



Validation of the SIC (Single Item Chronotyping) against 11 scales of three questionnaires

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ABSTRACT

In 2021, the Single-Item Chronotyping (SIC) was introduced in this journal. This is a new method to self-assess diurnal types by using 6 simple charts illustrating morning, afternoon, and evening levels of alertness of 6 chronotypes (lethargic, vigilant, evening, morning, afternoon, and napping). Its output is the names of chronotypes rather than clock time or scale score of any of other chronotype questionnaires. Consequently, the SIC cannot be validated by applying the conventional way of evaluating validity of a questionnaire against the already established questionnaires (e.g., by the simple estimation of correlation coefficients between outputs of the questionnaires). Therefore, we proposed here a method of validation of the SIC against the scales of already established multi-item chronotype questionnaires which output are scores on separate morning, afternoon, and evening scales. We suggested that, if three-score (morning, afternoon, and evening) diurnal curve can be constructed for each of the SIC chronotypes, we can test the hypothesis that the SIC charts predicted these three-score curves. Scores on scales of three questionnaires were obtained from 4940 survey participants and used to construct and statistically evaluate such curves. Results supported the hypothesis that the obtained curves were predicted by the SIC charts.

1. Introduction

Individual variation in human adaptation to the 24-h periodicity of geophysical and social environment is usually self-assessed with a morningness-eveningness scale, such as the 19-item Morningness-Eveningness Questionnaire (MEQ; Horne & Östberg, 1976) and the 13-item Composite Scale of Morningness (CSM; Smith et al., 1989). The main problem identified with these scales is their length, which would often prevent individuals from completing the questionnaire in full. Therefore, some researchers prefer to apply the reduced versions of

these morningness-eveningness scales, such as the 5-item reduced Morningness-Eveningness Questionnaire (rMEQ; Adan & Almirall, 1991) and the 6-item Preference Scale (PS-6; Di Milia, 2005). Moreover, some other simply ask to response to the last (19th) question of the MEQ (Horne & Östberg, 1976) to self-classify an individual as one of four chronotypes (or, in other terms, diurnal types), definitely morning type (Self-MM), more morning than evening type (Self-M), more evening than morning type (Self-E), definitely evening type (Self-EE; Turco et al., 2015).

Multi-scale questionnaires for assessment of chronotype were also

Abbreviations: SIC, Single-Item Chronotyping; SWPAQ, Sleep-Wake Pattern Assessment Questionnaire; SWAT, Sleep-Wake Adaptability Test; VJT, Visuo-verbal Judgment Task; LIVEMAN, lethargic, inconclusive, vigilant, evening, morning, afternoon, napping (type); rANOVAs, repeated measure ANOVAs.

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constructed, such as the 20-item Circadian-Type Questionnaire (CTQ; Folkard et al., 1979), the 72-item Sleep-Wake Pattern Assessment Questionnaire (SWPAQ; Putilov, 2007), the 16-item Chronotype Questionnaire (ChQ; Ogińska, 2011), the 168-item and 60-item Sleep-Wake Adaptability Test (SWAT; Putilov, 2016; Putilov, Budkevich, et al., 2021), the 19-item point Visuo-verbal Judgment Task (VJT; Marcoen et al., 2015), the 15-item Morningness–Eveningness–Stability Scale improved (MESSi; Randler et al., 2016).

The article entitled “Single-Item Chronotyping (SIC): a new method to self-assess diurnal types by using 6 simple charts” was published in this journal 5 years ago (Putilov, Sveshnikov, et al., 2021). The SIC was developed to distinguish between 6 rather than just two – morning and evening – chronotypes (Fig. 1). The English names for 7 response options to the SIC's question (“Self-assess your chronotype by choosing one of six patterns of daily change in alertness level”) were abbreviated as “LIVEMAN” (lethargic, inconclusive, vigilant, evening, morning, afternoon, napping). Fig. 1 illustrates that the charts and/or short descriptions of levels of alertness in the morning, afternoon, and evening were assigned to the names of the following chronotypes: 1) (M)orning type: high level in the morning, middle in the afternoon, low in the evening; 2) (E)vening type: low level in the morning, middle in the afternoon, high in the evening; 3) (V)igilant type: high level in the morning, afternoon, and evening; 4) (L)ethargic type: low level in the morning, afternoon, and evening; 5) (N)apping type: high level in the morning, low in the afternoon, middle in the evening; 6) (A)fternoon type: low level in the morning, high in the afternoon, middle in the evening; and 7) (I)nconclusive type: none of the above.

