Assessing Social Media Users' Affective Engagement with Narratives of Invisible Disability

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Abstract—**Narratives about invisible disabilities are poorly represented in public discourse and often go undisclosed [1], leading to false assumptions, discrimination, and stigma [2] against those who experience these conditions. To address these issues, recent studies have suggested that disclosure of first-person narratives of invisible disabilities should be increased [3]. To understand the mechanisms affecting recipients of such narratives, the present study evaluates how social media users (N = 124) engage affectively with this content in a digitally mediated narrative-form intervention designed to reduce harmful assumptions against persons who experience invisible disabilities. Results of this study indicate that such an intervention may prove effective at reducing harmful assumptions on the basis of visual cues, and in line with past research, finds that affect may play an important role in assumption-making processes [4]. Findings from this study may be used to inform novel digital interventions capable of counteracting harmful assumptions that drive prejudicial behaviors against a wide range of populations and communities.**

Keywords—**Affect, social media, disability, invisible disability, hidden disability, natural language processing, survey methods**

I. INTRODUCTION

Human perception, as far as we know, is limited to what can be sensed through physiological inputs [5]. Yet experience teaches us that not all truths are immediately accessible to us through our senses. No more can we innately know the thoughts and experiences of others than we can see through walls. Nonetheless, false assumptions permeate our waking lives [6], such that widely accepted tests have been developed to evaluate exactly which assumptions we make, in what situations, and why [7]. As Malcolm Gladwell argues in his *Talking to Strangers* [8], and drawing from the Darwinian notion of transparency, assumptions are an essential and natural part of human interaction, resulting from a need to infer others' emotions and intentions with limited available evidence. But while interpersonal assumptions are natural, they are not always correct [9], nor are they always constructive [10].

Humans begin to develop attention biases in infanthood [11] and assumptions of others' physical and mental facilities as early as 17 months old [12]. False assumptions and biases take root early and easily, playing a critical role in generating and perpetuating human conflict [13], stigma, and discrimination [14]. While some false assumptions may be relatively harmless, others are not, leading entire communities to face disproportionate negative impacts resulting from social bias. Although there are many such communities worthy of attention, the present study is concerned with everyday attitudes towards people living with disabilities (PWDs; [15], [16]) for whom false assumptions form the bedrock of prevailing cultural narratives detailing their lives and experiences [17].

A. Assumptions of People with Disabilities

In the United States, as many as 61 million adults–approximately 26% of the adult population–live with some form of disability [18], a physical or mental condition "that substantially limits one or more major life activities" [19], [20]. Disabilities vary greatly in their causes, impacts, and impairments [21], leading to unique forms of stigma [22] and discrimination [23]–[25]. Some disabilities are inborn while others are acquired; some require visible accommodation (e.g., wheelchair use), leading to challenges with physical accessibility, while others go unseen, leading to amorphous questions about disclosure and the uncertainty of appropriate public or workplace accommodations. Across the many forms that disability takes, the associations among assumptions, biases, and stigma run deep and have been the topic of significant academic inquiry [26], although assumptions made about people with invisible disabilities (PWIDs) are still poorly examined [27].

While popular media and social media representations conceive of disability in traditionally visual terms [28], as many as 96% of disabilities are invisible [29]. Invisible disabilities refer to a wide range of states and conditions that cannot be inferred from visual evidence [30], such as mental health conditions, chronic pain disorders, cardiovascular diseases, and autoimmune conditions, among many others. People with invisible disabilities may be less likely than people with visible disabilities to report their conditions to peers due to stigma and other concerns relating to this disclosure [31]. As Fitzgerald [32] explains, "When the external facade does not match the internal reality," peers may engage in "[internal dialogues] that deal with issues of personal, cultural, and psychological competency," a behavior of which PWIDs may be particularly aware.

Discrimination against people with disabilities is well-documented across a range of cultures and timescales, with the literature suggesting that those with invisible disabilities may face significantly more discrimination [33] than those with visible disabilities, perhaps especially in workplaces [34]. Consequently, narratives of invisible disabilities are poorly represented in public discourse [1], allowing prevailing social and cultural narratives to take root [35]. Accordingly, recent studies outline the need for PWIDs to become more vocal about narrating their experiences to their peers [3] in order to better manage and mitigate others' harmful assumptions, but there remain significant obstacles to this task.

