Embodiment of concealable stigma disclosure through dynamics of movement and language

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A concealable stigmatised identity (CSI) is any identity that can be hidden but, if revealed, can be potentially socially devaluing (e.g., sexual minority). Those living with a CSI have opportunities to disclose their identities to friends and family members or within professional contexts. According to the disclosure processes model, people adopt either approach-oriented or avoidance-oriented goals when self disclosing. The current study sought to identify how antecedent goals and relationship context are embodied in the dynamics of unintentional behaviours during disclosure. Participants simulated a disclosure event to both close other and professional other targets and were primed with either approach or avoidance-motivations. Postural activity and language were analysed using detrended fluctuation analysis and recurrence quantification analysis. Results revealed that the movement dynamics of participants who were motivated by approach goals exhibited more complex and flexible behaviour compared to those who were motivated by avoidance goals. In addition, there was more recurrent word use towards close others compared to professional others. These results support the supposition of the disclosure processes model that approach-avoidance motivation impacts behaviour and sheds light on the functional differences between relationship contexts on a CSI disclosure experience.

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Introduction

Individuals who have a concealable stigmatised identity (CSI) such as a mental health disorder, sexual minority identity, or history of sexual victimisation are faced with decisions regarding when and to whom to reveal their identities. Unlike more visible stigmas such as race and gender, which are often outwardly observed, those with a CSI make decisions how and when to reveal their hidden identities (Goffman, 1963; Jones, 1984). Though decades of research have demonstrated the positive health and psychological outcomes of social support following a disclosure (Quinn and Earnshaw, 2013), little is known about characteristics of a positive disclosure event, and the subtle information that an individual might reveal through unintentional behaviours such as posture and language use.

The present study sought to understand how these decisions—what to share and with whom—as well as a person’s motivational state are embodied in movement and language dynamics during a disclosure. In this paper, we draw from radical embodied cognition, which describes behaviour as emerging from complex interactions between the brain, body, and environment (Baggs and Chemero, 2021; Chemero, 2011). Under this framework, behaviour is not a static representation of mental states, but an emergent property of the complex agent-environment system that can best be explained using nonlinear tools such as the fractal analysis and recurrence analysis employed here (Raja, 2021; Richardson and Chemero, 2014). Further, this research aimed to develop an ecologically valid method to capture the disclosure process in a laboratory setting.

Investigating CSI disclosure in real-time has proven difficult, both practically and ethically. Researchers often rely on the self-reported recall of previous disclosures (Chaudoir and Quinn, 2010). As such, this project took a novel approach to disclosure research by simulating a role-played disclosure event to capture the behaviours in real-time. In the current study, we examined the dynamics of movement behaviour and language exhibited when revealing a CSI to a close other (e.g., friend or family member) and a professional other (e.g., professor, boss, or co-worker). More specifically, we explored how someone’s motivation and relationship context were embodied within an individual’s movement and language dynamics to better understand the disclosure event as a holistic, multi-modal process that not only includes the content of the disclosure, but postural information and word-use dynamics as well. Each of these behavioural modalities produce important verbal and nonverbal information that may be detected by the target of a disclosure and thus, impact the outcome of a disclosure event.

Movement dynamics. One behavioural system of interest is postural activity. Postural sway is a ubiquitous phenomenon that serves an important function for balance following a perturbation (Era and Heikkinen, 1985; Uiga et al., 2020) and for exploring the information within an environment (Carpenter et al., 2010). Traditionally, cognitive research has suggested this variability is a random outcome of a brain-body lag whereby the body must wait milliseconds for input from the brain, thus the lag results in a slight error (i.e., postural sway; Pellecchia, 2003). Though postural variability does appear to fluctuate randomly over time, there is a meaningful structure to postural movement dynamics, which allows individuals to adapt to different personal and task relevant constraints that can exist across different timescales (see Delignières et al., 2011; Balasubramaniam et al., 2000; Bardy et al., 2007; Manor et al., 2010 for detailed description of postural and behavioural complexity).

An individual’s postural movements provide an embodied metre of the co-dependent nonverbal, cognitive, and linguistic processes that characterise face-to-face social interaction (Richardson et al., 2008; Shockley et al., 2003). For instance, research within human movement sciences demonstrates how changes in situational constraint and an individual’s intentional state can significantly influence the structure of postural fluctuations within the time-evolving linguistic, perceptual, and social cognitive behaviours that shape the dynamics of human motor and postural activity (Corell, 2008; Delignières et al., 2004; Van Orden et al., 2003). This research reveals how intra- and interpersonal movements are typically characterised by long-range correlated (i.e., complex fractal or pink noise) patterns of behavioural variance, with overly controlled movements exhibiting more deterministic patterns of behavioural fluctuation (Van Orden et al., 2009; Washburn et al., 2014; Coey et al., 2016; Dotov et al., 2016). For example, drunkenness (Noda et al., 2005), schizophrenia (Kent et al., 2012), age (Lin et al., 2008), and movement disorders such as Parkinson’s disease and Huntington’s disease (Stylianou et al., 2011) are all characterised by a change in postural complexity away from adaptive, fractal patterns of behavioural variability. A change in the structure and complexity of postural activity is not only associated with poor health but can be impacted by increasingly difficult cognitive tasks (Riley et al., 2005).

As an example, when participants were asked to stand on a raised platform that would move to disrupt their quiet stance, anxiety related to the perturbation was associated with decreased postural control as measured by the amplitude of postural movement (Johnson et al., 2019). Paxton and Dale (2017), when examining synchrony between two participants engaged in either affiliative or argumentative conversation, found that behavioural synchrony (measured by %REC—see method for description) of head movements decreased during argumentative conversation. Furthermore, when the participants were exposed to a dual task in which they were asked to remember distracting stimuli, the interpersonal dynamics shifted and exhibited clear leader-follower pattern compared to a control noise condition. The growing literature of movement and interaction dynamics suggest the importance of situational context on unintentional human movement dynamics (Eiler et al., 2017).

