The Influence of Awe on Interpersonal Movement Synchronization: An Experimental Study

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Abstract

The experience of awe, a self-transcendental and profound emotion, is linked to various prosocial behaviours and is thought to promote a sense of connectedness between individuals. One such marker of interconnectedness is movement synchronization. This exploratory study examined whether awe influences interpersonal movement synchronization during dyadic interactions. Dyads watched either an awe-inducing (experimental) video or a neutral (control) video, followed by a 5-minute conversation about their ideal day. Interpersonal synchrony was quantified using Motion Energy Analysis of video-recorded interactions. Due to the limited sample size, the study remains exploratory. However, the findings showed that participants in the awe condition showed slightly higher movement synchronization and self-reported connection scores than those in the control condition. These results are in line with earlier findings suggesting awe reduces self-focus and promotes attention towards others and they support grounded cognition perspectives, which propose that experiences such as awe are not merely cognitive and emotional but also manifest in bodily states. The findings highlight the potential value of cultivating shared experiences of awe in therapeutic or work contexts. Future research should aim to replicate these findings with larger samples to enable robust statistical analyses and draw more definitive conclusions.

Keywords: awe, interpersonal movement synchronization, embodied awe, small self hypothesis, Motion Energy Analysis

The Influence of Awe on Interpersonal Synchronization: An Experimental Study

After gazing at stars in the night sky, experiencing art or taking in breathtaking scenery from a mountain summit, one may be overwhelmed with profound emotions. The term that is commonly used to describe this feeling is *awe*, a concept that only until more recently has gained interest in the field of psychology (Schneider, 2017). A foundational paper by Keltner and Haidt (2003) offers a prototypical framework for understanding awe, proposing that two core features encompass the experience; 'perceived vastness' and the 'need for accommodation'. Perceived vastness refers to the experience of stimuli considered to be much greater than oneself. This perceived vastness may be perceptual in nature (e.g. viewing the northern lights) or conceptual (e.g. contemplating infinity; Yaden et al., 2016). The need for accommodation, however, refers to the process of modifying existing mental structures to incorporate new information that currently does not fit within the individual's understanding (Piaget & Inhelder, 1969). This process may not always be pleasant, however, since awe may be perceived by the individual in both negative and positive ways (Keltner & Haidt, 2003; Lazarus 1991; Gordon et al., 2016; Yaden et al., 2018).

Awe and Its Psychological Impact

Beyond its recent theoretical development in psychology, the experience of awe holds significant real-world consequences. Research suggests that awe leads people to focus less on self-related issues and perceive a smaller sense of self (Piff et al., 2015; Bai et al., 2017; Valdesolo & Graham, 2014; Shiota et al., 2007; Van Elk et al., 2016). For example, Piff and colleagues (2015) randomly assigned participants to recall experiences of awe, pride, or a neutral affect in a controlled experiment to examine if awe shifts focus away from the self. The results showed that participants who reflected on and wrote about previous awe experiences reported a

stronger feeling of something greater than themselves, compared to those in the control condition. This shift in attention,in turn, has been related to prosocial behaviour such as increased generosity (Piff et al., 2015), collective engagement (Bai et al., 2017), willingness to volunteer time (Rudd et al., 2012), and a feeling of 'oneness' with others (Van Cappellen & Saroglou, 2012). Perlin and Li (2020) suggest that this reduced focus to self-related issues allows more attention to be given to the concerns of others, thereby increasing prosocial tendencies.

Moreover, the decreased focus on the self is linked with changes in cognitive and neurological changes. For example, awe may alter a person's time perception, making people feel like they may have more or less of it (Rudd et al., 2012). On a neurological level, awe has been shown to decrease activity in the default mode network (DFM), a brain system that is thought to be involved in self-referential processes (Van Elk et al., 2019). In line with earlier reasoning, this may allow an individual to have greater openness for external stimuli. Additionally, it has been shown that awe deactivates the left middle temporal gyrus (LMTG), which is linked to 'schema liberation' (Takano & Nomura, 2022). These findings suggest that awe has a significant influence on opening individuals up to new ways of experiencing the world and highlight its potential to promote psychological transformation.

Building on these insights, research has focused on how awe might be effective in a clinical context to promote therapeutic change. Monroy and colleagues (2023) found that daily encounters with awe led to people experiencing less stress and somatic health symptoms. Moreover, Tao and colleagues (2025) found that in cancer patients undergoing treatment experiencing awe resulted in less anxiety and a more relaxed and calm attitude. Reflecting a similar view, Schneider (2007) argued that cultivating awe is important for psychotherapeutic outcomes as it provides individuals with tools to overcome psychological blocks and adopt a

more mindful attitude. Given these effects on cognition and lived experience, it is unsurprising that awe has been associated with greater well-being, overall life satisfaction and the potential for personal transformation (Krause & Hayward, 2015; Rudd et al., 2012; Gordon et al., 2016; Anderson et al., 2018; Keltner & Haidt, 2003).

The Embodied Gap in Awe Research

However, although much research on awe has explored its psychological effects, relatively little attention has been given to its embodied experience. As the experience of awe is often overwhelming and sometimes even ineffable, approaching it with an embodied perspective allows researchers to go beyond simple self-report measures. This approach offers a more nuanced and comprehensive understanding of how awe is experienced in both the mind and body capturing the experience's complexity better. Some studies have already investigated physiological markers such as skin conductance, heart rate variability, piloerection and changes in autonomic nervous system activation (Chirico et al., 2016; Takano & Nomura; 2023; Chirico et al., 2017; Shiota et al., 2011; Bannister & Eerola, 2023; McPhetres & Shtulman, 2021). However, these physiological responses, on their own, do not fully capture how awe is experienced through an individual's body as they often overlook subjective and expressive aspects of embodiment such as alterations in movement, facial expressions, or posture. Since awe is a complex experience, Chirico and Gaggioli (2018) argue that it is crucial to treat it as such in a laboratory setting. Likewise, Yaden and colleagues (2018) posit awe is not to be understood merely as an emotion but as an 'altered state of consciousness', further supporting the need for a broader understanding of awe. Thus, studying the complexity of awe's manifestations through both the mind and body could be valuable.

