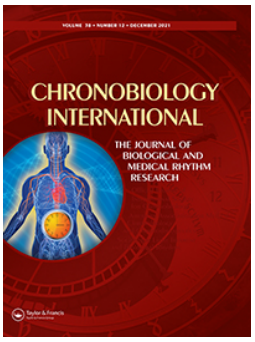

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ORIGINAL ARTICLE

Sleep and psychological characteristics in habitual self-awakeners and forced awakeners

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ABSTRACT

Previous studies described the modifications of physiological and behavioural variables associated with self-awakening, while only few studies assessed subjective sleep quality and psychological characteristics in habitual self-awakeners. Here we investigated self-reported sleep habits and features, as well as psychological variables of habitual self-awakeners and forced-awakeners, with special regard to subjective sleep quality, personality characteristics, anxiety and depression symptoms. In our sample, the prevalence of habitual self-awakeners was 15.1%. Compared to forced-awakeners, habitual self-awakeners showed more regular sleep/wake schedules and were more frequently morning types. Moreover, habitual self-awakeners referred to be more satisfied about their sleep, to wake up more easily in the morning, to need less time to get out of bed and to feel more refreshed upon awakening than forced-awakeners. We also observed an association between the habit of self-awakening and the "ability" to set the awakening to an unusual time. Concerning psychological features, habitual self-awakeners showed higher scores in Conscientiousness and Openness and lower scores in Extraversion compared to forced-awakeners, whereas no differences between groups emerged for anxiety and depression levels. In conclusion, our findings point to an association between the habit of self-awakening and good subjective sleep quality. In this perspective, future research should objectively test in detail the effects of the self-awakening habit on sleep structure and organization, taking into account also microstructural sleep features.

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Self-awakening; sleep habits; sleep quality; personality; anxiety; depression

Introduction

Inter-individual differences in awakening features and mechanisms represent a very important research topic, regarding for instance age-related changes from early development (Ficca et al. 1999; Giganti et al. 2006) to old age (Conte et al. 2014; Salzarulo et al. 1999) and sleep disorders (Roth et al. 2013; Solheim et al. 2018).

A particularly interesting aspect of awakening is the ability to wake up at a desired time in the absence of external devices, i.e., "self-awakening." Individuals who possess this skill are defined "*self-awakeners*" (SAs) in contrast to "*forced awakeners*" (FAs), who, instead, are able to wake up at a pre-determined time only by means of an alarm clock (Moorcroft et al. 1997).

The prevalence of self-awakening habit in the general population appears to vary with age, with older subjects more frequently reporting it (Moorcroft et al. 1997). In the earliest survey (Moorcroft et al. 1997), conducted on a wide age span (21–84 years), 52% of the sample reported to have the habit of self-awakening: specifically, out of the 269 respondents, 23% declared to never use external devices to get up and 29% reported to usually rely on an alarm clock but to consistently wake up before its ringing. Instead, in younger samples, the proportion of SAs appears much more limited, as shown by two questionnaire-based studies (Ikeda and Hayashi 2012; Matsuura et al. 2002). In Matsuura et al. (2002) only 10.3% of a sample of 643 university students referred to habitually self-awaken in daily life. In another longitudinal research (Ikeda and Hayashi 2012), following a sample of 362 15-years old adolescents for five years, the proportion of self-reported SAs decreased from 26% (first year) to 16% (fifth year) and only 5% of the sample maintained the self-awakening habit across the five years.

Several studies have attempted to detect SAs' peculiar psychophysiological characteristics by comparing them with FAs (Ikeda and Hayashi 2012; Matsuura and Hayashi 2009; Matsuura et al. 2002; Moorcroft et al. 1997). Their main findings concern differences in daytime subjective sleepiness and in sleep-wake rhythms. Specifically, SAs report to lower subjective sleepiness

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upon awakening in the morning (Matsuura and Hayashi 2009) and being less likely to doze off during daytime (Matsuura et al. 2002). Moreover, SAs declare to feel better in the morning and to experience greater comfort immediately after awakening (Ikeda and Hayashi 2012; Matsuura et al. 2002). As for sleep-wake rhythms, habitual SAs appear to be more consistent in night-to-night sleep duration (Moorcroft et al. 1997) and to maintain more regular sleep-wake schedules (Ikeda and Hayashi 2012) compared to FAs. Also, significant differences have been observed in chronotypology, with SAs showing higher morningness relative to FAs (Ikeda and Hayashi 2012; Matsuura et al. 2002) at the Morningness-Eveningness Questionnaire (MEQ; Horne and Ostberg 1976).

