

# Are difficulties perceiving and expressing emotions associated with low-back pain?

## The relationship between lack of emotional awareness (alexithymia) and 12-month prevalence of low-back pain in 1180 urban public transit operators

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Received 6 January 2004; accepted 26 May 2004

### Abstract

**Objective:** To assess the association of alexithymia (deficit in emotional awareness) with 12-month prevalence of low back pain (LBP) cross-sectionally in a cohort study of 1180 San Francisco transit operators. **Methods:** Alexithymia was measured by the Toronto Alexithymia Scale (TAS-20). LBP was assessed in medical histories during drivers relicensing exams. Multivariate logistic regression analyses controlled for demographic, behavioral (smoking, alcohol, coping style), and physical and psychosocial job factors measured by questionnaire and interview. **Results:** Of

all the drivers, 31.4% suffered from LBP. Scoring in the upper quartile of alexithymia summary scores was associated with twofold higher odds of LBP (adjusted odds ratio=2.00, 95% confidence interval: 1.31–3.00). The association was stronger in women (adj. OR=4.35) than in men (adj. OR=1.83). The factor “difficulty identifying feelings” showed the strongest association with LBP (adj. OR=2.23). **Conclusion:** The results support an association between alexithymia and LBP.

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**Keywords:** Low back pain; Alexithymia; Emotions; Psychosocial risk factors; Coping style

### Introduction

Work-related back injuries represent approximately 20% of all workers' compensation claims and are responsible for 33% of all workers' compensation costs in the US [1]. About 2% of the U.S. workforce are compensated for back injuries each year [2]. Disability due to chronic low-back pain (LBP) has been increasing faster than any other form

of chronic disability [3]. Traditional therapeutic interventions (NSAIDs, physical therapy, massages, and exercises) have an unsatisfactory success rate, and their therapeutic value has been repeatedly questioned [4]. Clearly, newer concepts in understanding and treating LBP are needed. Recent studies found that patients with (mostly chronic) LBP suffer from a measurable deficit of *proprioception*, which can be seen as a subcategory of “body-awareness” contributing to the clinical course of LBP [5–10]. Clinical studies suggested that these patients exhibit a deficit of *emotional awareness* as well [11–16]. For this unawareness of emotions, Sifneos et al. [17] introduced in 1973 the term “alexithymia”, literally (from Greek) no (a-) words (-lexi-) for feelings (-thymia). The alexithymia construct is related

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to and overlaps with two other more recently proposed constructs: “emotional numbness” from posttraumatic stress disorder (PTSD) [18] and “emotional intelligence”, which has been far less studied but received considerable attention in the public [19–21]. The current concept of alexithymia is defined, in part, by an insufficient realization that some physical sensations can be the manifestation of emotions [22]. Emotions, in general, have a component of sensory feeling (besides a motivational drive; [23,24]), and, according to most recent neuroscience, emotional awareness relies on the central processing of *interoception* (perception of internal body sensations or “somatic markers” [24]). Intriguingly, interoception uses the same afferent neurological pathways as slow pain does [23,25,26]. Lacking awareness of body sensations (deficit in proprioception) and of emotions (alexithymia, deficit in interoception) might be closely linked. Furthermore, the risk of chronicity of LBP has been found to be associated with an avoiding and repressive coping style [27–31]. Alexithymia might be a personality trait underlying this coping behavior [18,32], if not an independent risk factor for the chronicity of LBP. Addressing these deficits (i.e., attention regulation, discerning emotions, and physical sensations, cognitive modulation of pain, changing coping styles) might offer a new perspective for both treatment and prevention of chronic LBP.

Internationally, the concept of alexithymia has been widely investigated, reviewed [22,33–35], and debated. It was tested in patients with chronic pain, somatoform disorder, rheumatoid arthritis, inflammatory bowel disease, hypertension, coronary artery disease, oligozoospermia, addiction, pathologic gambling, eating disorders, and all-cause mortality [33,36–39]. Alexithymia seems to be associated with dysregulations in the direct experience of emotions (“phenomenal awareness”; [40]), particularly in its arousal dimension [41] and the reflection of the emotion’s content (“reflexive awareness”; [40]). Neurobiologically, according to several functional MRI and PET studies [40,42–45], alexithymia is associated with diminished activation in circumscribed brain regions, mostly in the rostral anterior cingulate cortex (ACC). This has been interpreted as representing decreased reflexive emotional awareness.