B. Narratives & Disability

Early in human history and across a global range of cultures and traditions, narratives about PWDs have reflected beliefs in their impurity, weakness, and sin–associations that continue in the present day [36]. But while narratives of disability have engineered stigma, recent studies have

detailed how first-person disability narratives may be used effectively to counteract this stigma [35], [37]. When certain cultural narratives go untold, or are left to be told by those unfamiliar with these narratives, related experiences may become stigmatized, shamed, or even thought to be irrelevant or uncommon [38]–[40]. Sharing first-person accounts of an underrepresented experience may not only return narrative agency to the one who experienced the condition, but also recalibrate cultural assumptions of what is, or isn't, true about that experience. For that reason, interventions that seek to combat stigma against PWDs may benefit from taking narrative form.

C. Social Media & Disability Narratives

Wherever we come into contact with others, we are likely to make assumptions [6]. Likewise, and naturally, we may make more assumptions the fewer our information channels, and the less information we have at our disposal [26]. It follows that social media platforms–where every day we come into contact with strangers about whom we know nothing more than can be inferred from the visual content they share with us–are ripe with assumptions, perhaps especially on anonymous and semi-anonymous forums like Reddit and Twitter. While the presence of social media platforms raises important questions of both ethics and accessibility for PWDs [41] it also provides forums for PWDs to tell their own stories and gain control over their own narratives. Likewise, it allows for what has been called new models of conviviality [42] for PWDs, "modes of structuring and conveying care that evade characterization as exchange and require that participants recognize and manage shared and disparate experiences of precariousness and vulnerability" [43], leading to more equitable discourse.

D. The Present Study

This study examines social media users' affective engagement with narratives illustrating first-hand experiences with invisible disabilities, which by their nature remain hidden until disclosed. We ask whether reflective engagement with these narratives may allow participants to gain improved attitudes towards PWD in general, as well as whether social media users are able to make fewer assumptions about disability status on the basis of visual cues, which may be used to assume a lack of disability status in the case of PWIDs. Since affect has been shown to play an essential role in the assumptions that we do or don't make about others and their experiences [4], we centrally examine the role of affect as well as compassion and empathy in shaping participants reactions to the narratives selected.

II. METHODS

In the present study, users (N = 124) of popular social media platforms were recruited to engage with curated first-person audio narratives that illustrate lived experiences with invisible disabilities, also called hidden disabilities [30]. These narratives were paired with reflection prompts to encourage a witnessing approach [44], in which participants observe testimonies as well as reflect upon their own experiences and how those experiences might impact their observations of those testimonies. In doing so, we aimed to increase affective engagement and consequently stimulate positive shifts in participants' attitudes towards persons with disabilities. Mechanisms for these perspective shifts were evaluated pre- and post-intervention through a comprehensive survey battery including measures assessing compassion, state empathy, self-reflection, attitudes toward disability, and locus of control. Participant reflections to the provided narratives, as well as responses to IPSAQ (Internal, Personal and Situational Attributions Questionnaire; [45]) measures, were collected and analyzed using deep learning techniques, Linguistic Inquiry and Word Count analysis (LIWC; [46]), and inductive coding [47].

A. Narrative Selection

To select narratives for intervention, open-source databases (n = 28) of healthcare journey narratives were identified through literature review. On the basis of data availability and formatting, three were selected, including the Health Story Collaborative, the Disabilities Visibility Project, and StoryCorps. Selection criteria required that narratives possess extractable audio content; be fewer than 5 minutes in duration; and be topically related to first-person experiences of invisible disability. Each narrative, at most, included two voices: a narrator and an interviewer. Narratives were selected based on their identified capacity to generate states of compassion, empathy, and reflection in audiences. To this end, selection criteria also required that narratives disclose experiences with contextually relevant themes (e.g., *hope, gratitude*, *meaning-making*). In order to optimize participant engagement, only audio narratives were used [48].

B. Recruitment

The present study employs convenience sampling, recruiting through social media platforms including Reddit (n = 85; 65%), Facebook (n = 14; 11.3%), Twitter (n = 11; 8.9%), LinkedIn (n = 2; 1.6%), and Instagram (n = 5; 4%); however, some participants shared the study within their own networks, resulting in several participants (n = 7; 5.6%) who may have been drawn to the study through email or other unknown communication channels. Of those individuals who saw recruitment postings on social media (n = 10,000+), 849 entered the recruitment process. Following consent (n = 176), and after removing bot accounts (n = 27) and drop-outs (n = 23), and bad-faith respondents (n = 7), 124 participants remained. For social media platforms that host moderated community groups (e.g., Reddit and Facebook), moderators of topically relevant groups (e.g., r/psychologyresearch, r/samplesize), as well as moderators of groups topically relevant to conditions discussed in intervention narratives (e.g., r/multiplesclerosis, Facebook's Invisible Disabilities community), were contacted to request posting permissions and to ensure that the recruitment text wasn't removed at the time of posting. Communities relevant to the geographies of the researchers (e.g., r/massachusetts) were also included with the aim of presenting a broader base of respondents who may not share particular experiences with medical or behavioral conditions, and who may be less likely to be subject experts in related research areas. To ensure optimal visibility of recruitment posts, all recruitment text was posted