Finally, SAs have been studied with regard to the changes in psychophysiological variables occurring during the last sleep periods, which are considered a preparation to awakening (Matsuura and Hayashi 2009). In fact, it is well established that a number of physiological and behavioural parameters during sleep gradually modify before spontaneous awakening (see Akerstedt et al. 2002, for a review): for instance, increases in body temperature and motility have been observed. Moreover, an increase in adrenocorticotropin hormone plasma concentration during the last hour of sleep before expected waking time has been reported by Born et al. (1999). Matsuura and Hayashi (2009) studied a sample of SAs in a self-awakening condition (subjects instructed to wake up on their own at a predetermined time, similar to their habitual rise-time) and a forced awakening condition (subjects instructed that they would be woken up by the experimenter). During the last hour of the sleep episode, a greater increase of heart rate and N1 sleep proportion was found in the self-awakening condition compared to the forced awakening one, suggesting that, in SAs, the intention to self-awaken at a certain time activates a preparatory process, which is limited to the pre-awakening period and does not disturb the whole structure of the sleep episode (Matsuura and Hayashi 2009).

Despite their potential relevance in affecting habitual self-awakening, psychological factors peculiar to SAs have been less investigated (Hayashi et al. 2010). High self-regulation in the context of awakening, namely high self-efficacy and independence from external means (Crabb 2003), as well as achievement motivation (Hayashi et al. 2010) have been reported in SAs. Also, in the abovementioned study by Matsuura and Hayashi (2009), SAs showed higher state anxiety at bedtime in the self-awakening relative to the forced awakening condition. Instead, other possible psychological variables involved in the phenomenon of self-awakening (such as subjective sleep quality perception and other trait-like features of SAs) remain to be explored.

Here, we aim to cover this gap by comparing a group of habitual SAs to one of the habitual FAs on a set of self-reported measures regarding both sleep features and psychological factors, with special regard to subjective sleep quality, personality characteristics and anxiety and depression symptoms. By doing so, we will also be able to compare the epidemiological findings on prevalence and characteristics of SAs, collected in USA (Moorcroft et al. 1997) and Japan (Ikeda and Hayashi 2012; Matsuura et al. 2002), with those from an Italian sample.

Materials and methods

Participants and procedure

The study design was preliminary submitted to the Ethical Committee of the Department of Psychology, University of Campania "L. Vanvitelli," which approved the research (code 22/2020) and certified that the involvement of human participants was performed according to acceptable standards.

Two thousand university students were screened through a brief ad hoc questionnaire to collect general demographic data and information on medical condition and health habits. A sample of 1549 subjects (M = 355, F = 1192; mean age = 21.57 ± 4.11) was selected according to the following inclusion criteria: absence of any relevant somatic or psychiatric disorder, regular sleep-wake pattern, absence of sleep disorders; no history of drug or alcohol abuse, limited caffeine (≤150 mg caffeine per day) and alcohol (≤250 mL per day) consumption.

All participants were administered a questionnaire on sleep habits (described in details in the following paragraph) and a further selection was made based on the answers to two questions about awakening habits: a) "*How do you usually wake up in the morning?*" (three alternatives: "*I regularly use external devices*"; "*I sometimes do not use external devices*"; "*I never use external devices*") and b) "*In case you use an alarm clock ...*" (three alternatives to fill the blank: "*I always wake up before the alarm goes off*"; "*I never wake up before the alarm goes off*"; "*I sometimes wake up before the alarm goes off*"). As in previous studies (Ikeda and Hayashi 2012; Matsuura and Hayashi 2009; Moorcroft et al. 1997), participants were classified as habitual SAs if they answered "*I never use external devices*" to the first question and/or "*I always wake up before the alarm goes off*" to the second. Instead, subjects were considered FAs if they answered "*I regularly use* *external devices*" to the first question and "*I never wake up before the alarm goes off*" to the second. Thus, the final sample included in analyses was made up of 234 SAs (M = 79, F = 154; mean age = 23.07 ± 5.82) and 385 FAs (M = 61, F = 324; mean age = 21.01 ± 3.30).

It is worth noting here that the extreme group design (Preacher et al. 2005) we adopted may entail some negative consequences (such as artificially inflated effect size, or non-normal distribution of the variables; Preacher et al. 2005). However, it represents the best cost-effective approach in order to obtain a sufficiently large samples of SAs and one of FAs as pure as possible. Moreover, these limitations are more serious in the case of extreme groups created by dichotomizing a continuous variable (Preacher et al. 2005) rather than by identifying the groups through categorical variables, as done here.

All participants were invited individually at the Sleep Lab where they were administered a set of questionnaires investigating sleep quality, circadian preference, personality dimensions, anxiety and depressive symptoms.

All subjects participated voluntarily and did not receive any payment.

Instruments

Questionnaire about sleep habits

This questionnaire, developed by Zilli et al. (2009), addresses sleep habits and features (both quantitative and qualitative) over the last three weeks.

Quantitative sleep features are assessed through a set of questions on: habitual bedtime and rise time on both weekdays and weekends (*hh:mm*), habitual nap frequency (five alternatives: from "*never*" to "*often*") and duration (*hh:mm*); nocturnal awakening frequency (five alternatives: from "*never*" to "*often*") and duration (four alternatives: from "*5 minute or less*" to "*more than 30 minutes*"); time to get out of bed (six alternatives: from "*in 5 minutes*" to "*I don't know*").