Therefore, the current study was designed to investigate the dynamics of postural behaviour when participants disclosed a CSI to an imagined close other or professional other and primed for either achieving positive (approach) or reducing negative (avoidance) outcomes, which are described below. To do so, we measured postural behaviour in both the medio-lateral (ML; side-to-side movement) and anterior-posterior (AP; forward–backward movement) planes during the disclosure of a CSI to gain a better understanding of how mental processes and disclosure context are manifested in the bodies’ relationship with the environment. It was expected that the postural behaviour would be more deterministic (i.e., previous states predict future behaviour; Riley and Turvey, 2002) and less flexible during a professional other disclosure compared to a close other. We also expect that the postural sway of participants who aim to achieve positive will have more flexible movement dynamics.

Language dynamics. In addition to nonverbal behaviour, we also explored language dynamics through recurrent patterns of word use. Considering the complex nature of word use in language, research has demonstrated the utility of studying dynamical properties of language during conversation (Dale and Spivey, 2006; Vinson and Dale, 2016; Paxton et al., 2016; Romero, 2017). In an exploratory analysis of an expressive writing intervention for women with Breast Cancer (Lyby et al., 2019), results suggest...
that a change in the recurrent structure of the essays was associated with a decrease in depressive symptoms at 3 and 9 months, post-intervention. This work demonstrates how a change in psychological or situational perspectives can be reflected in the structure of written language.

To date, most of the work using recurrence analysis to describe the dynamic structure of language has examined written texts (Orsucci et al., 1997) or recurrent behaviour in dyadic conversation (Dale and Spivey, 2006). In one study of written essays, a greater degree of overall word use was correlated with lower scores on measures of word choice and mechanics. On the other hand, longer maximum lines of recurrent text was associated with higher ratings for the body of the essay (Allen et al., 2017). Motivated by this existing research, we investigated the dynamics of word use by individuals during the simulated disclosure event. As language structure has previously been linked to overall ratings of writing quality, we expect that positive disclosure goals will be associated with less overall recurrence, but longer lines of maximum recurrence. Given the nascent stage of this research programme, and that these disclosures will not be assessed for writing quality as in the previously described study, these analyses are largely exploratory.

Disclosure context. Research investigating the process of disclosing a CSI has made considerable advancement towards understanding motivations for disclosure, and how these decisions impact positive and negative outcomes such as social support, rejection, and psychological well-being (Chaudoir and Fisher, 2010; Omarzu, 2000; Pachankis, 2007; Matsumoto et al., 2017). Existing models highlight the importance of goal motivation prior to a disclosure event. Specifically, the Disclosure Processes Model (Chaudoir and Fisher, 2010) argues that individuals share their CSI’s using either approach-oriented goals (aimed at achieving positive outcomes such as increasing trust in a relationship) or avoidance-oriented goals (aimed at avoiding negative outcomes including rejection) and that activation of either motivational system has a meaningful impact on the disclosure event. For example, antecedent goals (i.e., approach/avoidance-orientation) may influence the behavioural patterns that individuals exhibit when sharing hidden stigma such as language use and postural activity. Importantly, these subtle and often unintentional behavioural shifts can have a significant impact on the long term psychological and interpersonal outcomes of CSI disclosure, including the social support a confidant provides and future disclosure decisions. The Disclosure Processes Model also predicts that approach-oriented disclosures are likely to exhibit behaviours that elicit a more positive response from a confidant, whereas people who use avoidance goals are not only less likely to disclose but are more likely to experience negative outcomes when they do (Chaudoir et al., 2011).

Research on approach and avoidance-orientation is demonstrated in human and nonhuman animals to underlie many motivational processes (Elliot and Covington, 2001). This large body of research suggests that approach and avoidance motivational systems impact several outcomes including classroom performance (Elliot and Church, 1997), social and romantic relationships (Gable, 2006), therapy outcomes (Elliot and Church, 2002), and even our perceptions of the environment (Strachman and Gable, 2006). Generally, approach motivational systems are activated to achieve positive outcomes and are associated with attuning to positive social and environmental stimuli. Conversely, avoidance motivational systems are activated to avoid negative outcomes and are associated with attuning to negative social and environmental stimuli (Strachman and Gable, 2006). For example, following an avoidance motor action (arm extension), participants demonstrated a reduced ability to solve creative and insightful problems compared to approach motor action (arm flexion; Friedman and Förster, 2001). It is posited that this reduced ability to explore creative solutions under avoidance motivation is due to heightened anxiety and arousal, which impedes flexibility in cognition (Roskes et al., 2012; Roskes et al., 2014). Therefore, we expect that avoidance motivation in the present study would similarly be associated with reduced flexibility in postural behaviour and language compared to approach motivation.

Along with the antecedent motivations behind revealing a concealable stigma, people living with a CSI make decisions regarding the type of information they share within their different relationships, such as sharing with friends and family, or in professional contexts. In fact, many people are motivated to keep the details of their CSI hidden from their co-workers, as revealing stigmatising information can have a detrimental impact on their career path and job outcomes (Jones and King, 2014). Though all individuals with a CSI must consider the risks of disclosing against the potential intra- and interpersonal benefits (Pachankis, 2007), the additional emotional labour and impression management strategies that exist in a workplace context may impact the content of a disclosure (Berkley et al., 2019). Emotional labour is the emotion work required within the parameters of one’s job, such as maintaining emotional presentations desired by their organisation (Morris and Feldman, 1996). Therefore, individuals disclosing a CSI in a professional setting might be motivated to behave in a way that is congruent with the organisational context, even if it means portraying an inauthentic version of themselves (Berkley et al., 2019).

