Published in final edited form as:

Arch Phys Med Rehabil. 2011 April ; 92(4): 653–656. doi:10.1016/j.apmr.2010.10.029.

Multisensory Hypersensitivity in Women With Fibromyalgia: Implications for Well Being and Intervention

Julia L. Wilbarger, PhD and Dane B. Cook, PhD

Department of Kinesiology, University of Wisconsin-Madison, Madison, WI

Abstract

Objective—To document sensory sensitivities to nonnoxious sensory stimuli in daily life for participants with fibromyalgia (FM).

Design—Descriptive study of a convenience sample using a self-report survey of sensory processing.

Setting—Participants were recruited from the general community. The procedure took place in a research room at the University of Wisconsin-Madison.

Participants—Women with FM (n=27) were compared with women with rheumatoid arthritis (RA) (n=28) and healthy pain-free women (controls) (n=28) (N=83).

Interventions—Not applicable.

Main Outcome Measure—A self-report measure of sensory sensitivity to stimuli encountered in daily life. Items ask participants if they are sensitive to sensations that do not seem to bother other people or avoid common activities or environments because of sensory stimuli.

Results—The FM group reported significantly increased sensory sensitivities to both somatic (tactile) and nonsomatic (eg, auditory and olfactory) sensory stimuli compared with the RA and control groups. The RA and control groups did not differ in reported hypersensitivities.

Conclusions—Women with fibromyalgia reported increased sensitivities to stimuli in the environment and could experience more stress related to sensory conditions in daily life.

Keywords

Fibromyalgia; Pain; Rehabilitation; Sensation

Fibromyalgia is a baffling condition in which people, predominantly women, are afflicted with unexplained, chronic musculoskeletal pain. The disorder is also associated with increased fatigue, sleep disturbances, and higher levels of stress reactivity and anxiety. The etiology and underlying mechanisms of the disorder have not been well characterized. Recent research has highlighted the neurophysiologic underpinnings of the disorder. A key finding is a reduced threshold for the perception of discomfort or pain for somatic stimuli such as pressure and electric and thermal stimuli.¹⁻³ People with FM typically report discomfort or pain at lower levels of stimulus intensity than non-FM controls. Similar responses have been found for nonsomatic stimuli, such as sound,^{1,4,5} although not all

studies have found increased sensitivity to nonnoxious sensation. Peters et al⁶ reported no differences in detection of nonnoxious electric or visual stimuli between FM and controls. Most studies of sensory responsiveness in FM have included both noxious and nonnoxious stimuli.⁷ The inclusion of painful stimuli in the research protocols could have the generalized effect of priming or increasing responses to the nonnoxious stimuli, so it remains unclear whether people with FM are overresponsive to nonnoxious stimuli.

Increased sensitivity to and poor gating of somatosensory input are associated with differences in brain activity in people with FM compared with healthy controls as measured by magnetic resonance imaging and electroencephalographic muscle activity.^{3,8,9} People with FM appear to demonstrate brain activity in key pain processing areas of the brain when exposed to both painful and nonpainful stimuli.⁸ The affected areas of the brain include those that process or modulate responses to pain.^{3,8} For example, Cook et al⁸ found increased activity in the prefrontal cortex, supplemental motor cortex, anterior cingulate gyrus, and insula after exposure to nonpainful thermal stimuli and greater activity in the anterior insula for painful thermal stimuli in FM compared with controls. Further activation was found in key pain processing areas at a lower level of absolute stimulus intensity but perceptually equivalent pain ratings in the FM group.

The findings of augmentation of responses to sensory stimuli in both psychophysiologic and neural studies have contributed to multiple theories of FM, including poor central modulation of nociception, generalized hypervigilance to sensory stimuli, and general central nervous system sensitivity. The consistent finding of augmentation of responses to sensation is relevant to the daily lives of people with FM. Clinicians and patients frequently report the presence of sensory sensitivities to nonnoxious sensations like light touch, sounds, and smells encountered in everyday life. Reports of unusual sensory sensitivities commonly appear on FM informational websites and in chat rooms; however, there has been little or no empirical validation of these anecdotal reports in current research. The presence of such sensitivities may contribute to difficulties in function by creating an additional source of stress, anxiety, and fatigue as individuals with FM navigate through the sensations of daily life. The goal of the present study was to examine atypical sensory sensitivities to sensation in daily life in women with FM. In this study, women with FM were compared with women with RA and women without clinical pain on a self-report measure of the impact and the presence of sensory sensitivities across multiple sensory modalities. The participants with RA were included as a comparison group to rule out the possibility that chronic pain alone may increase sensitivity to sensation. Most previous studies examining sensory processing in FM have included only a healthy control group.¹ It is hypothesized that the FM group will report more sensitivity to everyday sensations than either of the other 2 groups. Further, it is hypothesized that increased sensory sensitivities in the women with FM will be identified in more than the tactile or somatic modality.

