positive, balanced, and non-emotional dreams did not differ between groups. Hence, the claim that people with PD and RBD would have more action-filled, vivid, threatening, emotionally negative, and aggressive dreams than those with PD without RBD was not supported by this study.

These findings are consistent with the findings of Bugalho and Paiva [7] and D'Agostino et al. [12] who conducted systematic dream report collection at home and found that there were no major differences in PD with RBD and PD without RBD dream contents [7] or iRBD patients' dream contents compared to healthy controls [12]. The violent content detected in previous dream diary [9] or interview/questionnaire studies [6,9,11] could thus not be verified on the basis of this study. In healthy individuals, however, aggression and pursuit situations have been found to be more abundant in dreams collected at home with a diary compared to sleep laboratory awakenings [21,22]. This could explain the lesser amount of aggression and number of pursuits in the present study compared to norms [23] in both of the studied groups.

Nevertheless, the fact that people with RBD estimate that their nightmares have become more frequent, that negatively toned dreams seem to prevail over positively valenced dreams in people with RBD when systematically sampled, and that the dreamed actions may have the tendency to be more intense in those with RBD than without RBD indicates that reports of dream alterations should be taken seriously. It may well be that the extent of dream alterations correlates with the severity of RBD symptoms and, thus, dream alterations are most pronounced in individuals with advanced RBD. Further, as people with RBD seem to have the tendency to act out their most intense dreams, and maybe negative dreams are more likely to be acted out than positive dreams [14], the acted out dreams are the ones most likely to be remembered afterwards. The retrospective memory bias for intense and aggressive dreams may thus reflect these infrequent tip-of-the-iceberg dreams (and not be a bias after all), although the majority of dreams of people with RBD are not altered in any way.

4.1. Methodological strengths and limitations of the study

A major strength of the present study is that instead of basing the conclusions on anecdotal or retrospective dream reports, systematic REM and NREM sleep awakenings were performed and the participants' dreams were collected in a controlled laboratory setting. In this setting, a representative sample of dreams from different sleep

stages and at different times of night can be acquired. Dream recall is highly dependent on the temporal relation between dreaming and the request to report the dream, and the only reliable method to obtain dreams as soon after an awakening as possible is the sampling method applied in this study. Assuming that the participants reported all their dreams without censorship, the dream reports that were collected reflect various dream contents of PD patients with and without RBD during two nights, in different sleep stages and at different times of night.

The number of participants in the study was lower than expected, as many recruited participants had to be excluded, and therefore the number of dreams in the sample was relatively small. While the number of elements reflecting action-filledness and vividness was adequate, yielding statistical power, the number of threatening events in the data was low. Therefore, the data do not allow any firm conclusions concerning the threatening events in the dreams of the people with RBD. Also, due to small sample size, it was impossible to study gender differences in the dream content of the different groups. Further, the data were unevenly distributed between participants so that some recalled more dreams and, thus, the dream data from these participants were overrepresented in the group results. Although the data were quite equally distributed between the groups, computing the results using averaged scores as well as raw scores was used to control the unequal contribution of data. In dream studies in general, and especially when the sample size is small, a single prolific dreamer whose dream data are overrepresented can have a major impact on the results. If the prolific dreamer's dream content is highly different from the dreams of the other participants, the results may be heavily biased. Thus, controlling for the number of dreams per participant, and for the length of dreams, if possible, is advisable

Another strength of the present study is that, for the first time, exact definitions for action-filledness and vividness were provided, which are concepts that have repeatedly been used in describing the dreams of people with RBD. There was a high reliability in detecting elements describing action-filledness, vividness, and threats. With the content analysis method used, the independent judges could predominantly find the same content in the data. Dream content was scored by two or three external judges, not by the dreamers themselves, which can be seen as both a strength and a limitation. The use of external judges, as opposed to dreamers, guarantees that all dreams are coded in exactly the same manner. External raters can, however, only code explicitly expressed content, while dreamers, in contrast, may have implicit knowledge that is inaccessible to raters. For example, external judges and dreamers seem to have a slightly different impression of the emotional valence of dreams, as external raters judge the dreams to be more negative than the dreamers themselves [24].

Due to the lack of a control group of healthy participants, the degree to how much the dream content of people with PD with or without concomitant RBD differs from those of age-matched healthy controls could not be determined. It might be that altered dream content is an early symptom of PD and may occur independently of RBD symptoms [7], or that with concomitant RBD (and especially with increased severity of symptoms) the dreams become more negative and more intense, as indicated by retrospective patient reports. Also, the influence of dopaminergic medication on dream content cannot be ruled out, as the majority of the participants were receiving dopaminergic treatment. Further, it remains to be

investigated whether the dreams of idiopathic RBD patients are different from those of healthy controls when dreams are systematically sampled in a laboratory setting. The home dream diary study by D'Agostino et al. [12] suggested that such a difference does not exist, a finding that is compatible with the present results on the dreams of people with PD and with or without RBD. Research directly comparing action-filledness, vividness, emotional valence, and threat content of dreams in healthy aged controls, idiopathic RBD patients, and other α-synucleinopathy patients with and without RBD is needed. Research on the effect of disease duration and severity of symptoms on RBD and PD patients' dream contents is also warranted.

