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Original article

Contextual factors and perceived self-reported sleepiness: a preliminary report

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Abstract

Objectives: The purpose of the present study was to determine whether contextual factors affect self-reported sleepiness. Specifically, when a reference situation is held constant (e.g. watching television), does the respondent's position, location, or interest in the activity alter sleepiness rating. We also evaluated interactions between an individual's level of sleepiness and the effect of these contextual factors.

Method: This is a prospective survey conducted at a teaching hospital. Samples were drawn from four populations: a general non-patient population ($n = 53$), a geriatric population ($n = 22$), a medical resident population ($n = 18$), and patients referred for sleep evaluation ($n = 53$). We developed and administered a questionnaire that included a list of activities varied according to respondent's position, location, or interest in the activity. This questionnaire, along with the Epworth Sleepiness Scale (ESS), was administered to 146 individuals.

Results: Overall, we found significant differences ($P < 0.01$) in self-reported sleepiness when contextual factors were varied. However, the influence of contextual factors declined as a function of increasing sleepiness (estimated using ESS scores).

Conclusions: The results of this preliminary study indicate that contextual factors can influence self-reported sleepiness rating; however, this influence diminishes as sleepiness increases. Thus, clarifying context may improve test sensitivity in more alert individuals but does not appear to add incremental value to self-reported sleepiness in sleepy patients.

Keywords: Self-reported sleepiness; Subjective sleepiness; Contextual parameters

1. Introduction

Daytime sleepiness is a common, serious, and potentially life-threatening condition. Although both objective and subjective techniques exist for assessing sleepiness, clinicians mainly rely on self-report. The most widely used sleepiness questionnaire is the Epworth Sleepiness Scale (ESS) [1]. ESS queries for self-rated probability of dozing in eight different situations. ESS is a global measure of self-reported sleepiness, is well validated [2], has been translated into several languages [3–5], and is extensively used in clinical setting and research [6,7]. Nonetheless, ESS correlation with objectively measured sleepiness (using Multiple Sleep Latency Test) and with pathophysiology underlying sleep-disordered breathing (apnea + hypopnea index) is modest [8,9].

Factors postulated to unmask sleepiness include being sedentary, performing a non-stimulating task, and/or being in a comfortable environment. As noted by Dement and Carskadon [10], moment-to-moment variations in sleepiness are influenced by "such diverse stimuli as light, noise, room temperature, activity level, motivation, recumbency, anxiety, bladder fullness, hunger, thirst, excitement, attention, and many others". Thus, self-reported sleepiness should be influenced by the contextual factors, including the respondent's position (standing, sitting, lying down), location (a public vs. private place), or an individual's interest level in the activity (interesting vs. boring). Moreover, such factors may affect whether a person will inadvertently doze. In ESS, four of the eight situations explicitly probe sleepiness while an individual is seated, two others imply sitting, one specifies lying down, and in one question the individual's position remains ambiguous (question 2: 'Watching TV'). Respondent's activity location and interest level are not otherwise considered in ESS.

The purpose of this study was twofold. First, we wanted

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to evaluate whether the respondent's position, location, or interest in the activity affect self-reported sleepiness. Secondly, we evaluated the differential effect of these factors across different severities of sleepiness and in different study groups.

2. Methods

2.1. Activity list generation

We compiled a list of verbs related to common activities (e.g. watching, reading, thinking, driving, listening, eating, riding, playing, waiting, talking, and attending) and then created a list of situations related to each verb (e.g. watching a TV show). From this we elaborated different situations varied according to the respondent's interest in the activity (e.g. watching your *favorite* TV show). Finally, descriptors for locality, position, or both were added to the activity description (e.g. watching your favorite TV show *while lying on a bed*). In total, 42 situations were constructed. For three of the activities specified *(reading, watching TV,* and *listening)*, we systematically varied interest level, position, and location. The first two of these activities are also used in ESS.

2.2. Subjects

Of 160 individuals approached, 146 completed the questionnaire. We enrolled subjects into four different groups: (1) general non-patient group, (2) geriatric group, (3) medical residents, and (4) patients referred for sleep evaluations. The number of individuals, age, and sleep habit information for each group are shown in Table 1. Questionnaires were given only to those subjects who were mentally and physically able to respond.

Subjects in the first group (general non-patient) consisted of individuals from the community with a variety of occupations and levels of education. This group was obtained by sampling workers at a large municipal corporation. The geriatric group included individuals that were age 65 years, or older. This sample was obtained from elderly volunteers attending their regular scheduled preventive medicine health care visits at outpatient clinics. The medical residents were a group of internal medicine residents who were on call at least every fourth night (therefore somewhat sleep deprived). Finally, the sleep patient group was comprised of unselected consecutive patients referred to the Sleep Disorders Center to evaluate daytime sleepiness and sleep-related breathing disorders.

2.3. Procedure

Questionnaires were distributed by hand. We provided instructions both verbally and in writing. Institutional review board approved informed consent coversheet was included with each questionnaire packet. In addition to the study questionnaire, each subject completed a demographic questionnaire, a sleep-schedule questionnaire, and the ESS. For purposes of analysis, ESS was used as a standard against which our experimental measures were compared.