between 7-8am, EST, which the study team identified as providing optimal visibility within the selected communities. Recruitment messages were re-posted up to two times, subject to prior approval by community moderators.

C. Data Cleaning

Survey-based studies that recruit through social media often encounter challenges with bots that have been programmed to mimic human survey response behaviors. While many automated methods to avoid bot infiltration have been identified [49], this study sought to evaluate the potential effects of bot activity within survey responses in order to outline risks for potential future intervention implementations. Our examination of bot detection and cleaning approaches builds upon the results of a recent study, also performed on the Qualtrics platform, that was infiltrated by significant bot activity [50]. To that end, no CAPTCHA or other bot screening methods were used.

In addition to bots, several bad faith respondents were removed from the study pool prior to analysis. These participants gave answers that were absent of content (e.g., entering empty spaces in required open text response fields to imitate text input), excessively redundant (e.g., entering identical text strings for sixteen consecutive responses), or patterned in ways that indicated inattention or lack of care (e.g., "asdfasdf"). Timers were also added to audio stories that were provided during the intervention portion of the study; participants who listened to fewer than 20 seconds of an audio story were likewise removed from the study, except in those cases where stories were made optional.
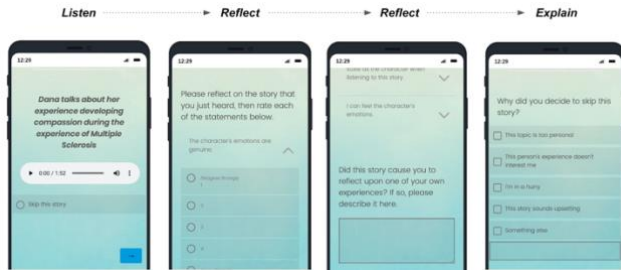

Fig. 1. Depiction of a narrative-based intervention sequence including audio narrative engagement, affective reflection, personal reflections, and reporting of skipped story causes.

D. Intervention

The intervention portion of this study sought primarily to improve participant attitudes towards PWDs through assumptions-breaking reflection mechanisms and exposure to first-person narratives disclosing experiences with hidden disabilities–those that can't be known without such disclosure. However, since compassion, empathy, and self-reflection were theorized mechanisms for altering participant attitudes, designing an experience that would stimulate these behaviors was crucial to the effectiveness of this intervention.

Each participant listened to between three and eight stories total, with three required stories and five optional stories; each story was brief, with an average duration of approximately 2 minutes and 27 seconds. No significant topical or thematic differences were observed between the two sets of stories, with both samples including stories that referenced positive and negative themes interchangeably. To best observe our outcomes of interest, the three required stories were those that the study team believed would result in the greatest benefits to participants: those that would stimulate the most empathy, compassion, and self-reflection. After each narrative, participants completed the affective empathy subscale of the State Empathy Scale [51], which evaluated whether participants viewed the speakers' emotions as genuine and whether participants felt the same or similar emotions as they engaged with each narrative. For each narrative, participants were then asked whether the story caused them to reflect upon one of their own experiences, and if so, to describe that experience. For the six optional narratives, participants who skipped a narrative completed multiple-choice responses indicating the reason for skipping (e.g., "this story is too personal"), and including an open response field for more detailed or unique reasons. Optional stories were used to test participant willingness to engage with particular story topics and to identify barriers to content engagement. These optional stories were also used to evaluate engagement endurance when compared against available demographic and other self-report features (e.g., we hypothesized that individuals with disabilities would be willing to engage with more stories about disability when compared against individuals without known disabilities).

Participants who chose to continue listening to optional stories were also evaluated on the basis of how many stories they listened to, which stories they skipped, and their reported reasonings for skipping particular stories, with multiple-choice responses showing the nature of skipping and engagement behaviors and for which stories.