Regardless of the potential for negative workplace outcomes following a CSI disclosure, sharing a concealable stigma in the workplace should not always be avoided. According to a 2000 report, it is estimated that up to 42% of individuals in the workforce live with a CSI (McNeil, 2000). With a large portion of the workforce making decisions about the information they should reveal, it is apparent that a better understanding of workplace disclosure is necessary. The existing research on workplace disclosure suggests that concealing one’s identity can lead to a less cohesive workgroup (Chrobot-Mason et al., 2001). Conversely, gay men and lesbian women who were open about their sexuality reported greater job satisfaction (Day and Schoenrade, 1997). However, concealment of a CSI can result in a stunted career path due to the social avoidance and isolation utilised to avoid unintentional disclosure (Croteau et al., 2008). Further, employees rated leaders who disclosed their transgender identities more positively compared to leaders whose transgender identities were unintentionally ‘found out’ (Adams and Webster, 2017).

Present study. The current study examined a simulated disclosure event targeted to close others and professional others and activated either approach or avoidance motivation to understand how these factors manifest in a disclosures verbal and nonverbal behaviour. We expected that the intrapersonal motivations and relationship contexts (close vs. professional other) would impact the postural activity and language dynamics of individuals during the simulated disclosure event. More specifically, we hypothesised that participants primed with avoidance goals and to professional targets would exhibit more rigid postural and language dynamics as indicated by a loss of complexity (DFA) and more structured, stable movement (RQA). We anticipate that disclosures to close other targets and motivated by approach goals will be more complex (DFA) and less mathematical stability (RQA). These
participants per group] for example). The majority
avoidance primed), which is similar to the sample size used in
between subjects groups (20 approach primed and 20
email to participate in the lab study. A total of 43 individuals
CSIs that were represented in the inclusion criteria, but are the
parental emotional abuse; note, this is not an exhaustive list of
online to determine eligibility. Participants were eligible if they
could end their participation at any time or take as many breaks as they needed. While the study procedure could be potentially distressing, we did not have any participants wish to end their participation early. Anecdotally, participants reported to the experimenter that the simulated disclosure was cathartic, this is in line with existing research on the benefits of expressive writing in stigma management (Pennebaker and Chung, 2011). At the end of the experiment, all participants were verbally debriefed on the purpose of the study and were provided with a written sheet containing information for university counselling services and external hotlines. That information was also provided in the participant’s copy of the consent form.

Method
Participants. Participants were recruited from a large Midwestern University’s Psychology participant pool and recruitment flyers placed around the university. Participation was voluntary and participants either earned credit towards their course requirement or were compensated $20.00 in cash for their time. To take part in this study, participants were pre-screened online to determine eligibility. Participants were eligible if they self-identified with a CSI (e.g., mental health disorder, history of sexual assault, gender or sexual minority, exotic dance work, or parental emotional abuse; note, this is not an exhaustive list of CSIs that were represented in the inclusion criteria, but are the types of identities disclosed by the study participants). If participants self-identified with any CSI, they were contacted via email to participate in the lab study. A total of 43 individuals participated in the lab study. We aimed to recruit 20 participants per between subjects groups (20 approach primed and 20 avoidance primed), which is similar to the sample size used in other studies of postural sway (see Balasubramaniam et al. (2000) [12 participants per group]; Carpenter et al. (2010) [between 10 and 19 participants per group] for example). The majority identified as white (n = 39; n = 3 Black/African American; n = 1 Asian/Asian American), and as women (n = 36; n = 5 men, and n = 2 gender non-binary), with the mean age being 20.21 years old (SD = 3.09). One participant’s data were excluded from analyses due to a sensor error during data collection, another participant’s data were excluded as they were audibly distressed during the role-played disclosure significantly impacting both postural behaviour and audio transcription. Finally, one participant’s data were excluded from analyses as they selected someone who they had disclosed to previously. Therefore, a total of 40 participants were included in the data analysis for postural activity. A further four participants were not included in the language analysis as they did not consent to being audio recorded. Finally, three more participant’s data were excluded from the language analysis as the disclosures were too quiet for a reliable transcription to be performed. For a breakdown of participant information in each analysis, see Table 1.

This study was approved by the University of Cincinnati’s Institutional Review Board (IRB No. 2014-0624). Participants provided written informed consent to take part in the study, they also signed written informed consent to be audio recorded during the simulated disclosure task but could still participate in the study if they declined to be audio recorded. Participants were told both verbally and in the written consent form that they could end their participation at any time without penalty. All study procedures were performed in accordance with the relevant guidelines and regulations outlined by the Belmont Report. As participation in this study had the potential to cause emotional distress, participants were able to self-guide the pace of the experiment and there were no length or duration requirements for the written and verbal disclosures. Participants were reminded that they could end their participation at any time or take as many breaks as they needed. While the study procedure could be potentially distressing, we did not have any participants wish to end their participation early. Anecdotally, participants reported to the experimenter that the simulated disclosure was cathartic, this is in line with existing research on the benefits of expressive writing in stigma management (Pennebaker and Chung, 2011). At the end of the experiment, all participants were verbally debriefed on the purpose of the study and were provided with a written sheet containing information for university counselling services and external hotlines. That information was also provided in the participant’s copy of the consent form.