Interpersonal Synchronization and Prosociality

An especially interesting avenue of embodied research on awe lies within interpersonal synchronization. It has been well documented in domains such as art and philosophy that people use their body to interact with each other – a process that plays a key role in promoting connection between individuals (Valdesolo & DeSteno, 2011) and enriching communication(Goldin-Meadow, 1999) .One way this embodiment is shown is through interpersonal synchronization, which refers to the matching of movements in time (e.g. coordinated movement) between two or more individuals (Bernieri et al., 1988). Although it seems quite similar to behavioural mimicry, it is different. In behavioural mimicry the individual repeats some mannerism after a brief delay, whereas synchronization occurs almost simultaneously (Mayo & Gordon, 2020). Moreover, interpersonal synchrony can happen at a physiological level and is not limited to only behaviour (Mazzurenga et al., 2011). Nevertheless, recent research has demonstrated that when people interact with each other they tend to synchronize their body posture and movements (Shockley et al., 2003; Tschacher et al., 2014). These findings underscore the prominence of interpersonal synchronization in everyday life and the potential for investigating it in an embodied research context.

In addition to the well-documented presence in social interactions, interpersonal synchronization has been found to be a significant predictor of prosociality. Research has demonstrated that people experience greater affiliation with their synchronous counterparts compared to their asynchronous counterparts (Hove & Risen, 2009; Ravreby et al., 2022). Similarly, Valdesolo and DeSteno (2011) found that synchronization elicited a stronger compassionate response, fostering empathy. Moreover, it has been demonstrated that interpersonal synchronization promotes cooperation (Valdesolo & DeSteno, 2010). Even in

infancy, synchrony is linked with altruistic behaviour (Cirelli et al., 2014). To conclude, a meta-analysis by Rennung and Göritz (2016) showed that interpersonal synchrony overall has a medium effect on prosociality. These findings suggest that interpersonal synchronization plays a significant role in fostering social bonding and a sense of connectedness, making it a key factor in understanding prosocial attitudes and behaviours.

Bridging Awe and Interpersonal Synchronization

Both awe and interpersonal synchronization play an important role in the prosocial nature of people's attitudes and behaviours. Both phenomena are associated with increases in a sense of connectedness or 'oneness' with others. As discussed above, they are found to have positive effects on a range of prosocial behaviours such as cooperation, helping behaviours, compassion, and empathy (Piff et al., 2015; Rudd et al., 2012; Van Cappellen & Saraglou, 2012; Bai et al., 2017). However, despite extensive research on the two phenomena no research exists on how they might be related, representing an important gap in the literature. Specifically, there is a limited understanding of how awe might facilitate the embodied process of interpersonal synchronization.

Exploring and deepening our understanding of the mechanism through which awe may influence interpersonal synchronization could be valuable for the development of practical applications. Previous research has already indicated that greater synchronization between patients and therapists leads to better outcomes in psychotherapy (Ramseyer & Tschacher, 2011) and that fostering awe experiences is important to be considered in a therapeutic setting (Schneider, 2007). If awe does indeed facilitate synchronization, incorporating awe-like experiences in a therapeutic context could further improve patient outcomes. Moreover, such

insights could be useful for developing interventions for, for instance, team-building in organizations and educational settings.

One explanation for awe's potential influence on interpersonal synchronization lies in its effects on the self and social perception. Awe may elicit a sense of the 'small self' where individuals focus less on themselves and are more connected with something bigger than themselves (Piff et al., 2015). This reduction in focus on the self may increase individuals' openness to others and increase their sensitivity to social signals and alignment with others. It could be argued that this greater attunement to others may create a situation in which interpersonal synchronization occurs more easily. In line with this reasoning, individuals who experience awe could enhance the process of synchronization. Because people synchronize their behaviour during everyday conversations and interactions (Shockley et al., 2003; Tschacher et al., 2014), interpersonal synchrony can be expected to occur irrespective of an awe-like experience. However, we expect that this synchrony will be amplified when individuals experience awe compared to when they do not. This leads us to the following hypothesis:

Hypothesis 1. Individuals who experience awe will synchronize their body movements more than those who do not experience awe.

Method

The hypothesis examined in this paper was part of a broader ongoing study. In addition to interpersonal movement synchronization, the broader study assessed other physiological and behavioural measures, such as heart rate, skin conductance and speech. Participants were invited to attend two separate sessions on different days: first a monadic session, where they completed

the study individually, then a dyadic session, where they completed the study in pairs. During the monadic session participants were assigned to one of two conditions. In the control condition, participants watched a neutral video showing a shoe repair accompanied by lighthearted, upbeat music (see Figure 1). In the experimental condition, they watched a video of outer space accompanied by calm and imposing music. If participants were in the control condition during the monadic session they were shown the video of space in the dyadic session. Conversely, if participants were in the experimental condition during the monadic session they watched the video of the shoe repair in the dyadic session. In the dyadic session participants were asked to return to the lab with a partner to perform the interpersonal synchronization part of the experiment. In order to examine the interpersonal synchronization to occur we had the participants engage in a conversation about their ideal day for 5 minutes. The conversation and participants' gestures and body language was recorded using a video camera. The study was submitted to the Ethics Committee of the Faculty of Behavioural and Social Sciences at the University of Groningen. The study was approved under the code PSY-2324-S-0412.