The question arises: How can we validate the SIC against already established chronotype questionnaires? The problem is that, in any other chronotype questionnaires, an output of chronotyping is either clock time reported for certain behavior or a score on a single scale or several scores on several scales of a multidimensional questionnaire (Putilov, preprint). The conventional easiest way of evaluating validity of a new chronotype questionnaire against already established questionnaires is to estimate correlation coefficients between the outputs of the new and one or more other questionnaires. However, validity of the SIC cannot be assessed by using this simple method because this is the only chronotype questionnaire which output is the names of 7 LIVEMAN types rather than clock time or score or several scores (Putilov, preprint). Therefore, we here presented another approach for its validation against the scales of already established multi-item chronotype questionnaires.

Until recently, at least, 75 other than the SIC chronotype questionnaires have been published (Putilov, preprint), but only three of them can be applied to validate the SIC using the proposed approach because each of these three questionnaires contains, at least, three separate scales for assessing sleepiness or sleepability or wakeability in the morning, afternoon, and evening (i.e., the SWPAQ, Putilov, 2007, SWAT, Putilov, Budkevich, et al., 2021, and VJT; Marcoen et al., 2015). Eleven scales of these questionnaires are designed to calculate scores on separate morning, afternoon, and evening scales that can be used to construct a three-score daily curve for each of chronotypes. This provides the possibility to compare these three-score curves with their counterparts among three-point charts shown in Fig. 1. If these chronotypes really exist, these 6 SIC charts (Fig. 1) must predict 6 three-score curves constructed from scores on morning, afternoon, and evening scales of each of three questionnaires.

Consequently, the aim of the present study was to demonstrate that any of these three questionnaires can be used to construct a three-score curve for each of LIVEMAN types for testing the hypothesis that each of these curves was predicted by one of the SIC charts (Fig. 1).

2. Material and methods

2.1. Sample

In winter season, lecturers invited their students and colleagues to respond to a set of questions asking about their sleep–wake traits and abilities. The responses were collected from the smartphones using Google Forms questionnaires. No exclusion criteria were applied for participation in the survey. All participants attended classes/office in the university buildings at the day of completing the forms, therefore, it is unlikely that they were in unhealthy physical and mental condition.

Institutional review board statement. The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of the Institute of Higher Nervous Activity and Neurophysiology (Approval#12402–02-7112 from 03.06.2019). **Informed Consent Statement.** The study participants were informed in detail about the survey procedure, and informed consent was obtained from each participant in the form of the response “Agree” to the following statement: “I give informed consent to anonymously and voluntarily participate in this online survey of sleep–wake behavior and habits”.

2.2. Chronotype questionnaires

Factor analysis of responses to the VJT that asks how sleepy study participants expect to be at different clock times (Marcoen et al., 2015) yielded three factors on the interval of everyday wakefulness, morning (from 8:00 to 11:00), afternoon (from 12:00 to 20:00), and evening (21:00 or later; Putilov, Sveshnikov, et al., 2021). This result prompted the three-point (morning, afternoon and evening) curves of the SIC (Fig. 1). Therefore, the validation of the SIC charts required multi-item chronotype questionnaires designed to calculate scores on separate morning, afternoon, and evening scales. All survey participants were asked to complete the following three questionnaires: 1) the SIC for self-choosing chronotype among 7 options (Putilov, Sveshnikov, et al., 2021), 2) the reduced (60-item) version of SWAT designed to self-assess abilities to sleep or wake on demand at different times of the day (Putilov, Budkevich, et al., 2021), and 3) the VJT for self-scoring sleepiness expected at different clock times across the 1.5-day interval of permanent wakefulness (Marcoen et al., 2015) in slightly modified version (Putilov, Budkevich, et al., 2021; Putilov, Sveshnikov, et al., 2021). To support the results obtained with the SWAT, a subset of the survey participants was additionally asked to complete 4) the SWPAQ for self-assessing abilities to sleep and wake in either appropriate or inappropriate for sleep and wakefulness times of the day (Putilov, 2007). See Tables S1–S4 for the detailed description of these multi-scale questionnaires including the results of assessment of their reliability and cross-validity in the present dataset.