Several studies examine the association between alexithymia and LBP [11–16]. Using the Thematic Apperception Test, 41 chronic LBP patients were independently evaluated for alexithymia by two clinicians; both evaluators agreed on alexithymia as one of the main features of these patients [15]. Two cross-sectional studies in the same 33 LBP patients showed significantly higher mean scores of seven alexithymia variables, measured by the Rohrschach test, when compared with healthy controls or depressive patients [11,12]. Another study examined 165 chronic LBP patients applying seeded cluster analysis to Minnesota Multiphasic Personality Inventory scores and found consistent alexithymia scores among empirically derived sub-

groups [14]. These four descriptive or cross-sectional studies show a positive association between alexithymia and LBP. However, the results of two prospective studies are inconsistent: One clinical trial among 175 Finnish patients with chronic LBP showed (comparing mean scores from the Rohrschach and the Sentence Completion Tests between good and poor responders by *t* test) that alexithymia played a hindering role in spontaneous recovery from chronic LBP during 1 year of follow-up; however, the study was limited to women [13]. On the other hand, a life-long prospective cohort study in Finland assessing alexithymia in 13-year-old children as lack of verbal productivity found no association with LBP in their adult life [16].

Several self-report instruments [33], an observer scale [46,47], and a performance test [48] have been developed to evaluate alexithymia. Today, the internationally widely used 20-item Toronto Alexithymia Scale (TAS-20) is the best psychometrically acceptable test [49,50] that can be used in larger epidemiological studies. However, none of the studies described above used the TAS-20, thus limiting inferences from the earlier data. Clearly, more research is needed to determine the possible role of alexithymia in chronic LBP. To this end, Krause and Rugulies [51] included the TAS-20 questionnaire into a larger prospective cohort study of municipal bus drivers in San Francisco. In this paper, we report on the baseline association of alexithymia with 12-month prevalence of LBP.

## Methods

### *Study design and population*

In 1993, the TAS-20 questionnaire was integrated into a cohort study of San Francisco Municipal transit operators designed to test physical and psychosocial risk factors for job-related back injuries [51]. The study population consists of 1841 active transit operators, who underwent a mandated biannual medical examination between August 1993 and September 1995, driving diesel buses, electric trolley buses, light rail streetcars, and historic cable cars. Immediately following the medical evaluation and after the decision on relicensing was made, 1502 (81.6%) participants answered an epidemiological baseline questionnaire including the TAS-20 items. Due to missing data for the outcome variable (LBP) and/or the predictor variable of interest (TAS scores), 86 participants were excluded from analyses. An additional 236 participants were excluded because of incomplete data for the covariates used in our regression models, leaving a total of 1180 public transit workers with complete data for analyses.

### *Measurement of LBP*

The 1-year period prevalence of self-reported LBP was assessed by a medical history form during the baseline

medical examination with the following question “Have you had pain, ache, or discomfort in the lower back area in the last 12 months?” The answer options were “yes” and “no”.

### Measurement of alexithymia

Alexithymia, the primary independent variable, was measured as (1) the continuous summary score of the TAS-20 and (2) three subscales (TAS-1, TAS-2, and TAS-3) using a four-point Likert scale. The subscales measure the difficulty in identifying feelings (TAS-1), difficulty in describing feelings (TAS-2), and external-oriented thinking (TAS-3).

The TAS-20 scale has acceptable internal consistency: Cronbach’s  $\alpha = .81$  [49] and mean interitem correlation coefficient .17 [49]. Intermethod reliability estimates compared with self-report Psychological Mindedness Scale (PMS; Pearson product–moment correlation  $r = -.68$ ,  $P < .01$ ; [50]), Need for Cognition Scale (NSC;  $r = -.55$ ,  $P < .01$ ; [50]), and NEO Personality Inventory (NEO-PI; relevant factors  $r = .29$  to  $.55$ ,  $P < .01$ ; [50]) support convergent construct validity. Comparisons with NEO-PI (irrelevant factors  $r = -.09$ – $-.21$ ; [50]) also support discriminant construct validity, as do comparisons with external observer ratings by the Beth Israel Hospital Psychosomatic Questionnaire ( $r = .48$  to  $.53$ ,  $P < .01$ ; [50]). The internal consistency is best for subscales TAS-1 and TAS-2, clearly less strong for TAS-3 [22], and the factor loading of the TAS-3 subscale is unsatisfactorily low [22].