METHODS

Responses on a self-report measure of sensory sensitivity were compared for sample of women in 3 groups: (1) FM (n=27), (2) RA (n=28), and (3) healthy control participants without pain syndrome (n=28) matched for age (targeted during recruiting ± 3 y). Participants ranged in age from 18 to 60 years with a mean of 44 years. Mean $\pm$ SD for the FM, RA, and healthy participants without pain syndrome groups are, respectively, 42.4 $\pm$ 11.7, 45.39 $\pm$ 12.6, and 44.39 $\pm$ 9.9 years. The groups' mean age did not differ ($P>.05$). Eighty-seven percent of participants were white, and the percentage did not differ significantly across groups. All participants were recruited as part of a larger study investigating brain responses to pain. Patients with FM and RA and healthy controls were recruited by newspaper advertisements, fliers in rheumatology clinics, and mass e-mail messages to female faculty, staff, and

students at the University of Wisconsin-Madison. Participants in the FM group met the 1990 American College of Rheumatology criteria for FM,¹⁰ and participants in the RA group met the American College of Rheumatology criteria for RA¹¹ and had pain in 3 of 4 body quadrants. Clinical diagnosis was confirmed by each subject's primary care physician. Any patient with FM or RA with a comorbid painful disorder (ie, arthritis for FM or FM for RA) and participants in any group who were taking analgesic (including opioids), cardiovascular, or high-dose antidepressant medications were also excluded from the study. Controls were all healthy women. Participants were free of Axis I psychiatric disorders as assessed by Structured Clinical Interview for DSM Disorders¹² by phone. Informed consent was obtained as approved by the University of Wisconsin-Madison institutional review board.

The 56-question sensory measure includes taste/smell, movement, sound, vision, and touch sections. Participants responded on a 7-point Likert-type scale with a response of 1 signifying "extremely untrue of me" and a 7 representing "extremely true of me." Higher scores indicate more sensory sensitivities. Questions ask the participants whether they are bothered by smells, sounds, or textures that do not seem to bother other people or avoid common activities or environments because of smells, tastes, sound, sights, movement challenges, or touch—for example, "I dislike being close to people who wear perfume or cologne," "I leave the room when others are watching TV or ask them to turn it down," or "I am bothered by turtleneck shirts, tight fitting clothes, elastic, nylons, or synthetic material in clothes."

The scale combined items from 2 questionnaires previously used in research on sensory sensitivity (AASP Sensory Sensitivity and Sensory Avoidance subscales,¹³ ASQ¹⁴) and portions of a well known adult temperament questionnaire (Adult Temperament Questionnaire¹⁵). The AASP was standardized on approximately 900 adolescents and adults and has previously been used to examine sensory processing across the age spectrum and in individuals who had mental health or developmental disorders. The ASQ was standardized on over 300 adults and has been used in over a dozen research projects related to sensory sensitivities in typical adults and adults with various disorders including anxiety disorders and chronic fatigue syndrome.¹⁶ The scales were combined because of limitations in each of the scales to address the specific research question posed by this study. First, none of the scales yielded a modality specific score. Second, across the 3 questionnaires, there were both redundant and unique items. Each of the 2 sensory questionnaires had a very limited number of questions in some areas such as smell and visual sensitivities and had a large number of redundant questions related to tactile stimuli. The scales were combined to increase the number of items in each sensory area, especially in areas like smell that appear to be a very common source of aversion in FM. Redundant items were eliminated. Items from the AASP were chosen when there was significant redundancy.

Because this was a pilot study in the context of a larger study, it was critical to keep the overall length reasonable for participants. The resulting combined scale demonstrates good internal consistency based on analyzing the item responses from the participants in the current study. The Cronbach alpha, a measure of the intercorrelations between items, calculated for the total score was .94 and ranged from .78 to 0.9 for the modality-specific sections, indicating that the items as a whole and within each section measured a unified construct. The strong intercorrelations between items show that the scale of combined items retained internal reliability.

Data Analysis

The 3 groups' total and modality specific scores from the sensory questionnaire were analyzed with a series of univariate ANOVAs using PASW software version 17.^a The

significance level was set at .05. Post hoc analyses used the Bonferroni statistic or a Dunnett C in the case of unequal variances.

