Psychology Documentation

BREATHING

Contents [hide]

Background

For centuries, Eastern cultures have emphasised the healing properties of breathing techniques. The physiological and psychological benefits of breathing exercises are now well established in therapy and healthcare. The most consistently used and simple method involves slowing down one's breathing rate, with short breathes-in and long breathes-out. The relaxation effects of this method can be the primary outcome of VR experiences, in which case the user's attention is directed to breathing instructions. Alternately, they can be the secondary outcome of VR experiences where users are exposed to visual or audio cues which are more subtle.

Research evidence

The therapeutic properties of slow and deep breathing are highly regarded, with both short- and long-term benefits on stress (Chandra, Jaiswal, Singh, Jha, & Mittal, 2017), anxiety (Busch et al., 2012), pain (Sharma, Mavai, Bhagat, Murugesh, & Sircar, 2017), and mood (Streeter et al., 2017).

Both the breathing rate (breath/min) and the time difference between the in and out breaths are proven essential components of effective breathing patterns.

Breathing rate

Studies have identified a range of breathing rates that can produce relaxation.

Inhalation/exhalation ratio

The difference in time between the inhalation and the exhalation period is also very important for calm and relaxation. Shorter inhalations and longer exhalations (low inhalation/exhalation ratios) have been found to produce greater relaxation effects than longer inhalations and shorter exhalations (high inhalation/exhalation ratios). These findings fit with evidence from studies assessing breathing patterns during states of relaxation. The evidence suggests a direct link between increased relaxation and lower inhalation/exhalation ratios (Boiten 1998; Gomez et al., 2004; Van Diest et al., 2001).

Ideal breathing parameters for calm

Breaths per minute

- A breathing rate of roughly 6 breaths per minute is most effective at inducing calm
- Going below 5 breaths per minute can be difficult for some users without training
- A gradual decrease in breathing rate throughout an experience is advised. Beginning at a rate of 6 breaths/minute or slowing the breathing rate too quickly may be uncomfortable for some users
- Through a series of trials we found that a starting rate of 10 breaths/minute is comfortable for most users

Inhalation/exhalation ratio

- Short inhalations and long exhalations are most effective for inducing calm and relaxation
- An inhalation/exhalation ratio of 0.42 has been found to be effective
- At a target rate of 6 breaths/minute, this would involve an inhale of 3 seconds and an exhale of 7 seconds

Pause in breath between exhale and inhale

- A pause in breath following each breath out is recommended
- Short pauses should naturally increase in length as the breath/min rate slows down
- Liminal's Ripple Effect starts with a 0.3 second pause between each exhalation and the proceeding inhalations, this increases to 0.6 seconds toward the final phase of the experience

Guiding desirable breathing patterns in VR

Visual cues

A variety of audio and visual techniques can be used to guide users toward desirable breathing rates in VR. For example, Chittaro and Sioni (2014) compared the relaxation effects of three different versions of a mobile-phone based application. A voice only condition provided breathing guidance via voice instructions i.e. “inhale” “2”, “3”, “4” and exhale “2”, “3”, “4”. Two further conditions called Sphere and Wave were compared which implemented visual cues alongside the counting voice guidance.

‘Sphere’ – participants inhale as the green sphere inflates (a) and exhale as the red sphere deflates (b) (Chittaro & Sioni, 2014).

'Wave' – the green wave moves slowly against a static vertical line instructing users to breathe in (the wave is rising) (b) and breathe out (the wave is falling) (a) (Chittaro & Sioni, 2014).

From diaphragmatic activity recordings, the results showed that the participants' actual breathing cycles were best matched to the breathing patterns of Wave and Sphere. Also, participants indicated that these two versions were significantly more relaxing and provided better breathing guidance than the Voice-only version.

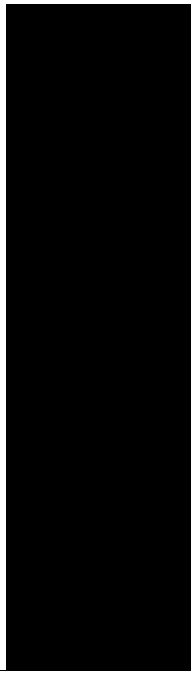
Wave was more effective than Sphere across physiological and subjective measures. The authors suggest that Wave is most effective because it provides a more accurate estimate of where in the breathing cycle participants should be (e.g., nearing the end of the breathe-out), maximising the volume of air that one inhales and exhales.