This might be due, in part, to cultural differences and language problems [52]. Data for these validations have been obtained primarily from college student samples or, to

Table 2

Alexithymia scores in drivers with and without 12-month history of LBP ( $N = 1180$ )

Alexithymia score	Low-back pain		<i>P</i> ( <i>t</i> test)
	No ( $n = 797$ )	Yes ( $n = 389$ )	
TAS-20	37.7 ( $\pm 9.6$ )	38.3 ( $\pm 9.4$ )	.31
TAS-1	11.4 ( $\pm 4.6$ )	12.0 ( $\pm 4.6$ )	.02
TAS-2	9.9 ( $\pm 3.4$ )	9.9 ( $\pm 3.3$ )	.89
TAS-3	16.6 ( $\pm 3.6$ )	16.4 ( $\pm 3.5$ )	.36

a lesser degree, from psychiatric patients but not from blue-collar or service workers such as transit operators. The observer alexithymia scale [46] was not published at the time of this study and would not have been feasible to use in this large cohort. For the same reason, the alexithymia performance test (Levels of Emotional Awareness Scale [48]) is not applicable in an epidemiological or occupational study setting.

The stability of the alexithymia trait has been supported by a test–retest reliability of 0.74 ( $P < .001$ ; [22]), mostly for periods of 3 months or less, with the exception of two studies on psychiatric and on coronary heart disease patients over 1 and 2 years, respectively [53,54]. Interestingly, the latter study showed a lasting significant decrease of alexithymia scores (and less prospective cardiac events) by group psychotherapy enhanced by mind–body techniques. Accordingly, the closely related “emotional numbness” in the PTSD context has been interpreted as a reactively acquired state.

### Measurement of potential confounders

The following covariates were assessed by questionnaire and interview administered after the baseline medical evaluation: age, gender, marital status, level of education and income [55], smoking, alcohol intake, physical workload, weekly hours of professional driving, vehicle type, job strain (Job Content Questionnaire, Karasek, 1985, [56,93]). Details of the respective instruments have been described elsewhere [57,58]. As coping styles have been reported to be associated both with alexithymia [37,59] and the chronicity of LBP [28,60–62], we also assessed for the following coping style variables included in the primary

Table 1

Characteristics of San Francisco municipal transit drivers ( $N = 1974$ )

	Respondents $n = 1180$	Nonrespondents <sup>a</sup> $n = 794$	<i>P</i> <sup>b</sup>
Age [mean ( $\pm$ S.D.)]	46.4 ( $\pm 7.9$ )	47.0 ( $\pm 7.5$ )	.118
Sex			.013
Female (%)	15.6	19.9	
Male (%)	84.4	80.1	
Ethnicity			.000
African-American (%)	54.3	64.6	
Caucasian (%)	12.5	10.6	
Hispanic (%)	12.6	9.3	
Asian/Pacific Islanders (%)	11.4	9.0	
Filipino (%)	7.5	4.4	
Vehicle type			.009
Diesel buses (%)	44.8	52.0	
Electric trolley buses (%)	34.3	29.2	
Light rail streetcars (%)	13.1	10.3	
Historic cable cars (%)	7.9	8.6	
Ergonomic Problems	16.0 ( $\pm 5.9$ )	15.1 ( $\pm 6.4$ )	.002
LBP in past 12 months (%)	33.0	28.9	.063

<sup>a</sup> Drivers who declined to respond to entire epidemiological questionnaire or individual items of final logistic model.

<sup>b</sup> Based on *t* tests for continuous and  $\chi^2$  test for categorical variables.