Procedure. Following informed consent, where participants could opt out of being audio recorded, participants were seated at a computer and were first asked to think about and describe a secret that they often keep hidden. While participants were recruited based on their response to a pre-screening questionnaire, this question was kept open ended, allowing them to provide as much information as they felt comfortable sharing. They were not explicitly told to respond consistent to their pre-screening response, however, all participants did describe the same identity previously reported. Each participant was then instructed to write two disclosure letters sharing this secret to a close friend/family member (e.g., family/friends) and the other to someone with whom they have a professional relationship (e.g., boss/co-worker/professor). Specifically, they were asked to think about a person in their life that they have not told this secret but would like to. Prior to writing each letter, participants were told to write 3–5 goals they have for their disclosure. To manipulate approach and avoidance goals, participants were told to either ‘think about achieving positive outcomes with their letter’ or ‘think about avoiding negative outcomes with their letter’, respectively.

After writing both disclosure letters, participants stood and role-played their disclosure as if the person they wrote the letter to was standing in the room. During the disclosure event, two magnetic motion-tracking sensors (Polhemus FASTRAK, Polhemus, VT, USA) recorded postural activity at 60 Hz—one sensor attached to a headband and positioned on the back of the participant’s head, the other sensor was attached to a belt and positioned on the middle-front of participant’s waist. The participant’s disclosure letters were projected onto a large projection screen positioned in front of the participants and the experimenter explained that they should act as though they were talking to the person that they chose, using their letter as a guide, but did not have to follow it word for word. Participants completed the role-played disclosure for both close other and professional targets in random order. The mean simulated disclosure duration and word count can be found in Table 2. Unless participants did not consent to being audio recorded, the role-played disclosures were recorded on a laptop equipped with Audacity software [https://www.audacityteam.org/]. The researcher was not in the room during the disclosure events.

| CSI type                           | Included in postural analyses | Included in language analyses |
|------------------------------------|------------------------------|------------------------------|
| Mental health disorder             | 20                           | 16                           |
| Gender or sexual minority          | 10                           | 8                            |
| Sexual assault                     | 7                            | 6                            |
| Exotic dance work                  | 2                            | 2                            |
| Parental emotional abuse           | 1                            | 1                            |

Table 1 Number of participants with each CSI type included in postural and language analyses.
Detrended fluctuation analysis: DFA determines the degree of association between the magnitude of variation in a behavioural time-series with respect to different timescales of measurement. As illustrated in Fig. 1, DFA involves calculating the average magnitude of residual variance across a range of windows sizes (e.g., 8, 16, 32, 64, 128... etc., data points) and then plotting the average residual variance estimates (i.e., RMS) as a function of window size in log-log form. The slope, $\alpha$ (alpha), of the regression line fitting this DFA plot then provides an estimate of fractal complexity or persistence ('stochastic determinism') of movement or behavioural variation. More specifically, $\alpha \approx 0.5$ reflects a random, non-correlated, structure of motion variation (i.e., white noise); $\alpha \approx 1$ represents a moderately persistent, long-range correlated structure of motion variation (i.e., fractal or pink noise); and $\alpha \approx 1.5$ characterises a highly persistent or diffuse structure of motion variation (i.e., brown noise or motion; Eke et al., 2000; Richardson et al., 2014; Ihlen, 2012; Shao et al., 2012). Given that postural activity is known to be characterised by highly diffuse or persistent 'Brownian' variation (i.e., fractional Brownian motion [FBM]) we expected $0.9 < \alpha < 1.5$ in all conditions.

Recurrence quantification analysis: RQA both visualises and quantifies the dynamics of a time-series within an $n$-dimensional phase space by means of a recurrence plot (RP). Such RPs are particularly useful when $n > 3$ and, thus, the true dynamics of the phase space trajectory cannot be visualised. Of relevance here, is that in combination with Phase Space Reconstruction (PSR), RQA enables one to identify and quantify the dynamics of a continuous time-series measure within phase space without making any prior assumptions about the structure of the underlying dynamics or the number of dimensions that defines the phase space that best entails the dynamic structure of the measured series.

As the name suggests, PSR provides a way of reconstructing a system's phase space from a 1-dimensional sequence or time-series of scalar measurements. The procedure is based on Taken’s embedding theorem (Takens, 1981), which states that information about the true dynamics of a multidimensional system can be uncovered through the measurement of a single scalar time-series. Essentially, PSR involves using time-delayed copies of a measured scalar time-series to embed or unfold the time-series into a higher dimensional, reconstructed space that is isomorphic to the system’s true phase space (Richardson et al., 2007; Abarbanel, 1996; Mitra et al., 1998). The process is illustrated in Fig. 2. In identifying the appropriate parameters for the RQA we took the average parameter across all time-series following PSR. The first step is to determine the time-delay, $\tau$, needed to create the surrogate dimensions that will be employed to unfold the time-series in phase space. $\tau$ refers to the temporal offset between...
The structures present in the RP can be quantified in numerous ways (see Riley et al., 1999; Zbilut et al., 2000 for details about all the various quantifications that can be extracted from an RP).
Here, we employed the two most well-known and widely employed RQA statistics: percent recurrence (%REC) and proportional maxline (pMaxline). %REC is simply the percentage of recurrent points within a recurrence plot and provides a general measure of recurrent activity. With regard to the postural movements recorded in the current study, %REC represents the extent to which a participant returned or revisited the same postural states over time (Shockley et al., 2003; Richardson et al., 2007). pMaxline is the longest diagonal line in a recurrent plot (see Fig. 3A) normalised with respect to the length of the analysed time-series. It provides a general measure of behavioural stability and, thus, with regard to the postural movement activity analysed here captures the stationarity of the movement patterns produced (Shockley et al., 2003; Richardson et al., 2007). RQA was conducted using the MATLAB code developed by Bruce Kay and Michael Richardson and colleagues. Example code and example GUIs can be found here [https://github.com/xkiwilabs/MATLAB-Toolboxes/tree/master/RQAToolbox] and here [https://github.com/xkiwilabs/RQA-and-CRQA-GUI-Application], respectively. The toolboxes also include the code employed for PSR.