RESULTS

First, significant differences were found between groups using 1-way ANOVAs by group (FM, RA, healthy individuals without pain syndrome) for the total score of the sensory questionnaire. The analysis for the total score indicated a significant difference between groups at the level of P less than .001. Post hoc analysis showed that the FM group had a significantly higher total score than both the RA group and the control group. Higher scores indicate a report of more sensory sensitivities. Second, the groups' scores were compared for the 5 modality-specific sections. Correcting for multiple comparisons between the groups for the 5 sections, the significance value was set at .01. As seen in table 1, the FM group also had significantly higher mean scores than the RA group for taste/smell, auditory, and tactile sections and the control group on all but the auditory section. The mean scores of the RA and the control groups did not differ for the total score or any section scores.

DISCUSSION

The finding of significantly more self-reported sensory sensitivities in women with FM compared with women with RA or controls is consistent with increased sensory sensitivities found in previous psychophysiologic studies of FM.¹ The differences across groups cannot be attributed solely to the presence of a chronic pain syndrome. The FM and RA groups differed in both somatic (tactile) and nonsomatic (taste/smell and auditory) sensory sensitivity. The women in the RA group were considered to experience more than mild chronic pain because they were selected on the basis of having pain in 3 of 4 body quadrants. Further, because the RA group did not differ from the control group on any section, the presence of a pain chronic pain syndrome alone does not seem to increase sensitivity to sensations in daily life beyond typical sensitivity. On the other hand, this does not rule out the idea that central nervous system augmentation of pain is a key factor in generalized sensory sensitivity in FM.

While increased tactile and auditory sensitivity have been well documented in previous studies, increased sensitivity for other sensations such as smell and taste have not. The FM group in this study had higher scores, indicating hypersensitivities across multiple modalities. In particular, scores were higher for taste and smell, auditory, and tactile sensations. Reports of increased aversion to nonnoxious sensory stimuli across modalities is supportive of a view of dysregulation of central nervous system mechanisms that modulate aversive responses to sensation in people with FM.¹ Sensory hypersensitivity reported here is consistent with neurophysiologic evidence of augmented responses to both noxious and nonnoxious sensory stimuli.^{1,7} In brain imaging studies of FM, nonnoxious sensation was seen to activate areas of the brain that modulate responses to pain, indicating a clear distortion in sensory processing.⁸

Increased multisensory sensitivities are also found in populations without pain syndromes. Sensory hypersensitivity or "sensory defensiveness" has been well documented in research with children and adults with neurodevelopmental disorders such as autism spectrum disorders¹⁶⁻¹⁸ and affective disorders such as anxiety¹⁴ and in a small percentage of children and adults without any clinical diagnosis.^{19,20} Behaviors associated with SD include avoidant or aversive responses to nonnoxious stimuli across multiple sensory modalities.²¹

^aSupplier
SPSS Inc., 233 S Wacker Dr, 11th Fl, Chicago, IL 60606.

For example, reports include irritation with clothing textures, seams, or elastic at the waist or wrists; dislike of sounds such as air conditioners, paper rustling, or loud noises; or aversion to some types of smells such as perfume or food odors. Similar to FM, individuals with increased levels of SD have been noted to have poor modulation of responses to sensation. Increased sensory sensitivities have been linked to increased magnitudes and slow habituation of electrodermal responses (sympathetic nervous system activation),²² weak regulation of vagal tone (parasympathetic regulation),²³ and poor sensory gating of event-related potentials.²⁴

The presence of sensory defensive behaviors results in functional and psychologic difficulties in daily life, including decreased participation in typical life activities, and increased stress and anxiety.^{20,25,26} Adults with sensory defensiveness often cope by avoiding certain social and physical environments, isolating themselves from society or “self-medicating.”^{20,26} Sensory sensitivities in people with FM may result in increased stress, further taxing their ability to cope with daily life and contributing to decreased function and quality of life.

The results of the self-reported distortions in responses to nonnoxious stimuli encountered in the environment parallel the findings of distortions in processing nonnoxious sensory stimuli in neural imaging studies.⁸ Such knowledge may guide the use of interventions that could increase participation in activities that improve quality of life. Occupational therapists have been providing effective interventions for atypical sensory sensitivities for several decades.¹⁶ Strategies have included sensory motor interventions such as low-challenge physical activity, massage, or yoga incorporated into daily life. Evidence strongly supports the role of physical activity in increasing well being, reducing depression and anxiety, and improving physical health measures in general,²⁷ but also in women with FM.²⁶ Finally, this study amplifies the need for further study using more objective measures. The knowledge gained in this and future studies may be used to refine the understanding of FM. For example, people with FM and SD have been noted to have increased autonomic responses to nonnoxious sensations.^{1,22} Future research could address possible common mechanisms.