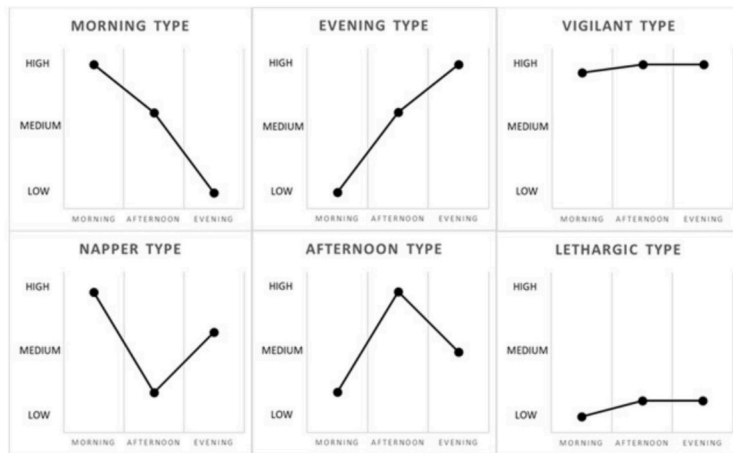
Morning lateness, morning sleepability, and morning sleepiness are three morning scales included in the SWPAQ, SWAT, and VJT, respectively (Table S1 and Figs. S1 and S2). Evening lateness, nighttime wakeability, and evening/early night sleepiness are three evening scales included in the SWPAQ, SWAT, and VJT, respectively (Table S1 and Figs. S1 and S2). The daytime sleepiness scale is the single afternoon scale of the VJT is, while the SWPAQ and SWAT include scales for assessing daytime wakeability and other scales for assessing daytime or anytime sleepability (Table S1 and Figs. S1 and S2).

2.3. Calculation of relative morning, afternoon, and evening scores

At the first step of calculations of scale scores, individual scores were expressed relative age-averaged score obtained in the subsamples of students and lecturers (ages 18–25 and > 25 years, respectively). The sign of deviation was changed when a scale is designed to score sleepability (SWAT and SWPAQ) and sleepiness (VJT) and it was not changed when a scale assesses wakeability (SWAT and SWPAQ). The chronotype-averaged curves were calculated and illustrated in Figs. S1 and S2.

(A) The SIC in English

Chronotype self-assessment



Self-assess your own chronotype by choosing one of six patterns of daily change in alertness level

- ☐ Morning type: high level in the morning, middle in the afternoon, low in the evening
- ☐ Evening type: low level in the morning, middle in the afternoon, high in the evening
- ☐ Vigilant type: high level in the morning, high in the afternoon, high in the evening
- ☐ Lethargic type: low level in the morning, low in the afternoon, low in the evening
- ☐ Afternoon type: low level in the morning, high in the afternoon, low or middle in the evening
- ☐ Napper: high level in the morning, low in the afternoon, high or middle in the evening
- ☐ None of the above

(B) The SIC in Russian

Самооценка хронотипа



Оцените свой собственный хронотип на основании графика уровня бодрости

- ☐ Утренний ☐ Вечерний ☐ Высокоактивный ☐ Сонливый днем ☐ Дневной тип ☐ Умеренно-активный ☐ Другое

Fig. 1. English and Russian versions of the SIC (Single Item Chronotyping). (A). English version. (B). Russian version. As illustrated in the graphs, 7 LIVEMAN types are characterized by the following patterns of daily changes in alertness level. M(orning): high in the morning, middle in the afternoon, low in the evening; E(vening): low in the morning, middle in the afternoon, high in the evening; V(igilant): high in the morning, afternoon, and evening; L(ethargic): low in the morning, afternoon, and evening; N(apping): high in the morning, low in the afternoon, middle in the evening; A(fternoon): low in the morning, high in the afternoon, middle in the evening, and, additionally, I(nconclusive): none of 6 above types.

Since the SWPAQ and SWAT include two scales for assessing daytime wakeability and daytime or anytime sleepability (Table S1 and Figs. S1 and S2), relative scores on each of two couples of scales were averaged prior to statistical analysis at the second step of calculations of scale scores (Fig. S3).

2.4. Statistical analysis

The SPSS_{26.0} statistical software package (IBM, Armonk, NY, USA) was used for statistical analysis. To confirm visible differences between scores of chronotype-specific three-score curves, we run one-way repeated measure ANOVAs (rANOVAs) with the following post hoc pairwise comparisons. The major results of post hoc Bonferroni comparisons of the relative scores of each type (Fig. S3) are reported in Tables S5-S9 and summarized in Tables 1 and 2. The two-way rANOVAs were applied to calculate relative scores averaged over three questionnaires (Fig. 2 and Tables 1 and 2, last column, and S10).