5. Conclusions

Based on the findings of this laboratory study and detailed content analysis, the dreams of people with PD and RBD are not more action-filled, vivid, or emotionally negative than the dreams of people with PD without RBD. However, in the interview the PD patients with RBD retrospectively reported an increase in nightmares since the onset of PD, and in within-group comparisons the PD patients with RBD had more negatively than positively toned dreams while the ratio was balanced in the PD without RBD group. Due to a small sample size, the data do not allow for any firm conclusions concerning the possible differences in the quantity or quality of threatening events and aggression in the dreams of people with PD and with or without RBD.

Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: http://dx.doi.org/10.1016/j.sleep.2014.10.014.

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Appendix: Dream and content analysis examples

Several illustrative dreams reported by the participants with PD and with or without RBD, and examples of the content analysis methods used in the study, are presented in this Appendix (Table A5). Note that only relatively short dreams have been selected as examples.

The dreams can be found in the left column. The identified elements are marked with italics and numbered consecutively. The category the element was assigned to and the intensity of the element can be found in columns 2 and 3, respectively. The overall emotional tone ratings are presented in column 4. If the dream included a threatening event, the identified threat is marked to the dream report with an underline. The detailed threat rating is shown in the last column.

Table A5 Illustrative dream and content analysis examples.

Dream	Element category	Intensity	Overall emotional valence	Threat coding
Dream 1. Participant with PD and RBD: Something big, something big happened			Negative	Nature: accident Target: self, non-significant strangers and resources Severity: physically severe Participation: no participation, appropriate reaction Realism: realistic but improbable
1) *A house was falling down.*	Env. event	Intense		
2) *I was afraid, for a moment,* and then I woke up. There were other people, also, but not more than one or two.	Emotion	Intense		
3) *I did not know these people.*	Cognition			
4) *I was astonished, amazed,*	Emotion	Intense		
5) *I screamed,* and then I woke up.	Action	Intense		
Dream 2. Participant with PD and RBD: I dreamt that			Positive	No threat content
1) *We were cooking.* Some friends and me. The food was amazingly good.	Action	Low		
2) *Somebody made peach soufflé.*	Action	Low		
3) *We invited in all the people we saw on the street*, and	Action	Low		
4) *ate it.* There were about seven to eight people. At the beginning	Action	Low		
5) *two people brought me some sugar*, and	Action	Low		
6) *at the end we ran from the stove* with a bowl in our hands, from the kitchen to another room.	Action	Moderate		
7) *I had good emotions*, because	Emotion	Moderate		
8) *I was so looking forward to the meal.*	Cognition			
9) *We did talk about cooking.*	Action	Low		
Dream 3. Participant with PD and RBD:			Non-emotional	No threat content
1) *I was shopping,* there was somebody with me. A woman, and the shopkeeper woman were there.	Action	Low		
2) *They were talking with each other* about women who have lost their shops.	Action	Low		
3) *I bought something* but I don't know what it was anymore. It was a little grocery shop.	Action	Low		
4) *The woman also bought something.*	Action	Low		
Dream 4. Participant with PD without RBD:			Negative	Nature: accident Target: self Severity: life-threatening Participation: yes, appropriate reaction Realism: realistic
1) *I rode a boat* out to the sea. The	Action	Moderate		
2) *boat turned upside down* and	Env. event	Intense		
3) *I nearly drowned.* I don't know if I was alone. I don't know what sea it was. The boat just turned upside down, I don't know why. *I could rescue myself, but I nearly drowned.*	Action	Intense		
Dream 5. Participant with PD without RBD: In the dream			Balanced	No threat content
1) *The children were playing football.* Somewhere where we live. But	Action	Moderate		
2) *I didn't know the children, they were strangers.* I wasn't playing with them, but I think	Cognition			
3) *I kicked the ball back to them.*	Action	Moderate		
4) *One of the children was whining* and	Action	Low		
5) *unhappy, not pleased. She was not content with something.* And	Emotion	Low		
6) *then I said to her*: 'Never mind, you are very good.' Then	Action	Low		
7) *she picked up the ball* and	Action	Low		
8) *went on playing.* And there was a small boy, also. It wasn't a football field where they were playing. It was like a meadow where you can also play football.	Action	Moderate		
Dream 6. Participant with PD without RBD: In my dream we were finished here in the sleep laboratory, and			Non-emotional	No threat content
1) *I had gotten dressed*, and	Action	Low		
2) *everything (the measuring equipment) had been taken away*, only the electrodes were left on. I was still wearing the electrodes. Nobody took the cables off. But I know that	Action	Low		
3) *I thought that everything was done, that everything was ready.*	Cognition			
4) *And my husband had come to pick me up.* He was waiting outside. And I was hungry. And	Action	Low		
5) *somebody told me that I can now go have breakfast.* There was already light, it was morning.	Action	Low		

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