Subjective perception of qualitative sleep features is investigated through questions on: calmness of sleep (five alternatives: from "*very quiet*" to "*very upset*"), ease of falling asleep (five alternatives: from "*very easy*" to "*very difficult*"), ease of awakening (five alternatives: from "*very easy*" to "*very difficult*"), freshness after awakening (five alternatives: from "*very awake and refreshed*" to "*not awake and not at all refreshed*"), need of napping on both weekdays and weekends (four alternatives: from "*never*" to "*always*"), optimal sleep duration (eight alternatives: from "*4 hours or less*" to "*more than 11 hours*"), satisfaction about sleep (five alternatives: from "*a lot*" to "*not at all*"), sufficiency of sleep on both weekdays and weekends (two alternatives: "*yes*"; "*no*").

Finally, the questionnaire includes three forced-choice questions about awakening features, two of which were used for the classification of subjects as SAs and FAs as described in the "Participants and procedure" section. The third question ("*Are you able to wake up at a certain time, different from the usual one, without an alarm clock?*," with three alternatives: "*no,*" "*sometimes,*" "*always*") was used to assess self-awakening "ability," that is the ability to self-awaken in the morning at an unusual time.

Morningness-Eveningness Questionnaire – reduced version

The reduced version of the *Morningness–Eveningness Questionnaire* (*MEQ-r*, Italian version; Natale et al. 2006) was adopted to evaluate circadian preference. This 5-item questionnaire assesses self-reported chronotypology with total scores ranging from 4 to 25: it permits to classify participants into evening-types (scores 4–10), intermediate-types (scores 11–18) and morning-types (scores 19–5).

Pittsburgh Sleep Quality Index

Subjective sleep quality in the past month was assessed using the *Pittsburgh Sleep Quality Index* (PSQI, Italian version; Curcio et al. 2013). The PSQI is a 19-item self-report questionnaire composed of seven subscales: *Subjective Sleep Quality* (PSQI1), *Sleep Latency* (PSQI 2), *Sleep Duration* (PSQI 3), *Habitual Sleep Efficiency* (PSQI 4), *Sleep Disturbances* (PSQI 5), *Use of Sleep Medication* (PSQI 6) and *Daytime Dysfunctions due to sleepiness* (PSQI 7). The PSQI total score ranges from 0 to 21, with higher scores indicating sleep difficulties and lower sleep quality. The cut-off score≥5 is adopted to discriminate between good and bad sleepers.

Big Five Inventory-10

The *Big Five Inventory-10* (BFI-10, Italian version; Guido et al. 2015) was adopted to assess personality dimensions. It consists of 10 items assessing the Big Five personality traits (*Extraversion, Agreeableness, Conscientiousness, Neuroticism* and *Openness*), with two items per each dimension, one coded in the positive and one in the negative direction of the scale. Subjects are requested to indicate their level of agreement with each of the 10 items using a 5-point scale, from "*disagree strongly*" to "*agree strongly*." A total score is calculated for each dimension.

Beck Anxiety Inventory

The *Beck Anxiety Inventory* (BAI, Italian version; Sica and Ghisi 2007) assesses the presence and severity of anxiety symptoms in the past week. It is made up of 21 items measuring the intensity of common somatic and cognitive symptoms of anxiety through a Likert scale ranging from 0 (*Not at all*) to 3 (*Severely – it bothered me a lot*). The score range is 0–63, with higher scores indicating more severe anxiety symptoms: specifically, a total score of 0–7 is considered to index minimal severity, 8–15 mild, 16–25 moderate and 26–63 severe.

Beck Depression Inventory-II

The severity of depressive symptoms was assessed using the 21-item *Beck Depression Inventory-II* (BDI-II, Italian version; Sica and Ghisi 2007). The total score ranges from 0 to 63, with higher scores indicating more severe depressive symptoms. Specifically, a total score of 0–13 is considered to index minimal severity, 14–19 mild, 10–28 moderate and 29–63 severe.

Data analysis

None of the variables were normally distributed, as shown by the results of the Shapiro–Wilk test. Therefore, the habitual SAs and FAs groups were compared using non-parametric Mann–Whitney U-test for the following dependent variables:

- sleep habits and quantitative sleep features: bedtime and rise time on weekdays and weekends; sleep duration on weekdays and weekends; differences (Δ) between weekdays (WK) and weekends (WKND) in bedtime (indicated as "Δ-WK/WKND bedtime"), rise time ("Δ-WK/WKND rise time") and sleep duration ("Δ-WK/WKND sleep duration"); nocturnal awakening frequency (median) and duration (hh:mm); time to get out of bed (median);

- subjective sleep and awakening quality: PSQI global score and PSQI single subscale scores; calmness of sleep (median); ease of falling asleep (median); ease of awakening (median); freshness after awakening (median); satisfaction about sleep (median); optimal sleep duration (median); need of napping on weekdays and weekends (median);

circadian preference: MEQ-r global score;

- personality dimensions: total score in *Extraversion, Agreeableness, Conscientiousness, Neuroticism* and *Openness* obtained from the BFI-10;

- anxiety and depressive symptoms: BAI and BDI-II global scores, respectively.