3. Results

3.1. Mean ages in two age subsamples and percentage of LIVEMAN types

In the two age subsamples of the whole sample, mean ages of 1271 male and 3075 female students $\pm$ standard deviation were 19.3 ± 2.1 and 19.4 ± 1.7 years, respectively, and mean ages of 138 male and 456 female lecturers were 41.0 ± 13.7 and 42.5 ± 12.2 years, respectively. Mean ages of those who additionally completed the SWPAQ were 19.1 ± 2.4 and 19.3 ± 1.8 years, and 42.1 ± 13.1 and 42.9 ± 12.5 years, respectively.

The numbers and percentages of LIVEMAN types are reported in the first column of Tables S5-S10. Only less than 5% of survey participants were not assigned to 6 types illustrated by the charts of Fig. 1 (i.e., classified as inconclusive type). The number of morning and evening types did not exceed 50%, and prevalence of any of 4 other types (Fig. 1) exceeded 8% (Tables S5-S10, the first column).

Table 1

Confidence intervals of relative morning, afternoon, and evening scores.

LIVEMAN	Supplementary Table		S5		S7		S9		S10	
Type, N = or	Level of	Time of	VJT		SWAT		SWPAQ		Averaged	
N=	alertness	the day	−95%	+95%	−95%	+95%	−95%	+95%	−95%	+95%
Morning	High	Morning	0.671	0.879	3.353	3.004	2.877	3.856	2.218	2.836
N = 451 or	Middle	Afternoon	−0.050	0.133	1.117	0.859	0.838	1.644	0.609	1.089
N = 756	Low	Evening	−0.640	−0.420	−3.176	−3.471	−5.785	−4.813	−3.134	−2.561
Evening	Low	Morning	−0.871	−0.679	−2.468	−2.717	−2.895	−2.138	−1.912	−1.445
N = 738 or	Middle	Afternoon	−0.113	0.056	−0.544	−0.763	−1.404	−0.716	−0.716	−0.291
N = 1292	High	Evening	0.496	0.681	2.889	2.654	3.809	4.537	2.332	2.753
Vigilant	High	Morning	0.856	1.132	3.535	3.097	2.812	3.993	2.198	2.944
N = 299 or	High	Afternoon	0.611	0.865	2.508	2.227	2.455	3.452	1.799	2.373
N = 501	High	Evening	0.443	0.756	0.754	0.350	1.542	2.644	1.026	1.705
Lethargic	Low	Morning	−0.555	−0.261	−0.611	−1.048	−1.163	−0.232	−0.660	−0.261
N = 231 or	Low	Afternoon	−0.443	−0.174	−0.573	−0.897	−1.154	−0.053	−0.691	−0.058
N = 595	Low	Evening	−0.493	−0.210	−0.883	−1.243	−2.228	−0.895	−1.312	−0.523
Napping	High	Morning	0.043	0.279	−0.376	−0.751	−1.570	−0.168	−0.723	0.125
N = 275 or	Low	Afternoon	−0.658	−0.434	−2.547	−2.835	−3.266	−2.233	−2.232	−1.568
N = 689	Middle	Evening	−0.301	−0.069	−0.023	−0.369	−0.898	0.439	−0.318	0.440
Afternoon	Middle	Morning	−0.083	0.123	−0.661	−0.994	−1.213	−0.267	−0.610	−0.024
N = 522 or	High	Afternoon	0.127	0.310	0.812	0.557	0.054	0.850	0.288	0.777
N = 867	Low	Evening	−0.562	−0.370	−1.562	−1.837	−2.217	−1.320	−1.280	−0.769
Inconclusive	Unknown	Morning	−0.085	0.347	0.317	−0.326	−0.571	1.413	−0.083	1.160
N = 131 or	Unknown	Afternoon	−0.170	0.224	0.027	−0.470	−0.837	0.661	−0.252	0.700
N = 240	Unknown	Evening	0.113	0.557	0.757	0.188	−0.832	1.228	−0.042	1.166

Notes. Post hoc pairwise Bonferroni comparisons following rANOVAs of relative scores in each of 7 subsamples of LIVEMAN chronotypes. Level of Alertness: See Fig. 1. Averaged: Questionnaires-averaged relative scores (Fig. 2) were obtained from rANOVAs of relative scores on morning, afternoon, and evening scales of the VJT, SWAT, and SWPAQ (Fig. S3). Time of day: Morning, Afternoon, and Evening relative scores. Afternoon score for SWAT and SWPAQ (Fig. S3) was calculated by averaging over wakeability and sleepability scales (Figs. S1 and S2). N = or N=: Either a subsample for SWPAQ and Averaged (N = 2647) or the whole sample for the VJT and SWAT (N = 4940). Printed in **bold**: −95% is always higher than zero; printed in **bold italic**: +95% is always lower than zero. These confidence intervals were taken from Tables S5, S7, S9, and S10. See mean scores and their standard deviations in Figs. 2 and S3.