**Dynamical language analysis.** The verbal disclosures were transcribed by three members of the research team and checked for accuracy. The structural dynamics of the language (words) participants used during the disclosure event were then analysed using Categorical RQA or catRQA. The procedures for conducting catRQA are illustrated in Fig. 3B. Following the removal of all punctuation from the transcripts, the words in each transcription were then coded as an integer number sequence, where each word in a transcript was represented by an integer value starting from word 1 to n (i.e., ‘I’ = 1, ‘need’ = 2, ‘to’ = 3 … ‘when’ = 12.). From these categorical (word use) data series an RP is then generated indicating recurrent states. For both continuous RQA and catRQA, the main diagonal or line of identity in the RP is ignored (removed). The quantification %REC still corresponds to the percentage of recurrent points on an RP and the quantification Maxline still corresponds to the longest diagonal sequence of recurrent points in a RP (red rectangle). See text for more details.

**Results**

**Postural movement dynamics**

**Data treatment and analysis.** The dynamic structure of these movement time-series was determined using two different time-series analysis methods, namely: Detrended Fluctuation Analysis (DFA) and Recurrence Quantification Analysis (RQA). The same pattern of results following the DFA and RQA procedures for the movement time-series was determined using two different time-series analysis methods, namely: Detrended Fluctuation Analysis (DFA) and Recurrence Quantification Analysis (RQA). The same pattern of results following the DFA and RQA procedures for the movement time-series was determined using two different time-series analysis methods, namely: Detrended Fluctuation Analysis (DFA) and Recurrence Quantification Analysis (RQA). The same pattern of results following the DFA and RQA procedures for the movement time-series was determined using two different time-series analysis methods, namely: Detrended Fluctuation Analysis (DFA) and Recurrence Quantification Analysis (RQA). The same pattern of results following the DFA and RQA procedures for the movement time-series was determined using two different time-series analysis methods, namely: Detrended Fluctuation Analysis (DFA) and Recurrence Quantification Analysis (RQA). The same pattern of results following the DFA and RQA procedures for the movement time-series was determined using two different time-series analysis methods, namely: Detrended Fluctuation Analysis (DFA) and Recurrence Quantification Analysis (RQA). The same pattern of results following the DFA and RQA procedures for the movement time-series was determined using two different time-series analysis methods, namely: Detrended Fluctuation Analysis (DFA) and Recurrence Quantification Analysis (RQA). The same pattern of results following the DFA and RQA procedures for the movement time-series was determined using two different time-series analysis methods, namely: Detrended Fluctuation Analysis (DFA) and Recurrence Quantification Analysis (RQA). The same pattern of results following the DFA and RQA procedures for the movement time-series was determined using two different time-series analysis methods, namely: Detrended Fluctuation Analysis (DFA) and Recurrence Quantification Analysis (RQA). The same pattern of results following the DFA and RQA procedures for the movement time-series was determined using two different time-series analysis methods, namely: Detrended Fluctuation Analysis (DFA) and Recurrence Quantification Analysis (RQA). The same pattern of results following the DFA and RQA procedures for the movement time-series was determined using two different time-series analysis methods, namely: Detrended Fluctuation Analysis (DFA) and Recurrence Quantification Analysis (RQA). The same pattern of results following the DFA and RQA procedures for the movement time-series was determined using two different time-series analysis methods, namely: Detrended Fluctuation Analysis (DFA) and Recurrence Qua...
therefore all measures were averaged across head and waist, with composite head/waist average values employed for hypothesis testing.

Detrended fluctuation analysis: DFA calculates the average magnitude of variance across a range of window sizes (e.g., 8, 16, 32...etc data points) and plots the average residual variance estimates as a function of window size. The slope of the regression line fitting the DFA plot provides an estimate of the fractal structure of the movement behaviour and is denoted by the parameter α (alpha). The α parameter, characterises the complexity of the behaviour such that α = 0.5 reflects a random, non-correlated structure of movement variation, α = 1.0 demonstrating moderately persistent, highly flexible behaviour, and α = 1.5 demonstrating a highly persistent or overly controlled structure of movement (i.e., white noise, pink noise, and brown noise, respectively). Given that postural activity is known to be characterised by moderately to highly diffuse pink or persistent ‘Brownian’ variation (i.e., fractional Brownian motion [FBM]) we expected 0.9 < α < 1.5 in all conditions. Of particular interest, was the degree to which approach and avoidance goal motivations and target confidant modulated participant’s postural activity within the 0.9 < α < 1.5 range. That is, we were interested in examining the degree to which the postural activity exhibited by participants was more or less persistent (i.e., less ‘brown’ and more ‘pink’ or more ‘brown’ and less ‘pink’) across conditions (see the Method for a detailed description of DFA).

Each model described below was fit using STATA 16 and the syntax can be found in the OSF repository for this project [https://osf.io/hjr7p/?view_only=3aa3ed71b514b129aae0d4f53006a]. A 2 (between subjects; target: close other/professional other) × 2 (within subjects; goal: approach/avoidance) × 2 (within subjects; sway direction: AP/ML) mixed analysis of variance was used to determine the effects of goal motivation and target on α_FBMs (i.e., postural complexity). Postural sway direction was included as a factor in the model to account for family-wise error testing. There was no significant main effect of disclosure target, postural plane, nor further interactions (all F < 0.72, p’s > 0.397; Supplemental Table 1).