Table 3

Cronbach’s alpha for TAS-20 summary scale and subscales ( $N = 1180$ )

Scale/subscale	$\alpha$
TAS-20: summary scale	.85
TAS-1: difficulty identifying feelings	.86
TAS-2: difficulty describing feelings	.73
TAS-3: external-oriented thinking	.48

Correlation coefficients for subscales: TAS-1/TAS-2: 0.68; TAS-1/TAS-3: 0.40; TAS-2/TAS-3: 0.48 ( $P < .0001$ ).

Table 4

Association between alexithymia<sup>a</sup> and 1-year prevalence of LBP with adjustment for demographic, workplace, psychological, and behavioral factors: San Francisco Public Transit Operators 1993 (*N* = 1180)

	TAS-20	<i>P</i>	TAS-1	<i>P</i>	TAS-2	<i>P</i>	TAS-3	<i>P</i>
Crude odds ratios (95% CI)	1.25 (0.89–1.77)	.198	1.68 (1.20–2.36)	.003	0.97 (0.70–1.36)	.878	0.89 (0.63–1.25)	.495
Odds ratios (95% CI) adjusted for <sup>b</sup>								
sex, age, ethnicity	1.55 (1.07–2.22)	.019	1.88 (1.32–2.68)	.000	1.13 (0.80–1.60)	.489	1.03 (0.72–1.48)	.874
+vehicle type	1.64 (1.13–2.37)	.008	2.01 (1.40–2.87)	.000	1.17 (0.83–1.67)	.373	1.07 (0.74–1.55)	.704
+ergonomic factors	1.60 (1.10–2.34)	.015	1.83 (1.26–2.65)	.001	1.17 (0.81–1.69)	.400	1.22 (0.83–1.79)	.305
+job strain, supervisor support	1.61 (1.10–2.36)	.014	1.84 (1.27–2.67)	.001	1.18 (0.82–1.70)	.374	1.22 (0.83–1.79)	.304
+denial and planning coping style	1.97 (1.30–2.97)	.001	2.18 (1.47–3.25)	.000	1.29 (0.88–1.90)	.187	1.47 (0.98–2.21)	.062
+smoking, alcohol	2.00 (1.31–3.00)	.001	2.23 (1.50–3.33)	.000	1.31 (0.89–1.92)	.167	1.45 (0.96–2.17)	.075

<sup>a</sup> Comparing upper (for TAS-20 *n* = 304; TAS-1 *n* = 295; TAS-2 *n* = 291; TAS-3 *n* = 263) with lower quartile (TAS-20 *n* = 294; TAS-1 *n* = 341; TAS-2 *n* = 312; TAS-3 *n* = 332).

<sup>b</sup> Incremental adjustment: each line includes the previous adjustments.

study questionnaire: denial, planning, and behavioral disengagement (COPE Scale [63]).

### Analysis

Respondents and nonrespondents were compared by *t* and  $\chi^2$  tests. Logistic regression models were used to examine the association between alexithymia and LBP prevalence. The three alexithymia subscales were treated as separate independent variables, as one or two of them might be more closely associated to the outcome [64]. The developers of the TAS-20 scale suggested cut-off scores for classifying individuals as alexithymic, which have been derived from a rather different population of college students [65] and were not based on a critical evaluation of relative sensitivity and specificity. Therefore, rather than classifying individuals as alexithymic or not, we compare those individuals with high scores (upper quartile) with those with low scores (lower quartile of the distribution). This method had been used previously in studies of alexithymia [38,39].

The internal consistency of the alexithymia scales was assessed by Cronbach's alpha. We also tested internal consistency for the different ethnic subgroups.

We identified potential confounding variables by individually entering them into age- and sex-adjusted logistic models. We entered groups of related confounding variables incrementally into the final model, thereby adjusting for demographic (age, sex, and ethnicity), physical work related (vehicle type and ergonomic problems), psychological work related (job strain and supervisor support), general psychological (denial and planning coping), and behavioral (alcohol and smoking) factors. We assessed the final models

for goodness-of-fit by the Hosmer-Lemeshow test and for the contribution of alexithymia by likelihood ratio tests. Data were analyzed using Stata Statistical Software, Version 8 (Stata, College Station, TX).