3.2. Charts of LIVEMAN types predict three-score curves for these types

Figs. 2 and S3 illustrate three score curves calculated for each of 6 chronotypes illustrated in the charts of Fig. 1. Any of these curves resembled its counterpart shown in Fig. 1. Results of statistical analysis (Tables 1, 2, and S5-S10) supported these visible chronotype-specific characteristics of the three-score curves.

For instance, all three (morning, afternoon, and evening) scores of vigilant and lethargic types were higher and lower than zero, respectively (Table 1), the morning scores of morning and evening types were higher and lower than zero, respectively, while their evening scores were lower and higher than zero, respectively (Table 1), etc. Pairwise comparisons of the morning and any of two other (afternoon and evening) scores and of evening and two other (morning and afternoon) scores confirmed significance of the differences between these scores (Table 2). Afternoon scores of napping and afternoon types were lower and higher than zero, respectively (Table 1), and this afternoon score was significantly lower and higher than two other scores, respectively (Table 2).

3.3. Three-score curve for inconclusive types

Moreover, morning, afternoon, and evening scores of inconclusive type (i.e., those survey participants were not self-assigned to 6 types illustrated with the charts of Fig. 1) were most frequently close to zero and each of these scores was not significantly higher or lower than two other scores (Tables 1 and 2). This result pointed at the possibility of existence of one more but very rare “atypical diurnal pattern” characterized by the close to middle levels of alertness throughout the day, i.e., in the morning, afternoon, and evening.

3.4. Discrepancy between a chart and a three-score curve

Results of statistical analysis pointed at one small disagreement between a daily pattern predicted by the SIC charts and a pattern yielded by the results of construction of three-score curve. The chart of napping

Table 2
Post hoc pairwise Bonferroni comparisons of relative morning, afternoon, and evening scores.

LIVEMAN	Supplementary Table		S5	S6	S7	S8	S9	S10
Type, N = or	Time of.	N	4940	2647	4940	2647	2647	2647
N=	the day vs.	another time	VJT	VJT	SWAT	SWAT	SWPAQ	Averaged
Morning	Morning	Afternoon	0.733***	0.707***	2.236***	2.200***	2.126***	1.678***
N = 451 or		Evening	1.305***	1.365***	6.529***	6.092***	8.666***	5.374***
N = 756	Afternoon	Evening	0.572***	0.658***	4.293***	3.892***	6.540***	3.697***
Evening	Morning	Afternoon	-0.747***	-0.636***	-1.924***	-1.431***	-1.459***	-1.175***
N = 738 or		Evening	-1.364***	-1.152***	-5.357***	-4.822***	-6.689***	-4.221***
N = 1292	Afternoon	Evening	-0.617***	-0.516***	-3.434***	-3.391***	-5.231***	-3.046***
Vigilant	Morning	Afternoon	0.256***	0.249**	1.027***	0.755*	0.450	0.485*
N = 299 or		Evening	0.395***	0.370***	2.780***	1.936***	1.310***	1.205***
N = 501	Afternoon	Evening	0.138	0.120	1.753***	1.180**	0.860	0.720**
Lethargic	Morning	Afternoon	-0.099	0.088	-0.038	0.176	0.085	0.117
N = 231 or		Evening	-0.056	0.253	0.272	0.805	1.096	0.718
N = 595	Afternoon	Evening	0.043	0.165	0.310	0.628	1.011	0.601
Napping	Morning	Afternoon	0.707***	0.669***	2.171***	2.252***	1.881***	1.601***
N = 275 or		Evening	0.346***	0.236	-0.353	-0.676	-0.639	-0.360
N = 689	Afternoon	Evening	-0.361***	-0.433***	-2.524***	-2.928***	-2.520***	-1.960***
Afternoon	Morning	Afternoon	-0.198***	-0.140***	-1.473***	-1.217***	-1.192***	-0.850***
N = 522 or		Evening	0.486***	0.441***	0.901***	0.653	1.029**	0.707**
N = 867	Afternoon	Evening	0.684***	0.581***	2.374***	1.869***	2.221***	1.557***
Inconclusive	Morning	Afternoon	0.104	0.202	0.290	0.231	0.509	0.314
N = 131 or		Evening	-0.204	0.155	-0.439	-0.449	0.223	-0.023
N = 240	Afternoon	Evening	-0.308***	-0.047	-0.729	-0.680	-0.286	-0.338