Fig. 4 Results of fractal analysis for postural activity. Mean α_FBMs of postural activity in the AP (left) and ML (right) directions.

Recurrence quantification analysis: RQA determines the degree to which the states of a movement trajectory reoccurred over time. With respect to the postural movement examined here, %REC provides an overall measure of the degree to which a participant revisited the same, or similar postural states during their simulated disclosure. As noted above, Maxline is the longest sequence or line of recurrent points and as behavioural time-series vary in length, is typically normalised with respect to the length of the analysed time-series (resulting in proportional Maxline or pMaxline). Essentially, pMaxline provides a general measure of stability of a movement time-series trajectory (Shockley et al., 2003; Richardson et al., 2007). Larger pMaxline is associated with more mathematically stable behaviour and less overall flexibility (see the Method for a more detailed description of RQA).

As with the DFA results, composite scores of the RQA statistics %REC and pMaxline averaged between the head and the waist are reported for clarity of presentation, there was no difference in each parameter at the head and waist. A 2 (target: close other/professional other within subjects) × 2 (goal: approach/avoidance) × 2 (sway direction: AP/ML [within subjects]) ANOVA was used to compare %REC between goal motivation and disclosure target. There was a significant main effect of disclosure confidant (F(1, 38) = 5.04, p = 0.027, η_p^2 = 0.04; Fig. 5) on %REC indicating that there was greater behavioural recurrence when disclosing to close others (M = 2.37, SD = 2.07, 95% CI [1.91, 2.83]) compared to professional others (M = 1.84, SD = 1.65, 95% CI [1.48, 2.22]) regardless of goals or sway direction. There was also a significant main effect of postural direction (F(1, 38) = 15.91, p < 0.001) as %REC was greater in the ML plane (M = 2.58, SD = 2.40) compared to the AP plane (M = 1.64, SD = 0.99). There was no main effect of goal motivation or target by goal interaction of %REC (all F < 1.79, p > 0.37; Supplemental Table 2).

The analysis of pMaxline for postural activity revealed a significant main effect of disclosure target (F(1, 38) = 8.36, p = 0.005, η_p^2 = 0.07) where disclosures to professional targets had a higher pMaxline (M = 0.77, SD = 0.24, 95% CI [0.71, 0.82]) compared to close other targets (M = 0.68, SD = 0.24, 95% CI [0.63, 0.74]). This was qualified by a significant target by goal interaction (F(1,38) = 4.98, p = 0.028, η_p^2 = 0.04). Simple effects analysis with a Bonferroni correction found that, in the approach condition, pMaxline was significantly greater towards professional targets (M = 0.76, SD = 0.23) compared to close disclosure targets (M = 0.61, SD = 0.25; F = 13.12, p = 0.001). There was no difference in pMaxline between professional and close other targets in the avoidance condition (F = 0.22, p = 0.99). There was also a significant main effect of postural direction on pMaxline (F(1,38) = 24.53, p < 0.001, η_p^2 = 0.18) and a significant postural
direction by goal motivation interaction ($F(1,38) = 8.48$, $p = 0.004$, $\eta^2_p = 0.07$). Results of simple effects analyses with a Bonferroni correction revealed that, in the approach condition only, pMaxline was significantly greater ($F(1,38) = 30.93$, $p < 0.001$) in the AP direction ($M = 0.80$, $SD = 0.17$) compared to the ML plane ($M = 0.57$, $SD = 0.26$). There was no significant difference between position in the avoidance condition ($F(1,38) = 2.08$, $p = 0.30$; Supplemental Table 3).

Language dynamics. The structural dynamics of the language participants used during the disclosure event were analysed using Categorical RQA or catRQA. Like RQA, catRQA quantifies the degree to which system states reoccur over time. However, it does so with respect to discrete or categorical states and, accordingly, can be employed to quantify the dynamics of verbal utterances by treating words spoken as discrete events (Dale and Spivey, 2006; Lyby et al., 2019). Indeed, here the words in each transcription were coded as an integer number sequence, where each word in a transcript was represented by an integer value starting from word 1 to word $n$ (i.e., ‘I’ = 1, ‘need’ = 2, ‘to’ = 3 … ‘when’ = 12). From these categorical data series, catRQA was then employed to determine the %REC and pMaxline for each interval time-series that resulted. With respect to language use, these two measures captured how often an individual re-used the same words (i.e., word repetition) and what the longest sequence of words that an individual repeated verbatim (i.e., phrase or sentence repetition), respectively. For a detailed description of this procedure, see the method section below.

For both parameters %REC and pMaxline, we conducted two $2 \times 2$ mixed ANOVAs with disclosure target (close other/professional other) as a within subjects variable and goal motivation (approach/avoidance) as the between subjects variable. There was a significant main effect of disclosure target on % REC ($F(1, 31) = 4.45$, $p = 0.04$, $\eta^2 = 0.13$), with disclosures towards close others defined by more recurrent (repetitive) language use ($M = 1.56$, $SD = 0.31$, 95% CI [1.45, 1.67]) compared to disclosures to professional other targets ($M = 1.47$, $SD = 0.25$, 95% CI [1.38, 1.56]). There was no significant main effect of goal motivation or interaction (all $F < 1.41$, $p > 0.24$; Fig. 6; Supplemental Table 4). Results revealed no significant main effects, nor an interaction for pMaxline (all $F < 0.89$, $p > 0.35$; Supplemental Table 5).