### Results

Complete data on LBP and all independent variables were provided by 1180 drivers. Table 1 shows the characteristics of San Francisco transit operators separately for respondents and nonrespondents. The sample population consists mostly of men at an average age of 46 years. More than half of all drivers were African-American. Compared with respondents, a significantly greater proportion of women, African-Americans, and diesel bus drivers declined to answer the questionnaire. Almost a third (31.4%) of all drivers suffered from some kind of LBP in the past 12 months before baseline exam. We found a higher LBP prevalence in drivers who provided complete answers to all questionnaire items compared with nonrespondents.

The study population's TAS-20 scores range from 20 to 72 (on a maximum scale range from 20 to 80), with a mean of 37.9 and standard deviation of 9.6. Table 2 compares the mean alexithymia summary and subscale scores for drivers with and without LBP. Drivers with LBP exhibited slightly higher alexithymia scores for the TAS-20 scale and TAS-1 subscale, but not for TAS-2 and TAS-3 subscales. As the study questionnaire used a four-point Likert scale, the absolute scale values cannot be directly compared with those of the more commonly used five-point Likert scale in other studies.

Table 5

Association of alexithymia with LBP prevalence stratified by sex (*N* = 1180)

Sex	<i>n</i>	TAS-20		TAS-1		TAS-2		TAS-3	
		OR (95% CI)	<i>P</i>	OR (95% CI)	<i>P</i>	OR (95% CI)	<i>P</i>	OR (95% CI)	<i>P</i>
Men	996	1.83 (1.16–2.91)	.010	1.90 (1.22–2.97)	.005	1.25 (0.82–1.90)	.308	1.52 (0.97–2.38)	.069
Women	184	4.35 (1.50–12.59)	.007	5.75 (1.98–16.67)	.001	2.52 (0.91–6.98)	.075	1.77 (0.61–5.12)	.289

Adjusted for demographic factors (age, ethnicity), vehicle type, ergonomic score, job strain, supervisor support, denial and planning coping style, and behavioral factors (smoking and alcohol); the same variables as used in Table 4 last row, except sex.

Table 6

Association\* between alexithymia and 1-year LBP prevalence for different ethnic subgroups in San Francisco Public Transit Operators (using the same model as in Table 4)

Ethnicity	<i>n</i>	TAS-20	<i>P</i>	TAS-1	<i>P</i>
African-American	637	1.64 (0.95–2.83)	.077	2.75 (1.60–4.74)	.000
Hispanic	149	1.66 (0.54–5.16)	.379	0.63 (0.23–1.72)	.366
Caucasian	143	4.66 (1.32–16.49)	.017	5.45 (1.58–18.84)	.007
Asian	135	5.76 (0.32–104.65)	.236	5.50 (0.61–49.85)	.129
Filipino	82	8.41 (0.49–143.50)	.141	4.97 (0.30–83.12)	.265

\* Adjusted for demographic factors (age and sex), vehicle type, ergonomic score, job strain, supervisor support, denial and planning coping style, and behavioral factors (smoking and alcohol); the same variables as used in Table 4 last row, except ethnicity.

Cronbach's alpha was assessed for all TAS-20 scales, as well as for the three subscales (Table 3). Good internal consistency was found for TAS-20, TAS-1, and TAS-2 scales but not for TAS-3. The lack of consistency was not limited to non-Caucasian groups: alpha was .46, .41, .59, .29, and .27 for African Americans, Hispanics, Caucasians, Asians, and Filipinos, respectively. Results did not change when we included the 236 drivers who did respond to the alexithymia and LBP items but not to the covariates used in the final model. The three TAS-20 subscales were inter-correlated (Table 3).

Table 4 presents the results from logistic regression analyses comparing the odds of LBP among drivers in the upper quartile of alexithymia with drivers in the lower quartile. The first row shows unadjusted odds ratios with 95% confidence intervals and *P* values. The second row shows odds ratios after adjustment for age, sex, and ethnicity. The following rows show odds ratios with incremental adjustment for additional covariates; the last row displays the results after simultaneous adjustment for all covariates: Higher alexithymia scores are consistently associated with self-reported LBP in all multivariate analyses. The strongest and statistically significant associations were found for the TAS-20 summary scale and TAS-1 subscale "difficulty identifying feelings". The odds ratios from the fully adjusted model were 2.00 (95% CI=1.31–3.00) for the TAS-20 scale and 2.23 (95% CI=1.50–3.33) for the TAS-1 subscale. The TAS-2 and TAS-3 subscales were only weakly and not significantly associated with LBP. Adjustments for additional variables, including marital status, level of education, income, body mass index, years of driving, overtime hours, weekly driving hours, behavioral disengagement coping, psychological job demands, and decision latitude, did not change substantially the strength of the association between alexithymia and LBP prevalence.

