

Supplementary Table 1:

Adherence at different time points in the PSRT and MBSR Group, numbers indicate hours spent per week in the last 4 weeks working on skills learned in the program.

| Group            | Response  | Time-point     |                |                 |                 |
|------------------|-----------|----------------|----------------|-----------------|-----------------|
|                  |           | <i>4 weeks</i> | <i>8 weeks</i> | <i>13 weeks</i> | <i>26 weeks</i> |
| PSRT<br>(n = 11) | 0 hours   | NA             | NA             | NA              | 4 (36.4%)       |
|                  | < 1 hour  | NA             | NA             | 5 (45.5%)       | 1 (9.1%)        |
|                  | 1-2 hours | 5 (45.5%)      | 5 (45.4%)      | 1 (9.1%)        | 1 (9.1%)        |
|                  | 2-4 hours | 4 (36.4%)      | 1 (9.1%)       | 4 (36.4%)       | 2 (18.2%)       |
|                  | 4-6 hours | 2 (18.2%)      | 2 (18.2%)      | 1 (9.1%)        | 3 (27.3%)       |
|                  | > 6 hours | NA             | 3 (27.3%)      | NA              | NA              |
|                  |           |                |                |                 |                 |
| MBSR<br>(n = 12) | 0 hours   | NA             | NA             | 1 (8.3%)        | 1 (8.3%)        |
|                  | < 1 hour  | NA             | NA             | 1 (8.3%)        | 1 (8.3%)        |
|                  | 1-2 hours | NA             | 1 (8.3%)       | 2 (16.7%)       | 2 (16.7%)       |
|                  | 2-4 hours | 4 (33.3%)      | 3 (25.0%)      | 7 (58.3%)       | 6 (50.0%)       |
|                  | 4-6 hours | 5 (41.7%)      | 4 (33.3%)      | NA              | 1 (8.3%)        |
|                  | > 6 hours | 3 (25.0%)      | 4 (33.3%)      | 1 (8.3%)        | 1 (8.3%)        |

Supplementary Table 2:

Medians and IQRs of the summed score from the Roland-Morris Disability Questionnaire (RDQ), the summed score from the Pain Anxiety Symptom Scale Questionnaire (PASS), and the back pain bothersomeness score (Pain Bothersomeness) for each group at each time-point.

| Variable            | Time-point (weeks) | PSRT (median, IQR) | MBSR (median, IQR) | Usual Care (median, IQR) |
|---------------------|--------------------|--------------------|--------------------|--------------------------|
| RDQ                 | 0                  | 10 (5, 11)         | 11 (8, 18)         | 6 (5, 14)                |
|                     | 4                  | 0 (0, 4)           | 10 (6, 11)         | 6 (4, 12)                |
|                     | 8                  | 0 (0, 0)           | 8 (3, 11)          | 9 (3, 16)                |
|                     | 13                 | 0 (0, 1)           | 5 (2, 14)          | 8 (3, 14)                |
|                     | 26                 | 1 (0, 8)           | 8 (3, 10)          | 7 (1, 16)                |
| PASS                | 0                  | 37 (28, 63)        | 40 (18, 61)        | 34 (23, 56)              |
|                     | 4                  | 6 (4, 27)          | 41 (11, 49)        | 25 (18, 50)              |
|                     | 8                  | 4 (1, 12)          | 24 (4, 49)         | 27 (20, 54)              |
|                     | 13                 | 3 (0, 14)          | 22 (3, 41)         | 25 (18, 52)              |
|                     | 26                 | 0 (0, 19)          | 26 (4, 40)         | 31 (20, 65)              |
| Pain Bothersomeness | 0                  | 6 (5, 7)           | 7 (6, 8)           | 7 (5, 10)                |
|                     | 4                  | 2 (0, 4)           | 5 (3, 8)           | 5 (5, 7)                 |
|                     | 8                  | 2 (0, 2)           | 3 (2, 7)           | 7 (5, 9)                 |
|                     | 13                 | 0 (0, 3)           | 6 (3, 8)           | 5 (5, 8)                 |
|                     | 26                 | 0 (0, 3)           | 4 (2, 8)           | 6 (4, 8)                 |

## **Appendix**

### **Components of the Psychophysiologic Symptom Relief Therapy (PSRT) program**

PSRT is a treatment program designed for patients with non-specific chronic back pain. The intervention consists of a one-on-one interview with the investigator, group educational and skills-training sessions over a four-week period for approximately 1.5-2 hours per session twice per week, followed by an eight-week mindfulness-based stress reduction program plus one full-day session/retreat. The course is delivered in small groups facilitated by a trained instructor. Participants receive reading materials on Dr. John Sarno's and Dr. Howard Schubiner's work to study during the intervention period. The educational sessions are focused on the relationship between psychological stress and pain and are divided in four components according to their content:

#### **Component I: Psychophysiologic Pain Education**

The mainstay of this component is for the participants to recognize their symptoms as a part of a psychophysiologic mind-body syndrome, as opposed to an exclusively physical etiology. This recognition is accomplished by exploring the history of their pain, identifying "inconsistencies" in the physical components of their pain (discrepancies in symptom localization and/or temporal occurrence), and acquiring information on the nature of nonspecific chronic back pain itself. Great focus is placed on the role of the relationship of underlying psychological stressors to physical pain. As participants are encouraged to examine the origin of the pain, they notice patterns in the experience of their pain that reflect the contribution of psychological and stress-related factors (e.g. experiencing severe back pain when driving but only when in heavy traffic, pain that occurs with sitting but not when sitting on a chairlift during recreational skiing, pain that is worse while walking into the workplace but fine when walking upon exiting). Hereby, participants gain awareness of the connection between pain and psychological processes and a better understanding of the variety of potentially modifiable factors that contribute to chronic back pain.

#### **Examples:**

In the above example of an inconsistency, a participant complaining about back pain when driving, was able to identify that he was experiencing pain only while driving on busy roads and not on less busy roads. As a next step, the participant was able to recognize both the role of stress and the underlying emotion of anger that occurred when driving on a busy road. As the participant became able to recognize the feeling of anger in this situation, his pain during driving dissipated. This, in turn, provided insight into his pain in other circumstances and his overall pain resolved over time in conjunction with the other components of this program.

Another participant experienced pain while sitting, yet upon reflection, she recognized there were times when sitting did not cause pain such as when she was knitting (an activity she loved to do and which she found relaxing). During the course of this program, she was able to recognize this "inconsistency" as well as others and worked on desensitization (see component II). Additionally, she was able to realize that she put tremendous pressure on herself to be the

perfect mother and wife. As she learned to be more accepting of herself, her unrealistic expectations of herself were reduced as was her pain experience.

## **Component II: Desensitization and returning to physical activity**

One of the main contributors hypothesized to contribute to chronic pain derived from psychophysiologic causes is that pain becomes a conditioned response to a physical trigger. According to the classical conditioning model, previously neutral stimuli can become linked to the pain experience. Thus, without the need for a current nociceptive input, this association can be coupled with physical reactions ultimately leading to pain. For example, formerly elicited pain-induced muscle tensions can become associated with other stimuli like sitting or walking and lead to fear and avoidance of these positions/movements. This association can result in fear of recreating pain and thus avoidance of these movements. Therefore, one of the key components of our therapy program is to “desensitize” the participants and break the cycle of pain. In order to achieve this goal, multiple desensitization techniques are utilized in this phase.

Visual motor imagery (mental simulation of a painful situation) is a desensitization technique during which the participant is asked to first visualize a movement where pain typically occurs. Often (though not universally) the visualization will bring on pain. When this occurs, this serves to help the participant recognize that the pain can be elicited simply in his or her mind without any physical movement. This concept helps support the fact that the pain is psychophysiologic in nature. Next, the person is encouraged to repeatedly visualize the movement which caused pain while they are repeating self-soothing statements. With these repeated visualizations (without physical movement), the pain can ultimately wane and cannot be reproduced using visualization alone. When this process is complete (and pain can no longer be elicited), the patient can then proceed with slowly undertaking the actual movements/positions (see example below).

Additionally, identifying conditioned responses in daily life is a crucial part of this phase. For example, if sitting were a trigger, one would sit with the knowledge that the pain associated with sitting is a conditioned response and not actually related to some physical injury or component of sitting. Over time, the pain will dissipate, and the conditioning will be effectively reversed, allowing the participant to return to full physical activity. By returning to previous physical activity, patients also reinforce the “knowledge therapy” component as they begin to recognize that pain is not actually related to physical triggers per se, but rather psychological triggers. The safety of participants during this process is ensured through the gradual increase of activity under the supervision of a physician (see examples below).

### **Example:**

A participant reported having pain with prolonged standing and notably when standing at a bus stop waiting for work. She attributed the pain to the physical activity of prolonged standing. Occasionally, she would return home and miss work because of the severity of the pain. During our program, she first visualized standing at the bus stop, and this reproduced her pain and discomfort. The ability for her to bring on severe pain simply through visualization allowed her to recognize the psychological component of her pain. She then reflected further on the situation from a different perspective and recognized that she was under a great degree of psychological stress while at the bus stop anticipating her day at work. With all this in mind, she first

performed visual motor imagery repeatedly over a few days using self-soothing techniques until she reached the point that she could no longer reproduce the pain during visualization. Then, she stood at the bus stop reminding herself that the origin of the pain was not the physical act of standing. Over time, she stood for longer periods of time and the pain decreased despite the overall increase in physical activity. Ultimately, the pain resolved to the point where prolonged standing was no longer a trigger for her pain.