Participants

The study initially aimed to recruit 170 participants (85 dyads) in order to ensure 90% power to detect medium effect sizes. However, due to time constraints and the limited pool of available and eligible participants, the final sample size consisted of 4 participants (1 control dyad and 1 experimental dyad). All participants were undergraduate students of the faculty of Behavioural and Social sciences at the Rijksuniversiteit Groningen who participated for course credits. The participants were recruited using SONA, a participant enrollment system. Participants were assigned through random assignment.

Exclusion Criteria

Individuals with autism spectrum characteristics have been linked to decreased susceptibility to spiritual perceptions and beliefs whereas those with schizotypal traits tend to show an increase in susceptibility (Crespi et al., 2019). Since the presence of these traits may interfere with a reliable induction of awe, individuals who were interested in participating in the study first had to complete two brief screening questionnaires for autism spectrum disorder (AQ-10) and schizotypal personality (SPQ-BR). Those scoring above 40 on the SPQ-BR and above 7 on the AQ-10 were excluded from participation. Additionally, participants were required to be able to stand comfortably for approximately one hour to ensure they could complete the experiment without physical discomfort.

Procedure

During the monadic session participants filled out several short questionnaires that determined baseline measures of their susceptibility to awe and personality characteristics relevant to the experience of awe. Of these questionnaires, the Dispositional Positive Emotions Scale (Shiota et al., 2006) was also employed in the current study. This questionnaire was incorporated to examine whether the experimental or control groups differed in their ability to experience awe, which may serve as a moderating variable.

For the dyadic part of the experiment, participants were asked to come to the lab in pairs. The pairs were formed based on participants' scheduling availability implying that individuals who were available at similar times were grouped together. Similar to the monadic session, participants filled in the Dispositional Positive Emotions Scale. Then, the participants were given instructions on how to attach the heart rate monitor and asked to do so in a nearby restroom. The experimenter verified the camera, audio and balance board were properly recording while the

participants were in the restroom attaching the heart rate monitor. Upon returning to the lab, both the participants were asked to stand on one of two balance boards while the experimenter connected them to the galvanic skin response (GSR) device. Both participants stood on the balance board facing the TV screen (see Figure 2). Another screen stood in between the participants so they could not see each other (see also Figure 2). This ensured that the participants could not get distracted and be fully immersed while watching the video. After all measurement devices were set, the participants watched the video they had not seen previously during the monadic session. Then, participants were asked to fill out the Awe Experiences Scale. After this, they watched a video of an animal playing as part of a study not included in this report. In the next phase, the screen in between the two participants was removed. At this point in the study the participants were able to see each other. Then, participants were asked to engage in a conversation about their ideal day while standing on the balance board. This approach follows that of Ramseyer and Tschacher (2011) who analyzed therapist-patient conversations. During the interaction, whole-body movements were captured using a video camera to make inferences about interpersonal synchronization. After the participants completed the conversation, they were asked to fill in the Inclusion of Other in the Self Scale and the Perception of Interaction Questionnaire. Once these measures were completed, the participants were disconnected from the equipment, marking the end of the study.

Figure 1.

Control and Experimental Video Snapshots

Note. The video of the shoe repair (left) was shown to participants in the control condition, whereas the video of space (right) was shown to participants in the experimental condition.

Figure 2.

Experimental Setup of the Lab

Materials and Analysis

Dispositional Positive Emotion Scale

The Dispositional Positive Emotion Scale (DPES; Shiota et al., 2006) is employed to establish participants' tendency to experience positive emotions, including dispositional awe. This measure allows us to control for individual differences in participants that might influence their susceptibility to stimuli that could induce awe. The DPES was completed at both the monadic and dyadic part of the study in order to account for potential mood fluctuations across days. However, only the scores relevant for the current study are used in the analysis (i.e. dyadic session). The DPES consists of 12 items with seven subscales: joy, pride, love, compassion, amusement, contentment and awe. The scale includes items such as *'I feel wonder almost every day'* that are rated on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The scale showed good internal consistency, with Cronbach's $\alpha = .83$.

Awe Experience Scale

To assess whether awe was successfully induced in participants we employed the Awe Experience Scale (AWE-S; Yaden et al., 2018) which operationalizes the construct of awe through five domains that, in line with the literature, are deemed to be central to the experience of awe: *perception of vastness, need for accommodation, alterations in time, self-diminishment, connectedness,* and *physical sensations.* The scale includes 30 items such as '*I felt my sense of self shrink*' that are rated on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The test showed high internal consistency with Cronbach $\alpha = .97$. Two items were excluded from this reliability analysis due to lack of variance.

Inclusion of Other in the Self Scale

The Inclusion of Other in the Self Scale (IOS; Aron et al., 1992) was sed to determine to what extent the participants felt a subjective closeness with one another during the conversation they had. In our study, this measure will act as a proxy for interpersonal synchronization, intending to capture the perceived alignment between participants following their interaction. Respondents answered one question in which they were provided with 7 pairs of circles that each vary in degree of overlap. The overlap ranges from 1 (no overlap) to 7 (most overlap) and indicates whether the individual feels closeness with the counterpart in their dyad.