Discussion
Using the nonlinear analytic tools DFA and RQA, we demonstrated that people may communicate cognitive and motivational (i.e., approach/avoidance) states through unintentional verbal and nonverbal modes of behaviour. The aim of the current study was to understand how antecedent goals and relationship context are embodied in the multiple dynamic behavioural streams of communication that define a disclosure event. Overall, we found that postural behaviour was more complex and flexible when participants disclosed using approach goals versus avoidance goals. We also found more recent word usage during close other disclosures as compared to professional other disclosures. The implications of these results are described below.

These results suggest that approach and avoidance-orientation may be embodied in our movement dynamics more so than language dynamics. This is particularly evident through the DFA procedure, which revealed that avoidance-orientated disclosures exhibited a loss of complexity towards Brownian motion, whereas approach-oriented disclosures were characterised by more complex patterns of movement variability. According to research on approach/avoidance motivational systems, when avoidance-orientation is activated, individuals are more attuned to negative outcomes, therefore, regardless of the target of the disclosure, the participants may have been focused on the potential for stigmatisation and discrimination and therefore, their movement dynamics were more rigid and less flexible, both characteristics of Brownian motion.

Results of the RQA procedure on postural behaviour provide further support that our postural dynamics are impacted by our cognitive, motivational, and emotional states. The significant interaction between goal motivation and disclosure target on pMaxline suggests that postural activity is more stable during professional other disclosures compared to close-other
disclosures in the approach-oriented condition only. Stability in terms of pMaxline indicates that similar postural behaviour is not necessarily exhibited more often, but that similar activity persists for longer periods of time. While professional other targets elicited longer pMaxline, they exhibited less overall recurrent behaviour. This compliments the results of the DFA as disclosures to professional others led to less complexity compared to close other targets in the approach condition. This unintentional behaviour is at the same time more rigid and less complex during professional-other disclosures may reflect the burden of emotional labour to reveal their CSI in a way that remains congruent with the professional culture (Berkley et al., 2019).

It should also be noted that %REC was significantly greater overall in the ML direction compared to the AP direction. This is consistent with previous research (Duran et al., 2013) and does not vary as a function of target or goal motivation. Interestingly, pMaxline in the AP and ML direction did differ as a function of goal motivation. In the approach condition, participants posture showed greater stability in the AP plane than the ML direction. Anterior-posterior, or forward–backward movement, in social psychology is associated with the embodiment of approach and avoidance motivation as people are more likely to lean towards (or approach) pleasing stimuli and lean away from (or avoid) negative stimuli. While the activation of approach or avoidance motivational systems may explain these unexpected results, there was no effect of postural direction in the avoidance condition.

Pink noise, as indicated by the DFA procedure, is characterised by the ability of a system to explore multiple states and reorganise following a perturbation of the system. As postural activity is more deterministic (DFA) and stable (RQA) during professional-other disclosures than close-other disclosures in the approach condition, participants in those conditions may be more controlled when disclosure to a professional confidant compared to a close-other. As there was no significant difference as a function of close and professional contexts in the avoidance condition, avoidance-orientation was associated with less flexible and responsive behaviours regardless of disclosure target. Both context and antecedent goals influence disclosure strategies and impression management for those living with a CSI. Indeed, Legate et al. (2017) suggest that variability in overall disclosure across a 2-week period is associated with greater well-being highlighting the importance of flexibility in disclosures decisions. Therefore, more rigid behaviour during a professional other disclosure may not necessarily result in negative disclosure experiences. Future research is needed to understand how different disclosure—or concealment—strategies across contexts lead to greater well-being. Altogether, these results suggest that movement dynamics characterised by postural activity unintentionally reveal the underlying motivations behind a CSI disclosure.

Surprisingly, the dynamics of language at the word level did not change as a function of the participant’s motivational system. Results of categorical RQA of the words used during the disclosure events revealed greater recurrence of words used to close others compared to professional others. This could be a function of disclosure length where close-other disclosures were longer overall (close other word count: $M = 447.54$, $SD = 272.29$; professional other word count: $M = 335.48$, $SD = 197.31$), therefore participants revealed more detail and in doing so repeated the same identity related words more frequently.

Further, when disclosing to a professional other, participants tended to use more ‘formal’ language when describing their identities and experiences. For example, one participant who disclosed his sexual identity to a boss said, ‘I want to tell you something very personal about me that will help me relax in a professional atmosphere. I am a homosexual man and my partner is someone you are acquainted with.’ On the other hand, when sharing his sexual identity to his grandfather, he was less formal in describing his identity and appealed to their interpersonal relationship, he said ‘You are a good person and someone I have often looked up to in my lifetime, however, I know you to be of a different generation….. People are working harder than ever to be considered equal to each other. This is why I wanted to tell you that I’m gay.’ This contrast between formal and more personal language during professional and close other disclosure supports existing work that highlights the importance of flexibility in disclosure across contexts (Legate et al., 2017). More formal and rigid language use may lead to more positive outcomes in a professional context compared to a close other context. While participants repeated the same words to close other disclosure targets than professional other targets, they did not use significantly longer phrases, which suggests that they are sharing more unique information to close-others than to professional-others.

**Limitations and future directions.** Disclosing a CSI is a deeply interpersonal process consisting of at least two coordinating individuals typically involved in a cooperative discussion. Owing to the nature of this research, capturing the dynamics of real-time disclosure poses many ethical and practical considerations. For example, having a participant disclose their CSI to others could potentially put them in a place of harm. While this exploratory research is lacking the explicit disclosure confidant, by asking participants to engage in a role-played disclosure in which they imagined they were talking to the person they chose, we have constructed a simulated disclosure via an imagined other. Research applying an imagined interaction suggests that this process allows actors to indirectly experience themselves in an anticipated conversation (Edwards et al., 1988). Therefore, despite lacking the presence of a disclosure target, this methodology can prove useful in safely capturing a disclosure event in a laboratory setting that has some ecological validity. It should be mentioned...
that interpersonal conversation can impact both acoustic onset (Abney et al., 2014) and postural activity (Shockley et al., 2003) such that participants tend to entrain to the acoustic onset and movement dynamics of their interlocutor. As such, we would expect that the presence of an interacting confidant might lead to subtle shifts in movement and language dynamics.