Notes. Post hoc pairwise Bonferroni comparisons following rANOVAs of scores in each of 7 subsamples of LIVEMAN chronotypes. Relative scores were from rANOVAs of relative scores on scales of the VJT, SWAT, and SWPAQ. Mean: chronotype-averaged relative score for Morning, Afternoon, and Evening or the difference between paired means. CI: Confidence interval. Level of significance for differences between two relative scores (post hoc pairwise Bonferroni comparisons): * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$. N = or N=: Data from the subsample for SWPAQ and Averaged (N = 2647) and from the whole sample for the VJT and SWAT (N = 4940). Printed in **bold**: Difference between time of the day is always significant; printed in **bold italic**: Difference between time of the day is always significant. The differences were taken from Tables S5-S10. See chronotype-averaged relative morning, afternoon, and evening scores and their standard deviations in Figs. 2 and S3.

type predicts high morning level of alertness, while middle rather than high level of alertness was revealed by the results of statistical analysis of morning score of the three-score curve of this type (Table 1).

4. Discussion

Output of chronotype all but one chronotype questionnaires is either clock time reported for certain behavior or a score on a single scale or several scores on several scales of a multidimensional questionnaire (e. g., Roenneberg et al., 2003, or Horne & Östberg, 1976, or Randler et al., 2016, respectively). The SIC (Putilov, Sveshnikov, et al., 2021) is this only chronotype questionnaire which output is simply the names of chronotypes rather than clock time or scale(s) score(s). Therefore, the conventional easiest way of evaluating validity of this new chronotype questionnaire against already established questionnaires, that is the estimation of correlation coefficients between the outputs of the new and one or more other questionnaires, cannot be applied for its validation. We here presented another approach for validation of the SIC against the scales of already established multi-item chronotype questionnaires. It consists of 1) the calculation of scores on separate morning, afternoon, and evening scales of the already established multi-item questionnaires to construct the three-score daily curves for chronotypes proposed by the SIC, and 2) the testing hypothesis that the SIC charts predict these chronotype-specific three-score daily curves. Here, we constructed these curves using 11 scales of three already established questionnaires and statistical analysis of the curves supported their practical identity to the SIC charts.

This analysis did not confirm only one of three points of one of 6 charts. The chart of napping type was a priori proposed to show high level of alertness in the morning that is much higher than low level of alertness proposed for the opposing afternoon type. However, napping types of our survey reported middle level of alertness in the morning instead of high level predicted by the SIC chart. It seems that this was a good idea to show high rather than middle level of alertness in this SIC chart. Therefore, correction of the chart of napping type can be recommended for further studies implicating the SIC. This correction does

not challenge the pattern of alertness in this type and the difference between this pattern and the pattern of afternoon type. Daytime level of alertness remains lower than both morning and evening levels in napping type, and morning level of alertness of this type remains higher than that of afternoon type.

Finally, the results of statistical analysis of the curve of 7th (inconclusive) type provided the possibility to interpret its daily pattern as the pattern characterized by middle level of alertness throughout the day, i. e., in the morning, afternoon, and evening hours.

Since chronotypes are subject to social valuation (Stolarski & Gorgol, 2022), the need for social approval may influence its self-assessments, particularly when it is based on a single forced-choice item. Due to this reason, ‘lethargic type’ was coined in the Russian version of the SIC to the term ‘moderately active type’. However, both the chart and description of alertness-sleepiness levels in the morning, afternoon and evening that are linked to the name of this type clearly pointed at the lethargic rather than moderately active levels. The results of validation of the SIC charts with multi-item multi-scale assessments (Figs. 2, S2A and S3B) showed that these types, indeed, reported lower than middle level of alertness/wakeability.

The multi-dimensional multi-scale questionnaires of our study (SWPAQ, SWAT and VJT) were designed to assess the dimensions of alertness/wakeability. Most of other such multi-dimensional multi-scale questionnaires (see Putilov, 2026) were designed to assess one or two dimensions of amplitude/stability (e.g., CTQ; Folkard et al., 1979; ChQ; Ogińska, 2011; MESSi; Randler et al., 2016). Such questionnaires were also used to distinguish between more than two (morning and evening) distinct chronotypes. For instance, the coining names of ‘lethargic type’ and its opponent ‘vigilant type’ was encouraged by such names as ‘languid (lethargic) type’ and ‘vigilant type’, respectively, from the much earlier proposed classification based on the CTQ (Folkard et al., 1979). Moreover, ‘morning and vigilant types’ of the SIC resemble ‘vulnerable and hardy larks’ most recently suggested by the MESSi-based classification (Gorgol et al., 2025). Only direct comparison of chronotypes proposed by different classifications of more than two distinct chronotypes can clarify the extent of their similarity between