Perception of Interaction Questionnaire

The Perception of Interaction Questionnaire (PIQ; Cuperman & Ickes, 2009) will assess how participants perceived the quality of the interaction, the degree of rapport, and the extent to which they liked the other person following their conversation. Similar to the IOS, this measure will be used as a proxy for interpersonal synchronization. The test contained 17 items with questions such as '*To what degree did you feel accepted and respected by the other person?'* which are rated on a 5-point Likert scale ranging from 1 (not at all) to 5 (very much). Due to lack of variance, one item was removed from the reliability analysis, which resulted in a Cronbach's $\alpha = .87$

Analysis

To determine the rate of interpersonal synchrony, we will employ Motion Energy Analysis (MEA) on the video footage. MEA is an automated software program that allows users to review and quantify the amount of change that is happening within a particular region of interest (Ramseyer, 2020). In our study we are particularly interested in full body movements and one region of interest covering the entire body was selected for each participant. This approach is similar to that used by Ramseyer and Tschacher (2011). From this region of interest,

the software then calculates the lagged and cross-correlations in order to measure how closely individuals' movements match over time and if someone moved slightly before or after the other. These data, captured over a 5-minute window, are then converted into a single continuous score ranging from 0 to 1, with 1 indicating complete synchrony, providing an overall measure of interpersonal synchrony during the interaction.

Results

The section outlined below presents the results of our analysis on whether inducing awe facilitates rates of interpersonal synchronization. Moreover, we examine how dispositional awe, perceived awe, and the subjective experience of the conversation influence interpersonal synchronization rates. Given the inadequate sample size, conducting inferential statistical analyses will not be appropriate for this sample. Instead, we will report the descriptive statistics and the standardized effect sizes using Cohen's *d* where possible (Table 1). This will help demonstrate the size and direction of differences between the awe and control condition.

Table 1.

Descriptive Statistics of Main Variables

	Awe	Control	Difference	Cohen's *d*
DPES score	4.197	5.542	–0.625	–0.832
AWE-S score	4.050	1.700	+2.350	1.962
IOS score	2.5	2.0	+0.5	*NA*
PIQ score	3.588	3.471	+0.117	0.162
Synchrony	0.179	0.176	+0.003	*NA*

Note. NA indicates values that could not be computed as a result of statistical limitations (i.e. lack of variance, inadequate sample size)

Before conducting the primary analysis we ensured whether or not awe was reliably induced. Participants in the experimental group reported a noticeably higher level of awe in the AWE-S score ($M = 4.050$) compared to the control group ($M = 1.700$), which lends support to the successful induction of awe and aligning with findings from previous research (Piff et al., 2015; Gocłowska et al., 2021). Cohen's d was 1.962, indicating a large effect size. This demonstrates that the experimental group experienced a more impactful subjective experience of awe. Moreover, it is important to note that the control group showed a greater proclivity to experience awe than the control condition as seen by the scores on the DPES.

In order to test our hypothesis that there is more interpersonal synchronization after individuals have an awe experience, we calculated the global synchrony scores using MEA across a 5-minute window. The findings show that individuals in the awe group had higher global synchrony scores ($z = 0.179$) than individuals in the control group ($z = 0.176$). The

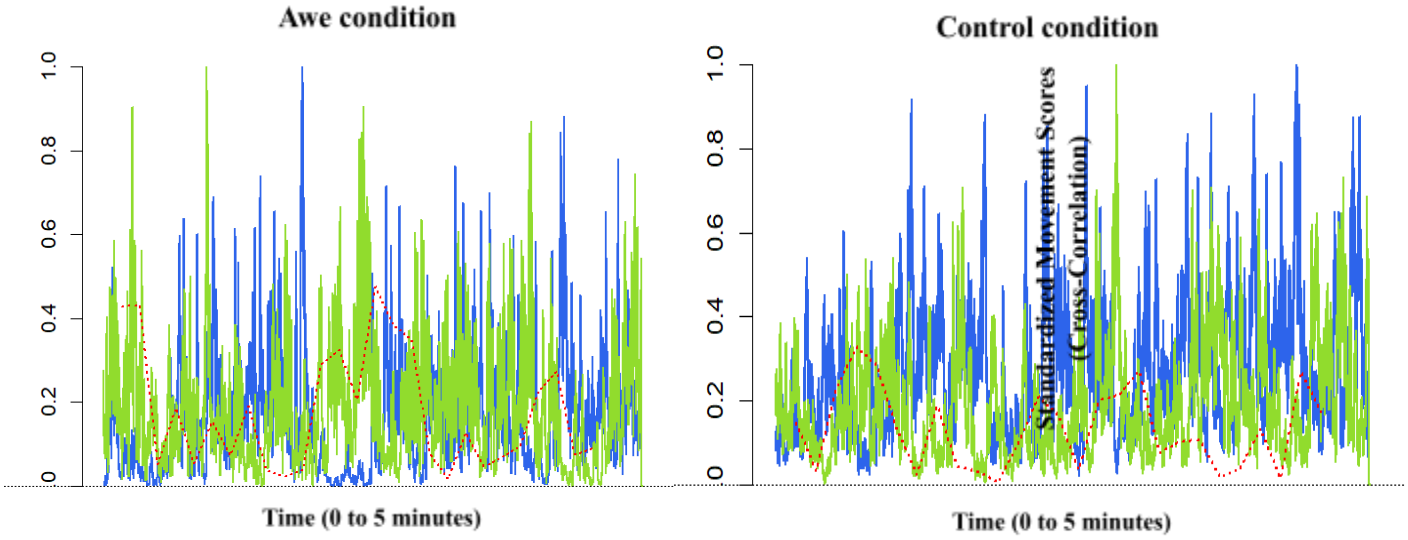
corresponding effect size of this difference could not be computed due to a lack of data, but the observed difference was minimal. Nevertheless, the results indicate a slight increase in interpersonal movement synchrony during the awe condition offering provisional support for our hypothesis.