Chi-square test was carried out for all nominal variables, as well as for the analysis of frequency distribution of chronotypologies.

Furthermore, a point-biserial correlation was conducted in the total sample between the habitual awakening type (FAs = 1; SAs = 2), sleep habits (bedtime, rise time and sleep duration in both weekdays and weekends; Δ-WK/WKND values), global scores of MEQ-r, PSQI, BAI, BDI-II and BFI-10.

To correct for multiple testing without running a too high risk of Type II Error (see, for example, Benjamini and Hochberg 1995), the conventional alpha value ($p \leq 0.05$) was divided by five, that is, by the number of relevant "dimensions" addressed in our research ("sleep habits and features," "circadian preference," "sleep and awakening quality," "personality dimensions," "psychological characteristics"). Therefore, statistical significance level was set at $p \leq 0.01$.

Results

Prevalence of habitual SAs and habitual FAs

The proportion of habitual SAs (N = 234) over the total screened sample (N = 1549) was 15.1%, whereas the proportion of habitual FAs (N = 385) was 24.8%.

Sleep habits and sleep quantitative features

Table 1 shows comparisons between habitual SAs and FAs in sleep habits. Bedtime was significantly anticipated in SAs on both weekdays ($p < .001$) and weekends ($p < .001$). Moreover, in SAs relative to FAs, sleep duration was significantly shorter during weekends ($p < .001$) and Δ-WK/WKND values of bedtime ($p < .001$) and rise time ($p < .001$) were lower.

Habitual awakening type (FAs = 1; SAs = 2) showed point-biserial correlations with bedtime on both weekdays ($r_{pb} = -0.17, p < .001$) and weekends ($r_{pb} = -0.27, p < .001$),

Table 1. Comparisons between habitual SAs and FAs in sleep habits. Mean and standard deviation are reported. Significant *p*-values are in bold; U = Mann Whitney test.

SLEEP HABITS	Habitual SAs	Habitual FAs	U	p
Bedtime weekdays	23:47 ± 00:54	00:06 ± 00:55	35552.00	<0.001
Rise time weekdays	07:37 ± 01:06	07:50 ± 01:11	40606.00	0.065
Sleep duration weekdays	07:48 ± 01:37	07:50 ± 01:09	43229.00	0.578
Bedtime weekend	01:22 ± 01:26	02:12 ± 01:23	30231.00	<0.001
Rise time weekend	09:30 ± 01:23	10:53 ± 01:25	21881.00	<0.001
Sleep duration weekend	08:08 ± 01:23	08:43 ± 01:45	33863.50	<0.001
Δ-WK/WKND bedtime	01:38 ± 01:21	02:08 ± 01:10	35174.50	<0.001
Δ-WK/WKND rise time	02:03 ± 02:34	03:03 ± 01:42	26608.00	<0.001
Δ-WK/WKND sleep duration	01:11 ± 01:02	01:24 ± 01:09	39687.00	0.026

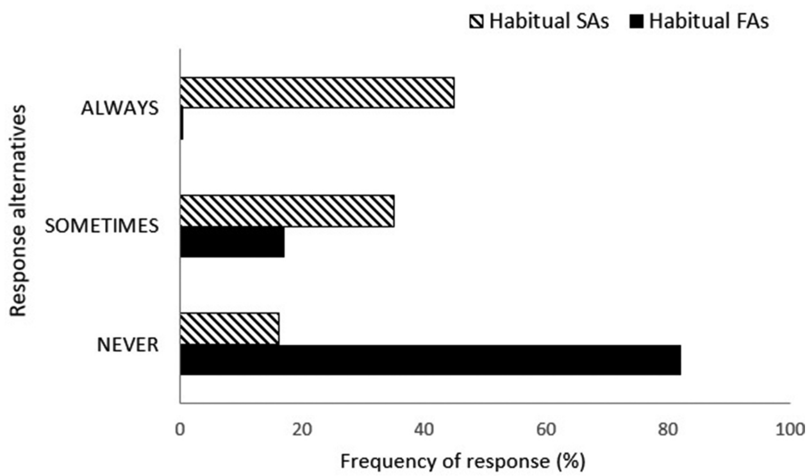

Figure 1. Prevalence of self-awakening "ability" in habitual SAs and FAs.

rise time (r_{pb} = −0.43, p < .001) and sleep duration in weekends (r_{pb} = −0.19, p < .001), Δ-WK/WKND bedtime (r_{pb} = −0.18, p < .001) and Δ-WK/WKND rise time (r_{pb} = −0.34, p < .001). No significant correlation emerged between awakening type, rise time (r_{pb} = −0.07, ns) and sleep duration (r_{pb} = 0.02, ns) in weekdays and Δ-WK /WKND sleep duration (r_{pb} = −0.09, ns).