Owing to our use of convenience sampling recruitment methods, these data represent the experiences of majority white, able-bodied, college-aged women living in the United States. While postural variability is universal, there may be differences in the embodiment of approach and avoidance motivation within difference cultures and across the lifespan. Future research should aim to determine how experience with previous disclosures, whether positive or negative, interact with antecedent goals and disclosure target to impact the disclosure process. Further, given our research methods and constraints, we were not able to examine the disclosure experience using an intersectional framework. There is a growing body of work in communications, disability, and queer studies that looks at concealable stigma disclosure through an intersectional lens, which explores how context and power dynamics shape the disclosure and concealment process (e.g., Balderston, 2013; Mac-Seing et al., 2020; McDonald et al., 2020; Pearson and Boskovich, 2019). As the results of this study demonstrates postural and language differences across close and professional contexts, future research in behavioural science should further examine the influence of power and identity intersectionality on the disclosure process for differentCSI’s and within different cultural contexts.

Finally, the instructions provided to participants were intentionally open ended to allow participants to simulate disclosures to targets they could imagine confiding in. Therefore, the chosen confidants varied greatly between participants, close-other targets were relatively homogenous consisting of best friends, parents, and grandparents. Professional-other targets, on the other hand, were much more variable—due to the age of our participants, many chose to disclose to previous high-school teachers and college professors. While still a professional relationship, the context of a student-instructor relationship may be different from a co-worker-boss relationship. Further, participants were asked to choose someone they have not yet told, but would like to disclose to, meaning the chosen disclosure confidant was often someone they already have a personal relationship with, even within the professional context. Future research should aim to understand how psychological and cognitive states are embodied across different professional contexts, including the degree to which the organisational culture is inclusive and welcoming of all identities (Lindsay et al., 2018), whether identity-specific non-discrimination policies are in place (Tejeda, 2006), and the quality of the relationship between the source (employee) and target (supervisor) of the disclosure (Goldberg and McKay, 2015). As this research used novel methods to simulate a disclosure event, the opportunity for testing further research questions that were previously unattainable are ample.

**Conclusion**

Taken together, these findings are not only in line with the existing disclosure process model (Chaudoir and Fisher, 2010), they also demonstrate that our cognitive and emotional states are embodied across multiple behavioural processes during a CSI disclosure event. Specifically, our results revealed that approach and avoidance antecedent goal motivation is embodied in postural activity, while disclosure target is more manifest in our language dynamics. Activation of approach and avoidance motivational systems are proposed to be a predispositional, automatic process, which can be seen in humans, nonhuman animals, and lower organisms (Elliot and Covington, 2001). Therefore, it is interesting that behavioural motivations were embodied in the more unintentional, nonverbal processes exhibited by humans and nonhuman animals alike. Further, evidenced by both the ‘pinker’ $F_{RM}$ and less stable $p$Maxline of participants primed for achieving positive outcomes, these results suggest that approach motivation allows for more flexibility in postural activity, particularly during close-other compared to professional other disclosures. Avoidance motivation, on the other hand resulted in more deterministic and rigid postural movements regardless of target. In fact, when disclosing with avoidance-motivations, the effect of target confidant appeared to be negated. Interestingly, no differences in the dynamics of word use as a function of goal motivation compared to disclosure context. Perhaps intuitively, these results suggest that, regardless of goal motivation, participants shared more unique, identity related information to close other targets compared to professional others. Future research should work towards a holistic understanding of how these behavioural systems are perceived by a disclosure confidant to impact the social support and positive or negative interpersonal outcomes of these important events.

**Supplemental results.** One-way analyses of variance were performed to determine if CSI type (sexual minority status, mental health disorder, and sexual assault experience only) had an impact on participants’ behavioural dynamics. This served as a check to ensure disclosure of unique CSI types did not result in significantly different behavioural dynamics, therefore, we expected to see no differences in postural activity and language dynamics as a function of secret type. As expected, there were no significant differences in postural activity and word-use dynamics for sexual minority status, mental health disorder, and sexual assault experience disclosure (all $F < 3.0$, $p > 0.07$). This confirms that, while each secret type carries distinctive stereotypes and impacts on daily life, the process of disclosing a concealable stigma is similar across secret types.

**Data availability**

Pre-processed postural time-series and transformed disclosure transcription from words to discrete numeric identifiers are available at the following link [https://osf.io/hjrp/?view_only=3aa3ed71b514b129acecd4fbd53006a]. Please contact the corresponding author for questions and clarifications.

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Competing interests

The authors declare no competing interests.

Ethical approval

This study was approved by the University of Cincinnati’s Institutional Review Board (IRB No. 2014-0624). All study procedures were performed in accordance with the relevant guidelines and regulations outlined by the Belmont Report.

Informed consent

Participants provided written informed consent to take part in the study, they also signed written informed consent to be audio recorded during the simulated disclosure task but could still participate in the study if they declined to be audio recorded. Participants were told both verbally and in the written consent form that they could end their participation at any time without penalty. At the end of the experiment, all participants were verbally debriefed on the purpose of the study and were provided with a written sheet containing information for university counselling services and external hotlines. That information was also provided in the participant’s copy of the consent form.

Additional information

Supplementary information The online version contains supplementary material available at https://doi.org/10.1057/s41599-022-01226-0.

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