3. Results

Means, standard deviations (SD), and the result of statistical comparisons for *reading, listening,* and *watching TV* in situations that differ with respect to contextual factors are shown in Table 2. Significant differences ($P < 0.01$) were found as a function of context. For example, the ESS item 'watching TV' mean was significantly lower than when subjects were asked about dozing while 'watching a boring TV show while lying on a bed'. The contextual factor *location* produced the most robust effect in that the activities in 'public places' had uniformly and significantly lower sleepiness ratings. A similar, but smaller, effect was found for the two other contextual factors evaluated in this study.

To test for possible differential contextual factor effects across subject groupings, we performed a Generalized Linear Models Analysis of Variance (with a main effect for GROUP) on ESS and the study questions. Further inter-group comparisons were made using Tukey procedures.

Table 1
Number of subjects, age, self-reported sleep schedule, and Epworth Sleepiness Scale (ESS) total score for subjects in each group

		General non-patient	Geriatric	Medical residents	Sleep patients
n		53	22	18	53
Age (years)	Mean	40.5	77.9	27.8	53.4
	SD	13.8	7.4	2.5	9.1
TST (h/night)	Mean	6.7	6.7	6.0	5.8
	SD	1.0	1.4	0.8	1.6
Nap frequency	Never	7.0	3.0	2.0	4.0
	Occasionally	40.0	9.0	15.0	18.0
	Daily	6.0	9.0	1.0	30.0
ESS*	Mean	7.6*	8.6*	12.0	15.2

TST, total sleep time. *Differs significantly ($P < 0.01$) from sleep patients.

Table 2
Means, standard deviations, and multiple comparison results for questions concerning sleepiness while reading, listening, and watching TV

	Designation	Description of Situation	Mean	SD	Differences
Reading	Situation E	ESS, Sitting & reading	1.71	0.98	Versus 2,3,4,6
	Situation 1	Reading, interesting, lying	1.64	1.09	Versus 2, 3,4,6
	Situation 2	Reading, interesting, sitting	1.35	1.03	Versus E, 1,3,4,5
	Situation 3	Reading, interesting, public place	0.98	1.00	Versus E, 1,2,4,5,6
	Situation 4	Reading, boring, lying	2.10	1.01	Versus E, 1,2,3,5,6
	Situation 5	Reading, boring, sitting	1.74	1.01	Versus 2,3,4,6
	Situation 6	Reading, boring, public place	1.29	1.03	Versus E, 1,3,4,5
Listening	Situation 1	Listening, interesting, lying down	1.39	0.99	Versus 3, 4, 6
	Situation 2	Listening, interesting, sitting	1.29	0.96	Versus 3, 4, 6
	Situation 3	Listening, boring, lying down	1.89	0.98	Versus 1, 2,5,6
	Situation 4	Listening, boring, sitting	1.72	0.97	Versus 1,5,6
	Situation 5	Listening, boring, public place	1.25	1.01	Versus 3, 6
	Situation 6	Listening, interesting, public place	1.0	0.96	Versus 1, 2, 3, 4, 5
Watching TV	Situation E	ESS, watching TV	1.70	0.99	Versus 2,3
	Situation 1	Watching TV, favorite, lying	1.58	1.05	Versus 3,4
	Situation 2	Watching TV, favorite, sitting	1.38	1.07	Versus E, 3,4
	Situation 3	Watching TV, boring, lying	2.08	1.03	Versus E, 1,2
	Situation 4	Watching TV, boring, sitting	1.85	1.03	Versus 2

Statistically significant ($P < 0.01$) differences are shown as comparisons to each situation designation.

Significantly higher scores for ESS and each of the study questions were found for sleep patients compared to the general population and the geriatric patient groups. An analogous statistical model was applied for regroupings stratified by severity of sleepiness, based on ESS total score.

Fig. 1 illustrates mean sleepiness scores across study groups (Fig. 1A) and across regrouping stratified by sleepiness (Fig. 1B). ESS-based groupings were normal (ESS = 0–8), mild to moderate (ESS = 8–15), and severe (ESS = 16–24). The normal non-patient group showed the most consistent variation as a function of contextual factors. The groups with higher overall sleepiness levels (medical residents and sleep patients) exhibited less context-dependent variation. Interestingly, geriatric patients did not have a