Compared to FAs, SAs referred more frequent (SAs median = 3, that is "sometimes," vs FAs median = 2, that is "rarely"; U = 32859, p < .001) and longer night awakenings (SAs median = 2, that is "from 5 to 15 minutes," vs FAs median = 3, that is "5 minutes or less"; U = 21220, p < .001). Also, daytime napping appeared less frequent (SAs: median = 2, that is "rarely," mean = 2.00 ± 0 .93, vs. FAs: median = 2, mean = 2.28 ± 1.07; U = 38440.50; p = .02) and with shorter duration in SAs (SAs mean = 68.62 min vs. FAs mean = 79.08 min; U = 15703, p = .007).

Regarding self-awakening "*ability*," chi-square test revealed an association with self-awakening habit (χ^2 = 297.99, p < .001) (Figure 1). Indeed, 45% of SAs reported to be "*always*" able to self-awake in the morning at an unusual time, 35% "*sometimes*," while 16% declared not to have this ability. Instead, 82% of FAs denied having this ability, 17% reported to have it "*sometimes*" and only 1% "*always*."

Sleep quality

Optimal sleep duration was lower in habitual SAs than habitual FAs (SAs median = 5, that is "7–8 hours" vs. FAs median = 6, that is "8–9 hours"; U = 31767, p < .001). Moreover, SAs referred less calm sleep (SAs: median = 2, that is "quite calm," mean = 2.53 ± 1.02, vs. FAs: median = 2, mean = 2.19 ± 0.89; U = 36187.50, p < .001) and higher sleep satisfaction compared to FAs (median SAs = 2, that is "quite" vs median FAs = 3, that is "moderately"; U = 39574, p = .017), whereas no significant differences emerged in ease of falling asleep (median in both groups = 2, that is "quite easily, U = 42113.50, ns).

Concerning awakening quality, SAs reported to wake up more easily in the morning relative to FAs (SAs median = 2, that is "quite easy," vs. FAs median = 4, that is "not very easy"; U = 17407, p < .001) and to need less time to get out of bed (SAs: median = 2, that is "5–10 minutes," mean = 1.93 ± 1.05, vs. FAs: median = 2, mean = 2.53 ± 1.24; U = 31525, p < .001). Moreover, SAs referred to feel more *awake and refreshed* upon awakening than FAs (SAs: median = 3, that is "*moderately awake and refresh*," mean = 2.81 ± 0.98; FAs: median = 3, mean = 3.43 ± 0.87; U = 28463, p < .001).

FAs also reported to feel a need to nap during daytime more often than SAs on weekdays (SAs: median = 2, that is "rarely," mean = 1.90 ± 2.08, vs. FAs median = 2, mean = 2.19 ± 0.82; U = 28645, p < .001), but not on weekends (U = 25885, ns).

Table 2. Comparisons between SAs and FAs in PSQI scores. Mean and standard deviation are reported. U = Mann Whitney test.

PSQI scores	Habitual SAs	Habitual FAs	U	p
PSQI global score	6.19 ± 3.30	5.47 ± 0.25	39149.00	0.035
PSQI 1 – sleep quality	1.19 ± 0.67	1.12 ± 0.63	41210.50	0.194
PSQI 2 – sleep latency	1.18 ± 1.07	0.91 ± 0.91	37747.00	0.005
PSQI 3 – sleep duration	0.91 ± 0.91	0.65 ± 0.76	36781.00	0.001
PSQI 4 – habitual sleep efficiency	0.77 ± 0.97	0.54 ± 0.81	37902.50	0.005
PSQI 5 – sleep disturbances	1.15 ± 0.62	1.09 ± 0.52	40962.00	0.172
PSQI 6 – use of sleep medication	0.12 ± 0.47	0.12 ± 0.51	42459.50	0.437
PSQI 7 – daytime dysfunction	0.89 ± 0.75	1.05 ± 0.74	38310.50	0.010

Finally, we observed an association between the habit of self-awakening and sufficiency of sleep on weekdays ($\chi^2 = 15.03$, $p < .001$) but not weekends ($\chi^2 = 0.31$, ns). Specifically, a high percentage of SAs considered their sleep sufficient during weekdays (64.9%).

As for PSQI scores, SAs reported higher scores than FAs at several PSQI sub-scales, i.e., Sleep latency ($p = .005$), Sleep duration ($p < .001$) and Habitual sleep efficiency ($p < .005$), and displayed lower scores at the Daytime dysfunction subscale ($p < .10$) (Table 2).

Moreover, habitual awakening type (FAs = 1; SAs = 2) showed a point-biserial correlation with several PSQI subscales: Sleep Latency ($r_{pb} = 0.11$, $p = .005$), Sleep Duration ($r_{pb} = 0.13$, $p = .001$), Sleep Efficiency ($r_{pb} = 0.12$, $p = .005$), Daytime Dysfunction ($r_{pb} = -0.11$, $p = .010$). No significant correlation emerged, instead, with PSQI global score ($r_{pb} = 0.08$, ns), Sleep Quality subscale ($r_{pb} = 0.05$, ns), Sleep Disturbances subscale ($r_{pb} = 0.066$, ns), use of Sleep Medication subscale ($r_{pb} = 0.03$, ns).