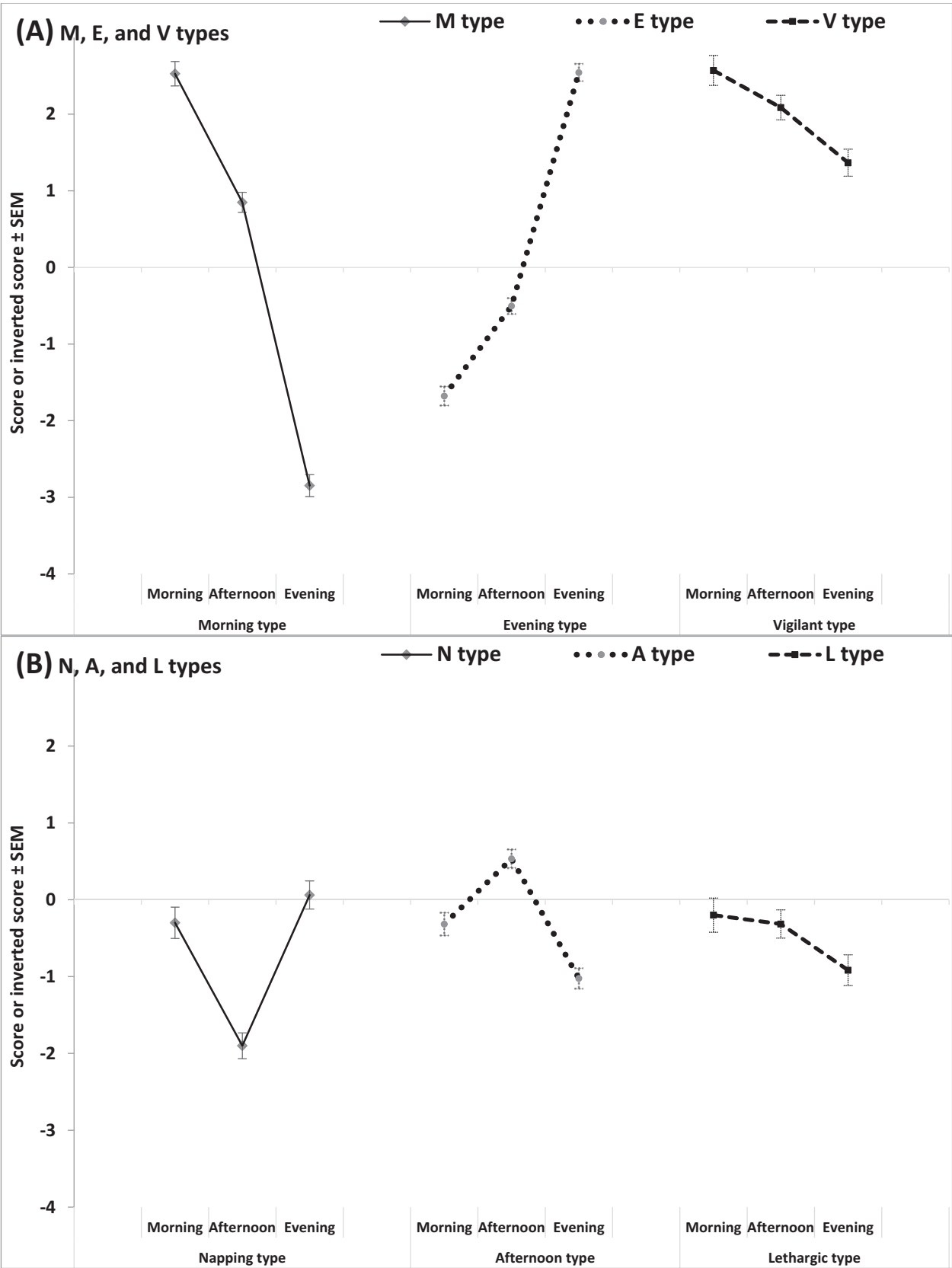


Fig. 2. Relative morning, afternoon, and evening scores of LIVEMAN types. (A). Morning (M), Evening (E), and Vigilant types (V). (B). Napping (N), Afternoon (A), and Lethargic types (L). Confidence intervals are given in [Table 1](#) (column: “Averaged”), and pairwise comparisons of morning, afternoon, and evening relative scores are reported in [Table 2](#) (the last column). See Figs. S1-S3 and Methods and Materials for the two steps of calculation of these scores.

such types.