The Hosmer-Lemeshow goodness-of-fit test demonstrated good fit for the full models, with the following *P* values: TAS-20, *P*=.398, and TAS-1, *P*=.240. Likelihood ratio

tests confirmed the statistically significant contribution of alexithymia as a predictor to the models: for TAS-20, *P*=.003, and for TAS-1, *P*=.001.

Alexithymia scores were not significantly different between men and women (mean TAS-1 score in men=11.41, in women=11.48; *P*=.825). Table 5 presents the analyses stratified by sex based on the fully adjusted logistic regression model showing that the association between alexithymia and prevalence of LBP is stronger in women than in men across all alexithymia measures (i.e., OR for TAS-20=4.35 for women vs. 1.83 for men). Table 6 presents the analyses stratified by ethnicities based on the same model. The effect of alexithymia on LBP appears to differ considerably between ethnic groups, even after adjustment for demographic, workplace, psychological, and behavioral factors. The association is particularly strong in Caucasians (OR=4.66 for TAS-20, and OR=5.45 for TAS-1) and statistically significant only in African-Americans and Caucasians.

We can summarize the main results in the following way: For those San Francisco transit workers who have difficulty identifying feelings, their odds of having LBP are more than twofold compared with drivers without that difficulty, even after adjusting for demographic factors (age, sex, and ethnicity), vehicle type, ergonomic factors, job strain, supervisor support, denial coping style, and behavioral factors (smoking and alcohol). The effects of alexithymia differ by ethnicity. Women with that difficulty are at higher risk than men are.

## Discussion

### Primary result

The 12-month period prevalence of LBP in San Francisco municipal transit operators is comparable with that of the general population (31.4% vs. 15–45%; [2]). Our data from 1180 active drivers reveal a statistically significant association of alexithymia, in particular the difficulty of identifying feelings with LBP. For female drivers with this difficulty, the odds of having had LBP in the prior 12 months is more than fivefold when compared with drivers without that difficulty. The TAS-1 subscale seems to be the major and only component of the entire TAS-20 scale statistically significant associated with LBP. It asks whether subjects feel unclear and confused about their emotions, body sensations, and feelings, whether they sometimes do not know what it is they are feeling, emotions or simple body sensations.

Our results confirm the association of alexithymia with LBP found in prior descriptive and cross-sectional studies [11,12,14,15] conducted with instruments of lesser validity than the one used in our study. These previous studies did not control for physical workload, job strain, coping styles, smoking, or alcohol consumption while we adjusted for all these.

From the very beginning, psychosomatic literature has speculated that patients with recurrent or chronic LBP might suffer from specific psychological conflicts [66] or have a certain personality trait [67], which might predispose them to LBP. In the era of psychodynamic theories, this personality was formulated as “endurance personality” [67]. The “endurer” was seen as a person who neglects and ignores her own feelings, never learned to incorporate an evaluation of her own emotions or feelings into her decision-making process or adaptive responses to challenging situations. Faced with stressful situations, the endurer simply sticks it out. Operationalizing this behavior as a possibly disadvantageous coping style and risk factor for chronicity of LBP, behavioral science confirmed the endurer and, interestingly, particularly the *happy* endurer as at increased risk of developing chronic pain [28–30,68,69]. Happy endurers, according to that concept, do not appear depressed; to the contrary, they rather maintain a smiling façade. Remarkably, the happy endurers are at even greater risk for pain chronicity when compared with depressed patients presenting with acute LBP [68]. The alexithymia and LBP findings, supported by the concept of the happy endurer, could possibly explain the contradictory findings on the association of depression and LBP [70,71].