Visual cues used in Ripple Effect

Ripple Effect uses a spiral pattern to provide breathing guidance. This pattern indicates where the user should be in their breathing cycle. The expanding of the spiral represents the end of the inhalation, while the inward-moving pattern represents the start of the exhalation. A pause is also included following each exhale which is signalled by the breathing pattern disappearing for a short time before the proceeding inhalation pattern.

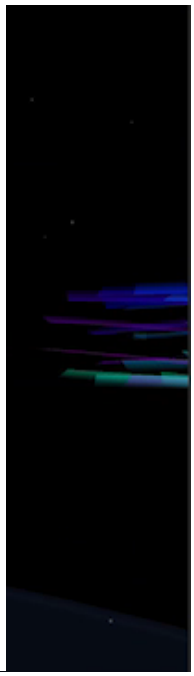
Breathing rates are set to gradually reach recommended target rates throughout the course of the experience. The 7 second breathe out shown below demonstrates the final exhalation and the end sequence of Ripple Effect.

Breath in



0:00 / 0:03

Breath out



0:00 / 0:07

Audio Guidance

In addition to voice guidance, audio techniques that can be used to guide breathing rhythms. Ripple Effect uses both sounds and patterns. An initial prototype used a human-breathing audio effect in parallel with the inhalation and exhalation pattern movements. User's response to this effect were slightly negative as it was associated with feelings of discomfort, we subsequently combined the original recordings with calming water sounds.

Music sounds may also be used to control breathing. Music guided technologies such as BIM (Schein et al., 1998) and RESPeRATE guide users to regular and slow breathing patterns. These technologies implement personalised breathe-in and breathe-out tones.

Advanced breathing techniques

In addition to slower breathing rates and low i/e ratios there are a variety of other breathing techniques experimentally shown to induce calm and relaxation. Pranayama breathing focuses around deep breathing with manipulations of the breath across three key stages: “Puraka” (inhalation), “Kumbhaka” (pause/hold) and “Rechaka” (exhalation) (Chodzinski, 2000). Participants are first instructed to inhale as slowly and as deeply as possible, followed by holding the breath for as long as feels comfortable, and proceeding to exhale slowly to complete the breath cycle. This technique often adopts an exhale period longer than the inhale period (Nemati, 2013) which is reflective of low i/e ratios. Deep breathing exercises reflective of Paranayama practice have been shown to treat anxiety, depression and stress (Gupta, 2010; Iglesias et al., 2012) whilst boosting mood and restoring cognitive fatigue more effectively than relaxation and visualisation techniques (Wood, 1993).

Pranayama based breathing techniques do not reflect normal resting breathing cycles. As such, implementing these techniques would require an appropriate level of voice and/or textual guidance as the core focus of the experience to support and guide the user’s abnormal breathing cycle.

Another promising technique is called Sudarshan Kriya Yogic (SKY) breathing which involves breathing cycles ranging from slow, calming breathing to fast, stimulated breathing (Zope & Zope, 2013). The range of health benefits associated with SKY is extensive (Jerath, Braun, & Barnes, 2015) yet long training periods are required to pick up even just the basics (Brown & Gerbarg, 2005).

References

Bernardi, L., Sleight, P., Bandinelli, G., Cencetti, S., Fattorini, L., Wdowczyc-Szulc, J., & Lagi, A. (2001). Effect of rosary prayer and yoga mantras on autonomic cardiovascular rhythms: comparative study. BMJ: British medical journal, 323(7327), 1446.

Bernardi, L., Porta, C., & Sleight, P. (2006). Cardiovascular, cerebrovascular, and respiratory changes induced by different types of music in musicians and non-musicians: the importance of silence. Heart, 92(4), 445-452.

Boiten, F. A. (1998). The effects of emotional behaviour on components of the respiratory cycle. Biological psychology, 49(1), 29-51.

Brown, R. P., & Gerbarg, P. L. (2005). Sudarshan Kriya yogic breathing in the treatment of stress, anxiety, and depression: part I—neurophysiologic model. Journal of Alternative & Complementary Medicine, 11(1), 189-201.

Busch, V., Magerl, W., Kern, U., Haas, J., Hajak, G., & Eichhammer, P. (2012). The effect of deep and slow breathing on pain perception, autonomic activity, and mood processing—an experimental study. Pain Medicine, 13(2), 215-228.

Cappo, B. M., & Holmes, D. S. (1984). The utility of prolonged respiratory exhalation for reducing physiological and psychological arousal in non-threatening and threatening situations. Journal of Psychosomatic Research, 28(4), 265-273.