Circadian preference

Significant differences were found in MEQ-r global scores between habitual SAs and habitual FAs (U = 21083, $p < .001$), with the former displaying higher scores (i.e., higher morningness) (Figure 2). Moreover, habitual awakening type (FAs = 1; SAs = 2) showed a point-biserial correlation with MEQ-r global score ($r_{pb} = 0.42$, $p < .001$).

Significant between-group differences also emerged in the frequency distribution of chronotypolgies ($\chi^2 = 59.13$, $p < .001$). Within the SAs group, frequencies of M-types, I-types and E-types were, respectively, 11.9%, 80.5% and 7.5%, while in the FAs group they were, respectively, 1.6%, 70.2% and 28.2% (Figure 3).

Personality

Table 3 displays mean scores for each personality dimension in the two groups. SAs showed higher scores in Conscientiousness ($p < .001$) and Openness ($p = .001$) and lower scores in Extraversion ($p = .01$) compared to FAs.

In addition, a point-biserial correlation emerged between habitual awakening type (FAs = 1; SAs = 2) and conscientiousness ($r_{pb} = 0.15$, $p \le 0.001$), extroversion ($r_{rb} = -0.10$, $p = .011$) and openness ($r_{rb} = 0.13$, $p = .001$), but not with agreeableness ($r_{rb} = -0.02$, ns) and neuroticism ($r_{rb} = 0.08$, ns).

Anxiety and depressive symptoms

No significant differences were found between the two groups either in BAI (SAs mean = 11.51 ± 11.12 vs. FAs mean = 11.64 ± 9.69; U = 41883.5, ns) or BDI-II global scores (SAs mean = 10.22 ± 9.17 vs. FAs mean = 10.08 ± 7.98; U = 43292, ns). No significant

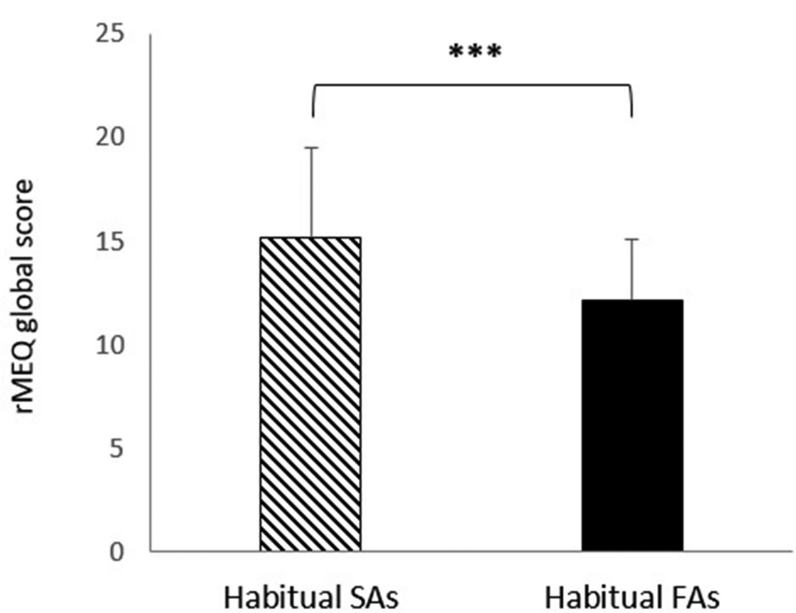

Figure 2. MEQ-r global score in habitual SAs and habitual FAs. * = $p < .001$.

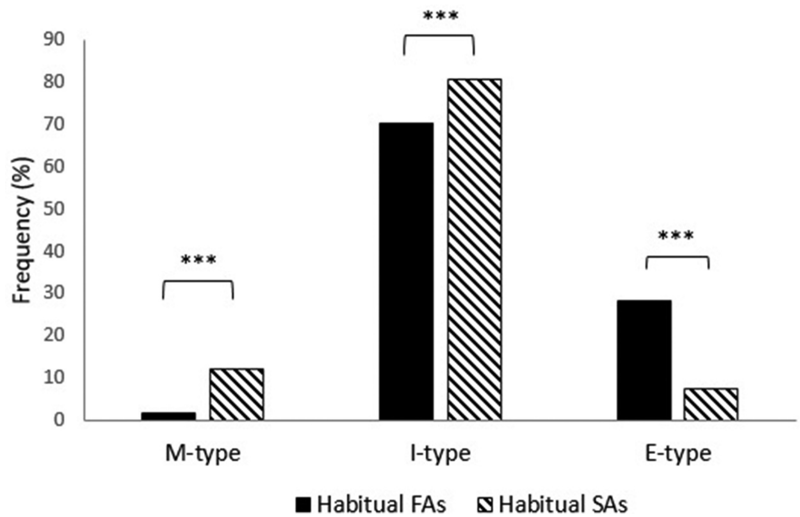

Figure 3. Frequency distribution of Evening (E-type), Intermediate (I-type) and Morning (M-type) chronotypologies in habitual SAs and habitual FAs. * = $p < .001$.