Study Limitations

The interpretation of the results of this study is limited by the use of a self-report measure and a relatively small sample of individuals. With self-report data, there is a risk of subjective bias. Future studies including more objective physiologic or neurologic measures targeting specifically sensory oversensitivity should be conducted.

CONCLUSIONS

Women with FM self-report more sensitivities to sensory experiences in daily life than women who do not experience chronic pain and women with RA. Sensory sensitivities extend beyond somatic complaints to taste/smell, auditory, and visual sensations. Because of the possible impacts of oversensitivity on daily function, it should be a factor to be considered in assessment and intervention for FM.

Acknowledgments

Partial support was provided through a National Institutes of Health grant (RO1 AR050969-05).

List of Abbreviations

AASP	Adult and Adolescent Sensory Profile
-------------	--------------------------------------

ANOVA	analysis of variance
ASQ	Adult Sensory Questionnaire
FM	fibromyalgia
RA	rheumatoid arthritis
SD	sensory defensiveness

References

1. Geisser ME, Glass JM, Rajcevska LD, et al. A psychophysical study of auditory and pressure sensitivity in patients with fibromyalgia and healthy controls. *J Pain*. 2008; 9:417–22. [PubMed: 18280211]
2. Kosek E, Ekholm J, Hansson P. Sensory dysfunction in fibromyalgia patients with implications for pathogenic mechanisms. *Pain*. 1996; 68:375–83. [PubMed: 9121827]
3. Gracely RH, Petzke F, Wolf JM, Clauw DJ. Functional magnetic resonance imaging evidence of augmented pain processing in fibromyalgia. *Arthritis Rheum*. 2002; 46:1333–43. [PubMed: 12115241]
4. Carrillo-de-la-Peña MT, Vallet M, Pérez MI, Gómez-Perretta C. Intensity dependence of auditory-evoked cortical potentials in fibromyalgia patients: a test of the generalized hypervigilance hypothesis. *J Pain*. 2006; 7:480–7. [PubMed: 16814687]
5. Hollins M, Harper D, Gallagher S, et al. Perceived intensity and unpleasantness of cutaneous and auditory stimuli: an evaluation of the generalized hypervigilance hypothesis. *Pain*. 2009; 141:215–21. [PubMed: 19121558]
6. Peters ML, Vlaeyen JW, van Drunen C. Do fibromyalgia patients display hypervigilance for innocuous somatosensory stimuli? application of a body scanning reaction time paradigm. *Pain*. 2000; 86:283–92. [PubMed: 10812258]
7. Watson NF, Buchwald D, Goldberg J, Noonan C, Ellenbogen RG. Neurologic signs and symptoms in fibromyalgia. *Arthritis Rheum*. 2009; 60:2839–44. [PubMed: 19714636]
8. Cook DB, Lange G, Ciccone DS, Liu W-C, Steffener J, Natelson BH. Functional imaging of pain in patients with primary fibromyalgia. *J Rheumatol*. 2004; 31:364–78. [PubMed: 14760810]
9. Montoya P, Sitges C, García-Herrera M, et al. Reduced brain habituation to somatosensory stimulation in patients with fibromyalgia. *Arthritis Rheum*. 2006; 54:1995–2003. [PubMed: 16732548]
10. Wolfe F, Smythe HA, Yunus MB, et al. The American College of Rheumatology 1990 criteria for the classification of fibromyalgia: report of the Multicenter Criteria Committee. *Arthritis Rheum*. 1990; 33:160–72. [PubMed: 2306288]
11. Arnett FC, Edworthy SM, Bloch DA, et al. The American Rheumatism Association 1987 revised criteria for the classification of rheumatoid arthritis. *Arthritis Rheum*. 1988; 31:315–24. [PubMed: 3358796]
12. First, MB.; Gibbon, M.; Spitzer, RL.; Williams, JBW. SCID-I: structured clinical interview for DSM-IV-TR axis I disorders. Biometrics Research; New York: 2001. research version, patient edition (SCID-I/P)
13. Dunn, W. Sensory profile: user's manual. The Psychological Corporation; San Antonio, TX: 1999.
14. Kinnealey, M.; Oliver, B. ADULT-SI (adult defensiveness, understanding, learning, teaching: sensory interview) manual. Temple Univ; Philadelphia: 2002.
15. Rothbart MK, Ahadi SA, Evans DE. Temperament and personality: origins and outcomes. *J Pers Soc Psychol*. 2000; 78:122–35. [PubMed: 10653510]
16. Pfeiffer B, Kinnealey M. Treatment of sensory defensiveness in adults. *Occup Ther Int*. 2003; 10:175–84. [PubMed: 12900790]
17. Baranek GT, Foster LG, Berkson G. Sensory defensiveness in persons with developmental disabilities. *Occup Ther J Res*. 1997; 17:173–85.