Moreover, Figure 3 presents the standardized movement scores for both the awe and control condition during the 5 minute conversation (*x*-axis), including the global synchrony scores (dotted red line). Interestingly, at the start of the conversation the participants in the awe condition appeared more attuned with each other as indicated by the peak of the dotted red line. In contrast, the control condition shows a lower and stable level of synchrony throughout the interaction with no noticeable peak in standardized movement.

To examine how interpersonal synchronization corresponded with the subjective experience of the participants, we compared the self-reported scores on the quality of the interaction and perceived closeness. The awe condition demonstrated higher scores on the IOS scale compared to the control condition ($M = 2.5$ vs. $M = 2.0$). Since there was no variance in scores for the control dyad, it was not possible to calculate an effect size. Nevertheless, the observed difference does suggest a potential direction toward greater perceived closeness in the awe condition. Moreover, the awe condition also showed slightly higher scores on the POI scale ($M = 3.588$ vs. $M = 3.471$). The differences between conditions showed a small effect size (Cohen's $d = 0.162$), suggesting a modest trend in line with existing theories that awe may promote interpersonal bonding and closeness. Thus, while the differences were minimal, these scores imply that the individuals in the awe condition experienced a slightly greater sense of connection with one another and rated the interaction somewhat more positively.

Figure 3.

Standardized Movement Scores and Synchrony Over Time in the Awe and Control Condition



Note. Blue lines show participants analyzed on the left side of the video, green lines those on the right; each color represents one member of the dyad. The dotted red line indicates the global synchrony score between them over time.

Discussion

In the current study, we examined the role of awe in enhancing and facilitating interpersonal movement synchronization between individuals. We hypothesized that participants experiencing awe would show greater interpersonal synchronization compared to those who did not. First, we examined the dispositional tendencies of participants to experience awe. Participants in the control condition were more prone to experience awe compared to the experimental condition, as indicated by the DPES scores. These scores may act as a confounding factor on the experience of awe and must be considered when interpreting the results. Second, we found that our manipulation check successfully induced awe, as indicated by the higher

scores on the AWE-S scale in the awe condition. Third, although the differences were minor, participants in the awe condition showed greater synchrony compared to the control condition, provisionally supporting our hypothesis. Finally, participants in the awe condition also reported a greater perceived connection and closeness with their partner, as indicated by the scores on the IOS and PIQ. However, these differences were also relatively small.

It is important to note that given the exploratory nature of our study and the limited sample size, the findings must be interpreted with caution. The present findings show a relatively small increase in interpersonal synchronization following the induction of awe. This, albeit limited, directional trend is in line with theories that propose awe promotes interpersonal alignment and coordination as a result of a reduced self-focus and an increase in attention toward others, often referred to as the 'small self' hypothesis (Piff et al., 2015). Moreover, the findings also align with the grounded cognition perspective that proposes emotional and cognitive processes are embedded in sensorimotor experiences (Barsalou, 2008). In line with this perspective, awe not only affects thoughts and feelings but also influences how individuals use their bodies. The shared experience of awe may have influenced participants' physical movements to be similar which naturally led to more synchrony. This is somewhat supported by Figure 3, which shows higher synchrony at the start of the interaction for participants in the awe condition, suggesting that experiencing awe could temporarily increase the initial attunement between individuals. Thus, although the difference in synchrony scores were minor, the findings provide preliminary support for the hypothesis that awe facilitates interpersonal movement synchronization and sheds light on the embodied nature of awe.

Besides using automated software to obtain an objective measure of interpersonal movement synchrony, we also examined the self-reported sense of connection and quality of the

interaction between participants, as indicated by the IOS and PIQ scores. Participants in the awe condition showed slightly higher scores on the subjective closeness they had with their partner and also reported higher scores on the overall perceived quality of the interaction. These findings are in line with previous research that posit that awe promotes a sense of oneness with others (Bai et al., 2017; Van Cappellen & Saroglou, 2012). It is important to note that the effect size for the PIQ was small and that no effect size could be calculated for the IOS scores. One possible explanation for these small effects and differences in scores is the composition of the dyad. Research has shown that same-sex dyads show greater movement synchrony than mixed-sex dyads (Ramseyer, 2020). In the current study, the control condition consisted of a female same-sex dyad, whereas the experimental condition consisted of a mixed-sex dyad. Therefore, the differences in dyadic composition could have confounded the impact of awe on subjective closeness.

The difference in DPES scores between the awe and control condition may further help interpret the findings, particularly the modest synchrony differences observed. Dispositional awe refers to an individual's trait-like tendency to experience awe. This trait-like tendency may in turn moderate an individual's susceptibility to stimuli that induce awe. Since participants in the awe condition scored lower on the DPES than those in the control condition, the induction may have had a weaker effect. This suggests that baseline differences in awe susceptibility may have contributed to the minimal differences in synchrony scores observed between conditions. Moreover, the participants' personality traits might have played an additional role in influencing the movement synchrony between dyads. Previous studies have found that personality traits such as extraversion could predict the degree to which individuals feel close with each other and how they perceive the quality of their social relationships (Berry et al., 2000; Lopes et al., 2003).

Given our small sample size, we were unable to account for these potentially confounding factors. Therefore, the modest observed differences in synchrony scores may result from a combination of different personality traits and tendencies, rather than only the awe induction alone.