Chandra, S., Jaiswal, A. K., Singh, R., Jha, D., & Mittal, A. P. (2017). Mental stress: Neurophysiology and its regulation by Sudarshan Kriya Yoga. International journal of yoga, 10(2), 67.

Chittaro, L., & Sioni, R. (2014). Evaluating mobile apps for breathing training: The effectiveness of visualization. Computers in Human Behavior, 40, 56-63.

Chodzinski, J. (2000). The effect of rhythmic breathing on blood pressure in hypertensive adults. J Undergrad Res, 1(6), 78-98.

Gomez, P., Stahel, W. A., & Danuser, B. (2004). Respiratory responses during affective picture viewing. Biological psychology, 67(3), 359-373.

Gupta, P. K., Kumar, M., Kumari, R., & Deo, J. (2010). Anuloma-Viloma pranayama and anxiety and depression among the aged. Journal of the Indian Academy of Applied Psychology, 36(1), 159-164.

Iglesias, S. L., Azzara, S., Argibay, J. C., Arnaiz, M. L., de Valle Carpineta, M., Granchetti, H., & Lagomarsino, E. (2012). Psychological and physiological response of students to different types of stress management programs. American Journal of Health Promotion, 26(6), e149-e158.

Jerath, R., Crawford, M. W., Barnes, V. A., & Harden, K. (2015). Self-regulation of breathing as a primary treatment for anxiety. Applied psychophysiology and biofeedback, 40(2), 107-115.

Kim, S. H., Schneider, S. M., Bevans, M., Kravitz, L., Mermier, C., Qualls, C., & Burge, M. R. (2013). PTSD symptom reduction with mindfulness-based stretching and deep breathing exercise: randomized controlled clinical trial of efficacy. The Journal of Clinical Endocrinology & Metabolism, 98(7), 2984-2992.

Lin, I., Tai, L., & Fan, S. (2014). Breathing at a rate of 5.5 breaths per minute with equal inhalation-to-exhalation ratio increases heart rate variability. International Journal of Psychophysiology, 91(3), 206-211.

Nemati, A. (2013). The effect of pranayama on test anxiety and test performance. International journal of yoga, 6(1), 55.

Schein, M., Gavish, B., Herz, M., Rosner-Kahana, D., Ben-Zvi, N., & Zlotnikov, E. (1998, June). Non-drug hypertension reduction by device-guided breathing exercises: a double-blind randomized study. In Journal of Hypertension (Vol. 16, pp. S217-S217).

Sharma, V. K., Trakroo, M., Subramaniam, V., Rajajeyakumar, M., Bhavanani, A. B., & Sahai, A. (2013). Effect of fast and slow pranayama on perceived stress and cardiovascular parameters in young health-care students. International journal of yoga, 6(2), 104.

Sharma, P., Mavai, M., Bhagat, O. L., Murugesh, M., & Sircar, S. (2017). Slow Deep Breathing Increases Pain-tolerance and Modulates Cardiac Autonomic Nervous System. Indian J Physiol Pharmacol, 61(2), 107-113.

Streeter, C. C., Gerbarg, P. L., Whitfield, T. H., Owen, L., Johnston, J., Silveri, M. M., Wixted, M. (2017). Treatment of major depressive disorder with Iyengar yoga and coherent breathing: A randomized controlled dosing study. The Journal of Alternative and Complementary Medicine, 23(3), 201-207.

Van Diest, I., Verstappen, K., Aubert, A. E., Widjaja, D., Vansteenwegen, D., & Vlemincx, E. (2014). Inhalation/exhalation ratio modulates the effect of slow breathing on heart rate variability and relaxation. Applied psychophysiology and biofeedback, 39(3-4), 171-180.

Van Diest, I., Winters, W., Devriese, S., Vercamst, E., Han, J. N., Van de Woestijne, K. P., & Van den Bergh, O. (2001). Hyperventilation beyond fight/flight: respiratory responses during emotional imagery. Psychophysiology, 38(6), 961-968.

van Dixhoorn, J. (1998). Cardiorespiratory effects of breathing and relaxation instruction in myocardial infarction patients. Biological psychology, 49(1), 123-135.

Wood, C. (1993). Mood change and perceptions of vitality: a comparison of the effects of relaxation, visualization and yoga. Journal of the Royal Society of Medicine, 86(5), 254-258.

Zope, S. A., & Zope, R. A. (2013). Sudarshan kriya yoga: Breathing for health. International journal of yoga, 6(1), 4.