18. Kientz MA, Dunn W. A comparison of the performance of children with and without autism on the Sensory Profile. *Am J Occup Ther.* 1997; 51:530–7. [PubMed: 9242859]
19. Ahn RR, Miller LJ, Milberger S, McIntosh DN. Prevalence of parents' perceptions of sensory processing disorders among kindergarten children. *Am J Occup Ther.* 2004; 58:287–93. [PubMed: 15202626]
20. Kinnealey M, Oliver B, Wilbarger P. A phenomenological study of sensory defensiveness in adults. *Am J Occup Ther.* 1995; 49:444–51. [PubMed: 7598160]
21. Wilbarger, PL.; Wilbarger, JL. Sensory defensiveness: a comprehensive treatment approach. Avanti Educational Programs; Panorama City: 2001.
22. McIntosh DN, Miller LJ, Shyu V, Hagerman RJ. Sensory-modulation disruption, electrodermal responses, and functional behaviors. *Dev Med Child Neurol.* 1999; 41:608–15. [PubMed: 10503919]
23. Schaaf RC, Miller LJ, Seawell D, O'Keefe S. Children with disturbances in sensory processing: a pilot study examining the role of the parasympathetic nervous system. *Am J Occup Ther.* 2003; 57:442–9. [PubMed: 12911086]
24. Davies PL, Gavin WJ. Validating the diagnosis of sensory processing disorders using EEG technology. *Am J Occup Ther.* 2007; 61:176–89. [PubMed: 17436840]
25. Rogers SJ, Hepburn S, Wehner E. Parent reports of sensory symptoms in toddlers with autism and those with other developmental disorders. *J Autism Dev Disord.* 2003; 33:631–42. [PubMed: 14714932]
26. Kinnealey M, Fuiek M. The relationship between sensory defensiveness, anxiety, depression and perception of pain in adults. *Occup Ther Int.* 1999; 6:195–206.
27. Busch AJ, Thille P, Barber KAR, Schachter CL, Bidonde J, Collacott BK. Best practice: e-model—prescribing physical activity and exercise for individuals with fibromyalgia. *Physiother Theory Pract.* 2008; 24:151–66. [PubMed: 18569853]

Table 1
Descriptive and Comparison Data for Total and Subsection Ratings on the Sensory Questionnaire

	FM Mean $\pm$ SD	RA Mean $\pm$ SD	Control Mean $\pm$ SD	F P Value	Effect Size (Partial η^2 *)	Group Differences (Post Hoc Results)
Total score	3.97 $\pm$ 0.75	3.1 $\pm$ 0.74	2.9 $\pm$ 0.68	15.08 >.001	.283	FM>RA and control P<.001 and >.001
Section scores						
Taste/ smell	4.35 $\pm$ 1.2	3.44 $\pm$ 1.0 [†]	3.42 $\pm$ 0.9 [†]	6.921 .002	.148	FM>RA and control P=.006 and .005
Movement	3.36 $\pm$ 1.2	2.71 $\pm$ 1.2	2.03 $\pm$ 0.83 [†]	10.05 <.001	.201	FM>control P<.001
Auditory	4.61 $\pm$ 1.1	3.51 $\pm$ 1.3 [†]	3.78 $\pm$ 1.2	6.415 .003	.138	FM>RA P=.003
Visual	4.05 $\pm$ 1.1	3.3 $\pm$ 1.1	3.02 $\pm$ 0.9 [†]	7.34 <.001	.155	FM>control P=.001
Tactile	3.64 $\pm$ 0.7	2.72 $\pm$ 0.7 [†]	2.62 $\pm$ 0.7 [†]	12.028 <.001	.231	FM>RA and control P<.001 and .001

NOTE. A higher number indicates more reported sensory sensitivity.

* Partial eta-square indicates the percentage of variance accounted for by the independent variable and is equivalent to the R^2 for the sum of squares.

[†] Significantly lower than the FM group when correcting for multiple comparisons in the 5 section scores (P=.001).