Limitations

The study has several limitations that must be considered when interpreting the results. First, the research was conducted as part of a broader ongoing study, which involved collecting additional physiological and behavioural data than merely the video-recorded interactions of the dyads. Specifically, participants' galvanic skin response (GSR) and balance were measured using wearable sensors and a balance board. While these measurements could provide valuable insights they also introduced some physical constraints. The GSR device was attached to the hands and fingers with wires and the requirement to stand fixed on the balance board during the dyad interaction may have obstructed the natural movement of participants or caused discomfort. This limitation may have reduced the authenticity of the observed interpersonal synchronization. Thus, the current study's ecological validity could be affected negatively as the experimental setup may have diminished genuine behaviour.

Second, while the dyad interaction was semi-structured by asking participants to talk about their ideal day, the content they were talking about was not tightly controlled. The benefit of this approach is that it allowed for natural dialogue to occur ensuring ecological validity. However, it may have also introduced differences in emotional engagement between dyads. Dyads that shared similar interests, values, or hobbies could have bonded more easily, possibly increasing feelings of rapport and increasing interpersonal synchrony irrespective of the awe manipulation. The topic content may have moderated interpersonal synchronization, potentially

influencing the results. Future research could address this limitation by conducting a post-hoc content analysis of the dyad interactions focusing specifically on the emotional tone and expressions of shared values or interests.

Last, as mentioned previously, the limited sample size made it impossible to control for the influence of individual differences. Variables such as mood, physical health, personality traits could all have impacted how individuals were behaving during the dyad interaction. It is assumed that this variability would even out in larger samples. However, in this small-scale experiment, these factors may have affected the observed interpersonal synchronization and self-reported measures. Additionally, the limited sample size did not allow the use of inferential statistical analysis. Consequently, the observed directional trend in interpersonal synchrony scores could simply be the result of chance. These limitations underscore the exploratory nature of the current research and emphasize the need for extra data collection in future studies.

Implications

Although the findings of the current study are not statistically robust, they provide preliminary support for existing theories that propose awe reduces self-focus and enhances closeness, captured in the 'small self' hypothesis (Piff et al., 2015) mentioned previously. Additionally, the findings contribute to new insights on the embodied nature of awe. They suggest that the shared emotional experience of awe could manifest itself as interpersonal movement synchrony between individuals. This adds nuance to the current understanding of how awe operates not merely cognitively but also through the body. If the current study were to be replicated in larger, more controlled studies these findings could have meaningful implications for applied settings. For example, within a therapeutic setting, shared experiences of awe could be cultivated on purpose in order to improve the therapeutic alliance, potentially improving

treatment outcomes. Moreover, beyond clinical settings, engaging in awe-inducing activities might prove to be valuable for enhancing group cohesion and cooperation in workplace or educational settings.

This exploratory study highlights several promising directions for future research. First, it is essential that future research uses a larger sample size to increase statistical power and enable more robust inferential analyses. This would help generate more reliable conclusions about the effects of awe on interpersonal synchrony. Second, it could be beneficial to content code the dyadic interaction allowing the results to be controlled for potential confounds. For instance, thematic differences in conversation topics (e.g. talking about having children vs. going to a restaurant) might influence how engaged participants are during the 5-minute interaction, thereby potentially affecting synchrony levels. Moreover, it could reveal whether awe influences the themes people discuss. For example, whether participants that experienced awe tend to center their ideal day around nature or other meaningful topics. Last, future studies could extend the duration of dyadic interactions to examine how interpersonal synchrony develops over time. This could provide insight into whether awe-induced effects are sustained, deepen with time, or fade during the conversation.

Conclusion

To conclude, this exploratory study offers promising preliminary support for the idea that awe may promote interpersonal movement synchrony. By employing both objective behavioural and subjective measures, this study contributes to a greater understanding of awe as a relevant social emotion with embodied effects. These findings pave the way for further research into how fostering shared experiences of awe may promote stronger social connections in both therapeutic and everyday contexts.

References

Anderson, C. L., Monroy, M., & Keltner, D. (2018). Awe in nature heals: Evidence from military veterans, at-risk youth, and college students. *Emotion*, *18*(8), 1195–1202. https://doi.org/10.1037/emo0000442

Aron, A., Aron, E. N., & Smollan, D. (1992). Inclusion of Other in the Self Scale and the structure of interpersonal closeness. *Journal Of Personality And Social Psychology*, *63*(4), 596–612. https://doi.org/10.1037/0022-3514.63.4.596

Bai, Y., Maruskin, L. A., Chen, S., Gordon, A. M., Stellar, J. E., McNeil, G. D., Peng, K., & Keltner, D. (2017). Awe, the diminished self, and collective engagement: Universals and cultural variations in the small self. *Journal Of Personality And Social Psychology*, *113*(2), 185–209. https://doi.org/10.1037/pspa0000087

Bannister, S., & Eerola, T. (2023). Vigilance and social chills with music: Evidence for two types of musical chills. *Psychology Of Aesthetics Creativity And The Arts*, *17*(2), 242–258. https://doi.org/10.1037/aca0000421

Barsalou, L. W. (2008). Grounded cognition. *Annual Review Of Psychology*, *59*(1), 617–645. https://doi.org/10.1146/annurev.psych.59.103006.093639

Bernieri, F. J., Reznick, J. S., & Rosenthal, R. (1988). Synchrony, pseudosynchrony, and dissynchrony: Measuring the entrainment process in mother-infant interactions. *Journal Of Personality And Social Psychology*, *54*(2), 243–253. https://doi.org/10.1037/0022-3514.54.2.243

Berry, D. S., Willingham, J. K., & Thayer, C. A. (2000). Affect and Personality as Predictors of Conflict and Closeness in Young Adults' Friendships. *Journal Of Research in Personality*, *34*(1), 84–107. https://doi.org/10.1006/jrpe.1999.2271

Chirico, A., Cipresso, P., Riva, G., & Gaggioli, A. (2016). Psychophysiological correlates of complex spherical awe stimuli: A comparison with a conventional induction technique. *Neuropsychological Trends*, 79–80.