Persons who do not know how to interpret their feelings and body sensations (somatic markers; [72]) might lack an important resource for behavioral adaptation to stressful events. This interpretation is supported by neuroscience: Damasio [24,72] proposes that emotional awareness constitutes the necessary background for our rational capacities and our sense of self and plays a key role in our cognition and everyday decision-making processes. One way to interpret our results is that the bus drivers of our study with increased alexithymia scores possibly ignore early warning signs in their physical sensations. For these drivers, the same overall burden of job-related physical, ergonomic, and psychosocial stressors might have a disproportionately greater impact on developing LBP than for drivers scoring low on alexithymia. This needs to be determined prospectively with *incidence* data to be reported separately.

This interpretation would lead to another intriguing question: If drivers with high TAS scores ignore early warning signs of physical sensations that precede subsequent LBP, could this imply that the association of alexithymia with LBP is, in part or essentially, due to poor interoception/proprioception (body awareness) in subjects with high TAS scores? This would be consistent with Damasio [24] and Craig [23], who have pointed out that the ability to recognize different emotions might rely on the perception of physical body sensations through interoception. In addition, at least two of the seven items of the TAS-1 subscale (“I have physical sensations that even doctors don’t understand”; “I am often puzzled by sensations in my body”) clearly ask for awareness of physical body sensations as a way of distinguishing emotions.

According to neuroimaging studies, patients with high alexithymia scores seem to be different from nonalexithymic patients in that they activate significantly less their rostral ACC (BA32), brain region for *reflexive emotional awareness*. Findings for the dorsal ACC (BA24), where interoceptive afferences are processed, are somewhat contradictory: *Phenomenal awareness* [40] of negative feelings might be decreased or increased. Decreased activity was found in U.S. [40], German [43], and Japanese [44] studies. Emotional numbing in patients suffering from PTSD is strongly associated with alexithymia [18] and impacts negatively the activity in the dorsal ACC through motivated inattention to one’s own emotions or feelings [73]. Interestingly, animal experiments showed that both the function and structure of the same brain region (synaptic input and dendrite density) are highly sensitive to the psychosocial environment in early childhood (amount of loving care experienced) [74,75]. In the dorsal ACC, a French [42] study, however, found increased activity for positive emotions and no difference for negative emotions. But for the rostral ACC, where feelings are further processed, reflected upon, and forwarded for decision making, these studies coherently report decreased activity and seem to indicate a deficit in the reflexive awareness of these feelings. Consequently, it does not seem to matter whether alexithymic patients have strong feelings and emotions, rather, they seem to be quasi-blind to them [76] and are not able (1) to evaluate them and (2) to incorporate such analysis into their adaptive behavior. Accordingly, these studies found consistently decreased activity in the right orbito-frontal cortex. This cortex seems to belong to a network that uses cognitive cues to activate the endogenous opioid system [77,78] to modulate pain perception. Alexithymic patients (intriguingly similar to placebo nonresponders; [78]) might have less resources in accessing this endogenous system for behavioral pain regulation. As pain, in its affective component or unpleasantness, is associated with the ACC projection, neuroscience confirms the behavioral science finding that alexithymia seems to be more related to the affective component or unpleasantness of pain than to the intensity or sensory qualities of pain [79]. This would be in line (a) with the concept of the happy endurer personality or coping style and (b) with previous findings of an endogen opioid system dysfunction mediating between certain emotional behavior styles and the affective component of chronic pain [80,81]. Both fewer resources for behavioral adaptation to stressors and less activation or dysfunction of the endogenous opioid system are possible theoretical explanations for the association between alexithymia and LBP.

## Secondary results

All ethnic subgroups show an association between alexithymia and LBP, with the possible exception of Hispanics. Interestingly, the effect of alexithymia on LBP appears to

differ considerably between these groups. It is unlikely that language barriers explain these differences, given the two- to threefold higher odds ratio among Caucasians compared with African-Americans. Although we adjusted the full model for ethnicity, this warrants further investigation.

The association between alexithymia and LBP prevalence was partially masked by two negatively confounding variables: denial and planning coping style [63]. Adjustment for coping seems to be necessary to identify an association between alexithymia and LBP.