Table 3. Mean scores and standard deviations at the BFI-10 for each personality dimensions in habitual SAs and FAs. U = Mann Whitney test.

PERSONALITY DIMENSIONS	Habitual SAs	Habitual FAs	U	p
Agreeableness	3.05 ± 0.92	3.07 ± 0.84	42300.5	0.649
Conscientiousness	3.58 ± 0.98	3.32 ± 0.88	35943.0	<0.001
Extroversion	2.87 ± 0.96	3.07 ± 1.03	38446.5	0.011
Neuroticism	2.89 ± 1.15	2.69 ± 1.08	39750.0	0.055
Openness	3.80 1.03	3.56 ± 0.94	37180.5	0.001

point-biserial correlation emerged between habitual awakening type (FAs = 1; SAs = 2), BAI and BDI scores ($p > .01$ for all correlations).

Discussion

The present study addressed self-reported sleep features and psychological characteristics in a group of individuals with self-awakening habit, by comparing them with a group of forced awakeners.

Our first set of results regards the prevalence of self-awakening habit in our sample. We found that 15.1% of the sample referred to habitually wake up from nocturnal sleep without using external means, a prevalence similar to those previously observed in Japanese samples of comparable age (Ikeda and Hayashi 2012; Matsuura et al. 2002). Therefore, here we confirm that at younger ages the percentage of habitual SAs is lower than the one found among the general population (Moorcroft et al. 1997).

Concerning the use of external devices to wake up in the morning, we found a lower percentage of FAs than previous studies conducted on university samples (Ikeda and Hayashi 2012; Matsuura et al. 2002). The more restrictive criterion we adopted in FAs selection can explain this result. In fact, we considered FAs only those who declared to "*always*" use an alarm clock to wake up in the morning, whereas we did not include subjects reporting to self-awaken "*sometimes*," with the aim to obtain an "authentic" FAs sample.

In the present study, habitual SAs were confident about their self-awakening "*ability*," that is the capacity to self-awaken in the morning at unusual times established before sleep (Hayashi et al. 2010). In line with what proposed by Moorcroft et al. (1997), this finding suggests that having a regular self-awakening time does not exclude the possibility to spontaneously awaken at unusual times. Therefore, future research should objectively study the ability of self-awakening at any target time in subjects with self-awakening habit.

As for sleep habits, habitual SAs reported more regular sleep/wake schedules compared to FAs, as shown by SAs' significantly lower difference in bedtimes and rise times between weekdays and weekends (a result also supported by the negative correlations between being a self-awakener and Δ-WK/WKND values).

Moreover, anticipated sleep-wake schedules were found in SAs. Specifically, relative to FAs, SAs reported earlier bed- and rise times on weekends and earlier bedtimes on weekdays, whereas rise time during weekdays did not differ between groups, probably due to the necessity for both to wake up early in order to follow university schedules. In line with this data, we also found higher rMEQ scores (i.e., greater morningness) in habitual SAs compared to FAs and an association between self-awakening and morning circadian preference. Globally, these findings confirm those of previous surveys conducted on students (Ikeda and Hayashi 2012; Matsuura et al. 2002) and adults (Moorcroft et al. 1997).

Furthermore, we observed an association between the habit of self-awakening and sufficiency of sleep on weekdays. In other words, despite the social constraints, SAs reported to sleep enough during weekdays, whereas FAs did not show such correlation and reported instead a greater need for napping during weekdays, probably linked to the misalignment between their circadian preferences and daily university schedules. In line with these results, SAs reported to need less daily sleep hours compared to FAs; also, SAs' actual total sleep time generally corresponded to their reported optimal sleep duration on both weekdays and weekends. Interestingly, these findings on SAs are accompanied by shorter sleep duration in this group relative to FAs (i.e., higher scores at the PSQI 3 subscale). Therefore, our results suggest that, despite sleeping less, SAs are more satisfied about their sleep.

Our findings on subjective sleep quality are coherent with the ones on sufficiency of sleep. In fact, the habit of self-awakening seems associated with good subjective sleep and awakening quality. Habitual SAs claimed to be satisfied with their sleep and reported to get up easily, to feel refreshed at awakening and to feel more alert during the day compared to FAs. In fact, SAs reported fewer daytime disturbances due to sleepiness (i.e., lower scores at the PSQI 7 subscale), consistent with previous studies showing that self-awakening at a usual time is associated with less dozing off during daytime and can reduce sleep inertia (Matsuura and Hayashi 2009; Ikeda and Hayashi 2010). Interestingly, habitual SAs also reported some sleep difficulties that do not apparently affect their subjective sleep quality. Previous studies found that self-awakening practice might disturb sleep, for example by extending sleep latency duration and increasing the number of awakenings (Hono et al. 1991; Lavie et al. 1979). Indeed, in our study, habitual SAs displayed higher scores at the PSQI 2 subscale and reported more frequent and longer night awakenings. These results could explain, on one hand, why habitual SA usually judge their sleep as less calm compared to FAs and, on the other hand, their higher scores at the Sleep Efficiency subscale of the PSQI and their higher PSQI global score (p = .03) compared to FAs. Anyway, we cannot exclude that these physiological events were functional for habitual SAs to successfully self-awaken at prescheduled times (Akerstedt et al. 2002).