### **Component III: Emotional expression - psychology of the syndrome**

Reports on “functional” back pain conditions date back from as early as 1946 (1). The notion that chronic pain may persist as a manifestation of unexpressed negative affective states (e.g. hostility or aggressive impulses that the individual is unwilling or unable to acknowledge) was formulated in 1959 (2). Taking into consideration that some of the contributors to persistent pain include underlying stressful conflicts and aversive affective states, strategies encouraging emotional expression are essential in the treatment of mind-body syndrome. Emotional expression is accomplished through a series of writing exercises and journaling (free writing, cluster writing, letters of forgiveness, gratitude lists), self-reflection, as well as through small group discussion. A recent treatment developed by Drs. Schubiner and Lumley, Emotional Awareness and Expression Therapy (EAET), includes similar techniques (3).

As an example, a participant realized during the above-mentioned exercises that he was being negatively impacted by the emotional pain caused by the imminent ending of his marriage. As he began to express his emotions, he noticed a significant reduction in his physical pain. Another example noted earlier was a patient who developed severe pain when driving on crowded streets but not on roads without traffic. He ultimately recognized that he was experiencing anger and frustration in a number of specific situations such as being stuck in traffic. This awareness of anger-related contributions to his pain (rather than an exclusively physical explanation that sitting for long periods results in mechanically induced increases in pain) and subsequent expression of those negative emotions helped the patient to improve his pain.

### **Component IV: Stress reduction - Mindfulness Based Stress Reduction (MBSR)**

As stress is an underlying component of MBS, the final arm of the program is to engage in stress-reduction techniques. By starting this program with the PSRT portion, participants are often already seeing improvements before embarking on this last portion of the program. MBSR was developed by Jon Kabat-Zinn at the Center for Mindfulness at the University of Massachusetts Medical Center for the prevention and treatment of stress related disorders (4). MBSR has been linked to significant improvements in overall health and well-being, leading to reductions in stress, anxiety, depression, and chronic pain (5, 6, 7). MBSR is an 8-week educational program which includes weekly sessions and mindful practice. Students are encouraged to perform daily home practice, which is explored throughout the program. Our MBSR classes adhered to the original protocol of the Center for Mindfulness at the University of Massachusetts. Our mindfulness sessions entail a series of strategies for cultivating present moment awareness - the ability to experience what is arising in the present moment. This allows for the observation of thoughts (past or future), the disengagement from emotional reactivity and

the ability to stay with the sensate experience in the body - the outcome of which is a deeper sense of ease, emotional balance and general well-being.

## References

1. Sargent M. Psychosomatic backache. *New England Journal of Medicine*. 1946 Mar 28;234(13):427-30.
2. Turk, D.C., Fillingim, R.B., Ohrbach, R. and Patel, K.V. 2016. Assessment of psychosocial and functional impact of chronic pain. *The Journal of Pain* 17(9 Suppl), pp. T21-49.
3. Lumley, M.A. and H. Schubiner, Emotional Awareness and Expression Therapy for Chronic Pain: Rationale, Principles and Techniques, Evidence, and Critical Review. *Curr Rheumatol Rep*, 2019. 21(7): p. 30.
4. Kabat-Zinn J. *Full catastrophe living: Using the wisdom of your body and mind to face stress, pain, and illness*. Dell Publishing; New York: 1990
5. Kabat-Zinn J, Massion AO, Kristeller J, Peterson LG, Fletcher KE, Pbert L, Lenderking WR, Santorelli SF. Effectiveness of a meditation-based stress reduction program in the treatment of anxiety disorders. *Am J Psychiatry*. 1992 Jul;149(7):936-43. doi: 10.1176/ajp.149.7.936. PMID: 1609875.
6. Kabat-Zinn J. An outpatient program in behavioral medicine for chronic pain patients based on the practice of mindfulness meditation: theoretical considerations and preliminary results. *Gen Hosp Psychiatry*. 1982 Apr;4(1):33-47. doi: 10.1016/01
7. Grossman, P., Niemann, L., Schmidt, S., & Walach, H. (2004). Mindfulness-based stress reduction and health benefits: A meta-analysis. *Journal of Psychosomatic Research*, 57(1), 35–43. [https://doi.org/10.1016/S0022-3999\(03\)00573-763-8343\(82\)90026-3](https://doi.org/10.1016/S0022-3999(03)00573-763-8343(82)90026-3). PMID: 7042457.