Chirico, A., Cipresso, P., Yaden, D. B., Biassoni, F., Riva, G., & Gaggioli, A. (2017). Effectiveness of Immersive Videos in Inducing Awe: An Experimental Study. *Scientific Reports*, *7*(1). https://doi.org/10.1038/s41598-017-01242-0

Chirico, A., & Gaggioli, A. (2018). Awe: "More than a feeling". *The Humanistic Psychologist*, *46*(3), 274–280. https://doi.org/10.1037/hum0000098

Cirelli, L. K., Einarson, K. M., & Trainor, L. J. (2014). Interpersonal synchrony increases prosocial behavior in infants. *Developmental Science*, *17*(6), 1003–1011. https://doi.org/10.1111/desc.12193

Crespi, B., Dinsdale, N., Read, S., & Hurd, P. (2019). Spirituality, dimensional autism, and schizotypal traits: The search for meaning. *PLoS ONE*, *14*(3), e0213456. https://doi.org/10.1371/journal.pone.0213456

Cuperman, R., & Ickes, W. (2009). Big Five predictors of behavior and perceptions in initial dyadic interactions: Personality similarity helps extraverts and introverts, but hurts "disagreeables". *Journal Of Personality And Social Psychology*, *97*(4), 667–684. https://doi.org/10.1037/a0015741

Gocłowska, M. A., Elliot, A. J., Van Elk, M., Bulska, D., Thorstenson, C. A., & Baas, M. (2021). Awe arises in reaction to exceeded rather than disconfirmed expectancies. *Emotion*, *23*(1), 15–29. https://doi.org/10.1037/emo0001013

Goldin-Meadow, S. (1999). The role of gesture in communication and thinking. *Trends in Cognitive Sciences*, *3*(11), 419–429. https://doi.org/10.1016/s1364-6613(99)01397-2

Gordon, A. M., Stellar, J. E., Anderson, C. L., McNeil, G. D., Loew, D., & Keltner, D. (2016). The dark side of the sublime: Distinguishing a threat-based variant of awe. *Journal Of Personality And Social Psychology*, *113*(2), 310–328. https://doi.org/10.1037/pspp0000120

Hove, M. J., & Risen, J. L. (2009). It's All in the Timing: Interpersonal Synchrony Increases Affiliation. *Social Cognition*, *27*(6), 949–960. https://doi.org/10.1521/soco.2009.27.6.949

Keltner, D., & Haidt, J. (2003). Approaching awe, a moral, spiritual, and aesthetic emotion. *Cognition & Emotion*, *17*(2), 297–314. https://doi.org/10.1080/02699930302297

Krause, N., & Hayward, R. D. (2015). Assessing whether practical wisdom and awe of God are associated with life satisfaction. *Psychology Of Religion And Spirituality*, *7*(1), 51–59. https://doi.org/10.1037/a0037694

Lazarus, R. S. (1991). Cognition and motivation in emotion. *American Psychologist*, *46*(4), 352–367. https://doi.org/10.1037/0003-066x.46.4.352

Lopes, P. N., Salovey, P., & Straus, R. (2003). Emotional intelligence, personality, and the perceived quality of social relationships. *Personality And Individual Differences*, *35*(3), 641–658. https://doi.org/10.1016/s0191-8869(02)00242-8

Mayo, O., & Gordon, I. (2020). In and out of synchrony—Behavioral and physiological dynamics of dyadic interpersonal coordination. *Psychophysiology*, *57*(6). https://doi.org/10.1111/psyp.13574

Mazzurega, M., Pavani, F., Paladino, M. P., & Schubert, T. W. (2011). Self-other bodily merging in the context of synchronous but arbitrary-related multisensory inputs. *Experimental Brain Research*, *213*(2–3), 213–221. https://doi.org/10.1007/s00221-011-2744-6

McPhetres, J., & Shtulman, A. (2021). Piloerection is not a reliable physiological correlate of awe. *International Journal Of Psychophysiology*, *159*, 88–93. https://doi.org/10.1016/j.ijpsycho.2020.11.011

Monroy, M., Uğurlu, Ö., Zerwas, F., Corona, R., Keltner, D., Eagle, J., & Amster, M. (2023). The influences of daily experiences of awe on stress, somatic health, and well-being: a longitudinal study during COVID-19. *Scientific Reports*, *13*(1). https://doi.org/10.1038/s41598-023-35200-w

Perlin, J. D., & Li, L. (2020). Why Does Awe Have Prosocial Effects? New Perspectives on Awe and the Small Self. *Perspectives On Psychological Science*, *15*(2), 291–308. https://doi.org/10.1177/1745691619886006

Piaget, J., & Inhelder, B. (1969). *Psychology Of The Child*. New York : Basic Books.