Concerning psychological characteristics, in our study no relationship emerged between self-awakening and anxiety levels. Prior research found higher state-anxiety scores among subjects in a self-awakening condition compared to those in a forced-awakening one, attributing this result to a greater pre-sleep activation associated with self-awakening practice (Matsuura and Hayashi 2009). In our study, we observed low and comparable levels of anxiety in the two groups, through a questionnaire assessing the intensity of physical and cognitive anxiety symptoms over a prolonged period (i.e., the past week). Therefore, it is plausible that a difference between SAs and FAs in anxiety levels would appear only immediately before sleep, not emerging when evaluated over longer periods or in relation to a stable psychological trait.

We also did not observe differences between habitual SAs and FAs in depression levels, which appeared low in both groups. Together with data on anxiety levels, these results suggest that the spontaneous awakening occurring in habitual SAs should not be erroneously interpreted as an early awakening linked to a strong emotional distress (Cox and Olatunji 2020; Fava 2004).

This is the first study evaluating personality differences between SAs and FAs according to the Five-Factor Model (McCrae and John 1992). We found a relationship between habitual awakening type and specific personality dimensions: particularly, SAs appeared more conscientious, open to experience and less extrovert compared to FAs, a result also supported by correlational analysis. The specific psychological features linked to conscientiousness may explain its preferential link with self-awakening habit. In fact, individuals with high conscientiousness display high self-control, self-discipline and more effective task planning; also, they are more responsible and more organized than people who score low in this trait (MacCann et al. 2009). All these psychological features might promote and sustain a habitual self-awakening practice. Moreover, previous studies found an association between conscientiousness, on one hand, and sleep satisfaction and sleep quality, on the other, suggesting that this personality trait could be a predictor of healthy sleep-related habits as well (Bogg and Roberts 2004; Duggan et al. 2014). In this perspective, the positive effects of self-awakening (i.e. satisfaction for sleep, feeling better after awakening) might reinforce this practice among habitual SAs.

Habitual SAs also show higher openness compared to FAs. Individuals with high openness display an inclination to seek, detect, comprehend and creatively utilize information coming from different environments (DeYoung et al. 2005). Moreover, openness belongs to a meta-trait, defined "*plasticity*," characterized by exploratory behaviors, positive affect and reward sensitivity (DeYoung et al. 2005). In relation to awakening habit, this trait might be linked to the desire to attempt an unusual strategy for awakening, i.e., one based on internal signals rather than on a typical clock or other devices. The experience of positive effects after self-awakening, coupled with increased self-efficacy related to the achieved self-awakening (Crabb 2003), might then promote the consolidation of this habit.

As for the introversion-Extraversion dimension, it has been suggested that introverts are innately more aroused and have an active internal life providing them with impulses (Eysenck 1967): therefore, introverts are largely self-sufficient and find inside themselves the excitement that extroverts conversely seek externally (Heinström 2010). In this perspective, SAs, as introverts, might be primarily prone to rely on their internal sources to achieve their goal of awakening at a predetermined time rather than to adopt external means.

Overall, our results show that the habit of self-awakening is linked to a better sleep experience compared to that of forced awakening. In fact, SAs are satisfied about their sleep duration and about their sleep and awakening quality, they show more regular sleep-wake schedules and report less daytime sleepiness than FAs. These subjectively reported sleep features suggest that SAs are characterized by a well-organized sleep episode, which allows them to spontaneously awaken at a desired time with no detrimental fall-outs on diurnal functioning. Moreover, the better awakening quality experienced by SAs might be a determining factor in retrospective judgments about the quality of the entire sleep episode, given its relationship with subjective sleep quality (Keklund and Akerstedt 1997). To this regard, according to Buysse (2014), satisfaction for one's own sleep, daytime alertness and adequate sleep duration are relevant components of the multi-dimensional construct of sleep health and our study showed that all these variables characterize habitual SAs. On the other hand, morningness chronotipology, being a significant predictor of sleep quality (Lehnkering and Siegmund 2007; Tonetti et al. 2013; Vollmer et al. 2017), also can explain the better sleep experience in self-awakeners. However, the determinants of sleep quality in self awakeners should be systematically explored. In this perspective, future research should objectively test in detail the effects of the self-awakening habit on sleep structure and organization, taking into account also microstructural sleep features (Arzilli et al. 2019; Conte et al. 2014, 2020; Vegni et al. 2001).

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Data availability statement

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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