Several limitations of this study require acknowledgement. The profound change in chronotype across ages (i.e., the transition from morningness to eveningness and back to morningness across adolescence and adulthood, respectively) does not allow the generalization of the results to the whole lifespan. Further research is necessary to demonstrate that the three-score (morning, afternoon, and evening) diurnal curves of chronotypes resemble their SIC counterparts irrespective of age of study participants and whether they are forced to switch from early and later wake ups on weekdays and weekends, respectively. One of other methodological limitations is the application of cross-sectional and non-repeated measures design in our survey that did not allow to evaluate test-retest reliability of the SIC. Therefore, the question about self-awareness regarding diurnal rhythms of an individual can be asked in future studies and replicability of the choice of one of chronotypes desires quantitative evaluation in these studies. Moreover, we did not measure subjective alertness levels at different clock times throughout the day, and did not apply objective methods for construction of diurnal curve of activity, e.g., by using such methods as actigraphy. Therefore, the subjectively determined daily patterns of LIVEMAN chronotypes require confirmation by measurement of subjective or objective level of alertness-sleepiness throughout the day. Additionally, results on subjective alertness-sleepiness levels might be confirmed by other subjective assessments, such as energetic arousal, tense arousal, and hedonic tone (see Jankowski & Ciarkowska, 2008) and measurements of cognitive and physical performance (see Facer-Childs & Balanos, 2018). Finally, the phase positions of objective markers of the circadian phase were not measured. Therefore, further studies can be based on, at least, two objective methods that can provide supporting evidence for the results of our survey: 1) the measurement of diurnal variation in behavior markers of alertness by applying the actigraphic methodology for replication of diurnal patterns suggested by the SIC charts and 2) the measurement of circadian phase markers, such as onset of melatonin secretion, for showing that the difference in circadian phase underlies the difference in the charts proposed for morning and evening types.

5. Conclusion

Here, we proposed a method of validation of the SIC against the scales of already established multi-item chronotype questionnaires and demonstrated its plausibility by statistical analysis of questionnaire data collected from 4940 survey participants. The method includes the following steps. 1. Calculation of scores on separate morning, afternoon, and evening scales of the already established multi-item questionnaires to construct a three-score daily curve for each of chronotypes proposed by the SIC charts. 2. Testing hypothesis that the SIC charts predict all these chronotype-specific three-score daily curves. These curves were constructed and statistically tested using scores on 11 scales of three already established questionnaires and the results supported the close resemblance between the three-score curves and SIC charts.

CRedit authorship contribution statement

Arcady A. Putilov: Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Methodology, Formal analysis, Conceptualization. **Dmitry S. Sveshnikov:** Writing – original draft, Investigation. **Zarina V. Bakaeva:** Writing – original draft, Investigation. **Elena B. Yakunina:** Writing – original draft, Investigation. **Olga V. Mankaeva:** Writing – original draft, Investigation. **Vladimir I. Torshin:** Writing – original draft, Investigation. **Elena A. Trutneva:** Writing – original draft, Investigation. **Michael M. Lapkin:** Writing – original draft, Investigation. **Zhanna N. Lopatskaya:** Writing – original draft, Investigation. **Roman O. Budkevich:** Writing – original draft, Investigation. **Elena V. Budkevich:** Writing – original draft, Investigation. **Anton I. Taranov:** Writing – original draft, Investigation. **Olga N. Tkachenko:** Writing – original draft, Investigation. **Eugenia O.**

Gandina: Writing – original draft, Investigation. **Alexander E. Manenkov:** Writing – original draft, Investigation. **Evgeniy A. Cheremushkin:** Writing – original draft, Investigation. **Natalya V. Ligon:** Writing – original draft, Investigation. **Alexandra N. Puchkova:** Writing – original draft, Investigation.

Ethical approval

Institutional Review Board Statement. The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of the Institute of Higher Nervous Activity and Neuropsychology (Approval#12402–02-7112 from 03.06.2019). **Informed Consent Statement.** The study participants were informed in detail about the survey procedure, and informed consent was obtained from each participant in the form of the response “Agree” to the following statement: “I give informed consent to anonymously and voluntarily participate in this online survey of sleep-wake behavior and habits”.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.paid.2026.113913>.

Data availability

Dataset is included in Appendix (Supplementary Tables S1-S10; Supplementary Figures S1-S3; Dataset), and a link is provided: DOI: 10.13140/RG.2.2.33622.31042 ((PDF) Appendix)

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