Piff, P. K., Dietze, P., Feinberg, M., Stancato, D. M., & Keltner, D. (2015). Awe, the small self, and prosocial behavior. *Journal Of Personality And Social Psychology*, *108*(6), 883–899. https://doi.org/10.1037/pspi0000018

Ramseyer, F. T. (2020). Motion energy analysis (MEA): A primer on the assessment of motion from video. *Journal Of Counseling Psychology*, *67*(4), 536–549. https://doi.org/10.1037/cou0000407

Ramseyer, F., & Tschacher, W. (2011). Nonverbal synchrony in psychotherapy: Coordinated body movement reflects relationship quality and outcome. *Journal Of Consulting And Clinical Psychology*, *79*(3), 284–295. https://doi.org/10.1037/a0023419

Ravreby, I., Shilat, Y., & Yeshurun, Y. (2022). Liking as a balance between synchronization, complexity and novelty. *Scientific Reports*, *12*(1). https://doi.org/10.1038/s41598-022-06610-z

Rennung, M., & Göritz, A. S. (2016). Prosocial Consequences of Interpersonal Synchrony. *Zeitschrift Für Psychologie*, *224*(3), 168–189. https://doi.org/10.1027/2151-2604/a000252

Rudd, M., Vohs, K. D., & Aaker, J. (2012). Awe Expands People's Perception of Time, Alters Decision Making, and Enhances Well-Being. *Psychological Science*, *23*(10), 1130–1136. https://doi.org/10.1177/0956797612438731

Schneider, K. (2017). The resurgence of awe in psychology: Promise, hope, and perils. *The Humanistic Psychologist*, *45*(2), 103–108. https://doi.org/10.1037/hum0000060

Schneider, K. J. (2007). The Experiential Liberation Strategy of the Existential-Integrative Model of Therapy. *Journal Of Contemporary Psychotherapy*, *37*(1), 33–39. https://doi.org/10.1007/s10879-006-9032-y

Shiota, M. N., Keltner, D., & John, O. P. (2006). Positive emotion dispositions differentially associated with Big Five personality and attachment style. *The Journal Of Positive Psychology*, *1*(2), 61–71. https://doi.org/10.1080/17439760500510833

Shiota, M. N., Keltner, D., & Mossman, A. (2007). The nature of awe: Elicitors, appraisals, and effects on self-concept. *Cognition & Emotion*, *21*(5), 944–963. https://doi.org/10.1080/02699930600923668

Shiota, M. N., Neufeld, S. L., Yeung, W. H., Moser, S. E., & Perea, E. F. (2011). Feeling good: Autonomic nervous system responding in five positive emotions. *Emotion*, *11*(6), 1368–1378. https://doi.org/10.1037/a0024278

Shockley, K., Santana, M., & Fowler, C. A. (2003). Mutual interpersonal postural constraints are involved in cooperative conversation. *Journal Of Experimental Psychology Human Perception & Performance*, *29*(2), 326–332. https://doi.org/10.1037/0096-1523.29.2.326

Takano, R., & Nomura, M. (2022). Neural representations of awe: Distinguishing common and distinct neural mechanisms. *Emotion*, *22*(4), 669–677. https://doi.org/10.1037/emo0000771

Takano, R., & Nomura, M. (2023). A closer look at the time course of bodily responses to awe experiences. *Scientific Reports*, *13*(1). https://doi.org/10.1038/s41598-023-49681-2

Tao, V., Tennant, G., Clayden, C., & Reynolds, L. M. (2025). Shifting perspectives: an investigation of a virtual reality awe experience in people going through cancer treatment. *Supportive Care in Cancer*, *33*(2). https://doi.org/10.1007/s00520-025-09192-4

Tschacher, W., Rees, G. M., & Ramseyer, F. (2014). Nonverbal synchrony and affect in dyadic interactions. *Frontiers in Psychology*, *5*. https://doi.org/10.3389/fpsyg.2014.01323

Valdesolo, P., & DeSteno, D. (2011). Synchrony and the social tuning of compassion. *Emotion*, *11*(2), 262–266. https://doi.org/10.1037/a0021302

Valdesolo, P., & Graham, J. (2014). Awe, Uncertainty, and Agency Detection. *Psychological Science*, *25*(1), 170–178. https://doi.org/10.1177/0956797613501884

Valdesolo, P., Ouyang, J., & DeSteno, D. (2010). The rhythm of joint action: Synchrony promotes cooperative ability. *Journal Of Experimental Social Psychology*, *46*(4), 693–695. https://doi.org/10.1016/j.jesp.2010.03.004

Van Cappellen, P., & Saroglou, V. (2012). Awe activates religious and spiritual feelings and behavioral intentions. *Psychology Of Religion And Spirituality*, *4*(3), 223–236. https://doi.org/10.1037/a0025986

Van Elk, M., Gomez, M. A. A., Van Der Zwaag, W., Van Schie, H. T., & Sauter, D. (2019). The neural correlates of the awe experience: Reduced default mode network activity during

feelings of awe. *Human Brain Mapping*, *40*(12), 3561–3574. https://doi.org/10.1002/hbm.24616

Van Elk, M., Karinen, A., Specker, E., Stamkou, E., & Baas, M. (2016). 'Standing in Awe': The Effects of Awe on Body Perception and the Relation with Absorption. *Collabra*, *2*(1). https://doi.org/10.1525/collabra.36

Yaden, D. B., Iwry, J., Slack, K. J., Eichstaedt, J. C., Zhao, Y., Vaillant, G. E., & Newberg, A. B. (2016). The overview effect: Awe and self-transcendent experience in space flight. *Psychology Of Consciousness Theory Research And Practice*, *3*(1), 1–11. https://doi.org/10.1037/cns0000086

Yaden, D. B., Kaufman, S. B., Hyde, E., Chirico, A., Gaggioli, A., Zhang, J. W., & Keltner, D. (2018). The development of the Awe Experience Scale (AWE-S): A multifactorial measure for a complex emotion. *The Journal Of Positive Psychology*, *14*(4), 474–488. https://doi.org/10.1080/17439760.2018.1484940