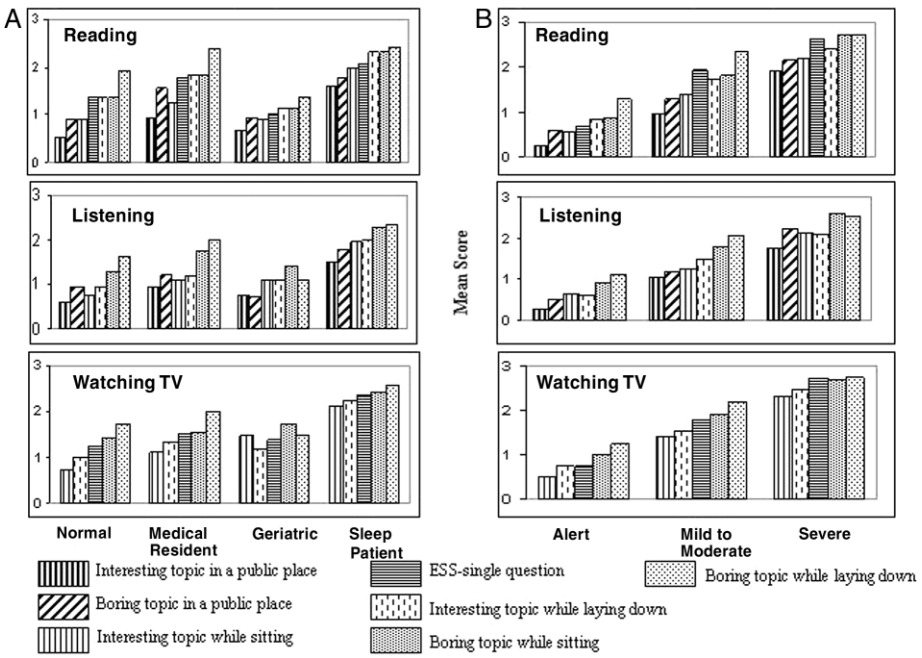

Fig. 1. Mean sleepiness scores showing contextual factor effects for each study group (A) and groups stratified according to ESS total score (B). ESS groupings were alert (ESS ≤ 8), mild to moderate sleepiness (8 < ESS ≤ 15), and severe sleepiness (ESS ≧ 16). Note: The number of bars differs between activities because not all contextual modifiers could be used; additionally, no ESS-like item exists for 'listening'. For Reading and Listening, six different variations were generated in addition to the ESS item (for a total of seven bars for Reading but only six bars for Listening). For Watching TV, four different variations were generated in addition to the ESS item (for a total of five bars).

consistent pattern. In data stratified by sleepiness, the most consistent patterns were found in less sleepy subjects because context effects were less likely to increase scores in already sleepy individuals.

4. Discussion

The results of current study indicate that contextual factors affect self-reported sleepiness. However, we also found that the influence of contextual factors was attenuated as sleepiness increased. Generally, sleepiness assessment questionnaires used in clinical practice (e.g. ESS) do not specify context and this may contribute to variability. Thus, the subtle differences that under normal circumstances affect self-reported sleepiness are less relevant to the sleepy individual. This indicates that current paper-and-pencil tools used to clinically assess sleepiness are minimally compromised by differential context effects in patients with excessive daytime sleepiness. Nonetheless, the three different contextual factors under study all systematically affected self-reported sleepiness in a predictable manner.

The contextual factors studied included respondent's position, location, and interest in the activity. The most potent factor in altering reported sleepiness was location. Being in a public place outweighed other contextual factors in nearly all study groups. After the influence of location, the subject's interest level in the activity (boring vs. interesting) followed. Surprisingly, the weakest contextual factor studied was respondent position (sitting vs. lying down).

Several mechanisms may underlie the influence of contextual factors on self-reported sleepiness. One possibility is that these effects are mediated through change in sympathetic nervous system activity [11]. Sympathetic activation, whether it is internally generated (e.g. fear) or externally generated (e.g. stimulant medications), can increase alertness. This aminergically mediated activation system, together with the circadian and homeostatic sleep systems determine an individual's overall alertness [12]. Many sleepiness countermeasures involve using substances or maneuvers designed to increase sympathetic activation. Postural change, stimulus relevance, and environmental stimuli are known to alter autonomic balance. These factors, in turn, could change the estimated probability of dozing.

Stimulation provided by autonomic activation often exhibits declining efficacy in the face of increasing sleepiness. This is why many sleep countermeasures eventually fail to keep an individual awake in more extreme cases. This may explain why the contextual factors produced less alteration of self-reported sleepiness in our sample drawn from the sleep disorders clinic compared to controls. At some stage, sleepiness may overwhelm wakefulness regardless of an activity's location or interestingness. Thus, a patient with excessive daytime sleepiness will have a high probability of falling asleep whether the TV show they are watching is interesting or boring.

This study is only a preliminary step toward understanding the effect of contextual factors with respect to sleepiness. The study is limited in that it used only self-reported measures rather than directly monitoring electroencephalographic activity or vigilance during activities with different contextual factors. Additionally, although the sample size was adequate to show the effect, additional subjects are needed to validate the finding. This is especially the case among our elderly subjects in which results were more variable. Finally, to further explore possible underlying mechanisms associated with the effect of contextual factors on the measures of self-reported sleepiness it would be helpful to index sympathetic nervous system activation in different contexts.

In summary, contextual factors affect perception of self-reported sleepiness. The largest effect is found in normal controls and diminishes as sleepiness increases. Therefore, including contextual factors in sleepiness questionnaires minimally affects self-report in patients with excessive sleepiness; however, it may improve test sensitivity for detecting small differences in sleepiness in alert individuals.

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