The factor “difficulty identifying feelings” (TAS-1 subscale) showed a stronger association with LBP than the TAS-2 (difficulty describing feelings) and TAS-3 (external-oriented thinking) subscales did. Cronbach’s alpha for the TAS-3 subscale was unsatisfactorily low, indicating poor reliability of that subscale in our population across all ethnicities, confirming previous studies [22]. This limitation of TAS-3 appears not to be due to language issues or cultural differences.

The relationships between all other covariates and LBP have been reported separately [57,82,83]. These reports demonstrated that physical workload and psychosocial job factors both independently predict LBP in this population.

## Limitations

The outcome measure “LBP prevalence in the past 12 months” is a rather crude summary measure including acute, recurrent, and chronic LBP and all degrees of pain severity. From a practical point of view, a secondary data analysis is limited to the data provided by the primary study. Therefore, in this report on prevalence data, we cannot differentiate between acute and chronic LBP. However, if such a crude measure finds an association between LBP prevalence and alexithymia, we would expect an even stronger association with one or more subgroups of LBP sufferers.

This study did not measure depression or somatization. Both are associated with alexithymia [79,84,85] and are associated with LBP as well [29,31,79,86,87]. Depression and alexithymia scores have been reported as being correlated (Pearson) at .40 to .59 [88], and somatization with alexithymia at .21 (quantitative meta-analysis [89]). However, these have not been separately assessed in this study and, thus, represent limitations of the study.

Particularly, depression has been suggested to mediate the association between alexithymia (TAS-1 and 2 scores, not TAS-3) and the affective component of chronic myofascial pain [79,90]; these studies found no additional contribution of alexithymia when controlled for depression, but persistent contribution of depression when controlled for alexithymia [79]. Another study, however, found that alexithymia predicts self-report of somatic symptoms in depressed patients [91].

All variables used for this report are collected by self-report. It is possible that recall bias interferes with answering our question: “Have you had pain, ache, or

discomfort in the lower back area in the last 12 months?” Failure to remember episodes of LBP could affect the high and low alexithymic drivers differently. On theoretical grounds, however, we would expect that low-alexithymic drivers remember their pain better, which would have resulted in an attenuation of the association between alexithymia and LBP. Furthermore, we would expect this recall bias to affect mostly the group of drivers with high degree of denial coping, which we did control for.

Respondents did not differ in age from nonresponders. However, respondents tended to be proportionally more men, more Caucasian, Asian, Hispanic, and Filipino, less African-American, and more light rail and less diesel-bus drivers. Therefore, our ability to generalize our findings to all San Francisco municipal transit operators is limited.

Finally, the temporal relationship between alexithymia and LBP cannot be determined in a cross-sectional study, thereby limiting the ability to draw causal inferences. However, because alexithymia is considered a trait [92], or at least a rather stable state [22,92], it is very unlikely that the experience of LBP would have caused alexithymia. Nevertheless, prospective studies are needed to establish a causal relationship. We are currently gathering follow-up data for the study population and plan to examine the association between alexithymia and LBP prospectively, as well as a potential dose–response relation between the degree of alexithymia and the severity or duration of LBP.

## Conclusions

Our results confirm and strengthen previously reported findings of an association between deficiencies in emotional awareness and LBP. Although the findings need to be confirmed by prospective studies, the strength of the observed associations and our ability to control for several important psychological and workplace factors strengthen the evidence for alexithymia as a possible psychosocial risk factor for LBP. The higher risk of LBP in women with high alexithymia scores and the differences between ethnic subgroups warrant further investigation.

Behavioral or other mind–body interventions might have to appreciate these deficits in emotional awareness, be they state or trait. Before this background, mind–body approaches, which integrate training in emotional and proprioceptive awareness, might deserve scientific study as potential innovative approaches for the treatment and prophylaxis of chronic LBP.

## Acknowledgments

This research was funded by the Centers for Disease Control/National Institute for Occupational Safety and Health (CDC/NIOSH) Grant Number 1-R01-OH-03604-01A2 and by a Health Resources and Services Administration

(HRSA) fellowship of the U.S. Department of Health and Human Services.

We thank the City of San Francisco, the management of San Francisco Municipal Railways, San Francisco Transport Workers Union Local 250A for their support, and the transit operators for their participation in this research.

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