E. Qualtrics Survey Battery

The present study utilizes a survey battery approach, comparing pre- and post-intervention responses, with self-report scales and measures selected based on their ability to provide insight into our outcomes of interest. Following baseline demographics and personality (BFI-10; [52]) measures, our pre- and post-intervention battery evaluated self-compassion [53]; compassion-for-others [54]; affective state empathy [51]; attitudes towards disability [55]; and locus of control [45]. Notably, during initial literature review, no sufficient tests were identified that evaluate participant assumptions of others' health or disability status on the basis of visual cues, which was an important phenomenon in our inquiry. Therefore, we designed and performed an experimental measure to evaluate participants' assumptions of disability, physical illness, or mental illness based on visual cues. This test was also conducted based on the study team's belief that engagement with stories of invisible disability would lead some participants to become more open-minded to the possibility that anyone, regardless of appearance, may be experiencing a disability. In this experimental Condition Associations Test (CAT), participants were shown stock photographs of people engaging in a wide range of activities, with some visible cues that may indicate disability or injury status (e.g., wheelchair or hearing aid use), others indicating psychological distress (e.g., yelling at oncoming traffic), and other suggesting positive health status (e.g., swimming).

F. Analysis Methods

Once selected, audio narratives were transcribed using Google Speech-to-Text API [56]. To ensure that narratives were accessible to listeners, we used Voyant [57] to generate vocabulary density scores for each text, with the study team deeming texts appropriate for use prior to intervention. Qualitative inductive coding [58] was then performed to extract core content themes, including those described previously. Using LIWC, we extracted ninety-five (95) affective-linguistic features from intervention narratives, user-generated reflection statements, and the IPSAQ and performed additional deep learning and statistical analysis on these results using Python and JASP [59].

III. RESULTS

A. Participant Recruitment

All participants (N = 124) were 18 years or older, geolocated within the United States, and reporting that the content of the study, which was described briefly prior to participant consent, would not place them at undue risk of harm. It is worth mentioning that 39.5% (n = 49) identified as having an invisible disability and 29% (n = 36) identified as having a visible disability; 6 others (4.8%) identified as having both an invisible and visible disability. Slightly more than half of participants (n = 71; 57.3%) identified as women and a significant number of participants (n = 17; 13.7%) identified their sex as non-binary or other.

B. Condition Associations Test & Attitudes to Disability

The CAT examined participants' ability to recognize that regardless of visual cues–or lack thereof–anyone could be experiencing a medical condition, physical condition, or disability-qualifying condition. Pre-intervention, 43 participants responded that the photographs being shown depicted people who could not, under any circumstance, have a disability. Post-intervention, no participants chose this response. Significant increases post-intervention were also seen in the number of participants selecting images that they believed could plausibly include individuals with mental health conditions (n = 36 > n = 60) or disabilities (n = 43 > n = 82). Pre- and post-intervention, participants were also asked to complete a scale evaluating Attitudes to Disability to identify whether participants' attitudes towards PWDs, and knowledge and beliefs regarding their experiences, changed as a result of the intervention. Post-intervention, three of four subscales of the Attitudes to Disability scale showed improvements in mean values, with the most significant improvement ($p = 0.051$) shown in the *Gains* subscale, reflecting views that PWDs have unique experiences and perspectives to offer society.

C. Compassion, Self-Compassion, and State Empathy

Paired t-tests were conducted to compare pre- and post-intervention results across two compassion scales: the State Self-Compassion Scale Short-Form (SSCS-S; [60]) and the Compassion Scale; Pre- and post-intervention, participants were asked to complete these scales to identify whether compassion was a mechanism affecting assumptions of others within the context of our study. Slight but not statistically significant increases were observed post-intervention for both compassion and self-compassion measures. During the intervention, and following each engagement with an audio narrative, participants also completed the affective empathy subscale of the state empathy scale [51], which asks participants to reflect on their experiences with affective empathy during intervention narratives (e.g., "The character's emotions are genuine"). State empathy ratings tended to be high for most participants and for most narratives, with ratings showing that most responses indicated agreement with the empathy prompts (i.e., at least 4 out of 5 on a 5-point Likert-scale). However, and curiously, state empathy was observed to be highest for the first 3 narratives that participants were required to engage with, then showed drops in intensity roughly correlating to the number of optional written reflections provided.

D. IPSAQ & Deep Learning Analysis

The IPSAQ test was provided to evaluate whether the intervention affected participants' locus of control: the extent
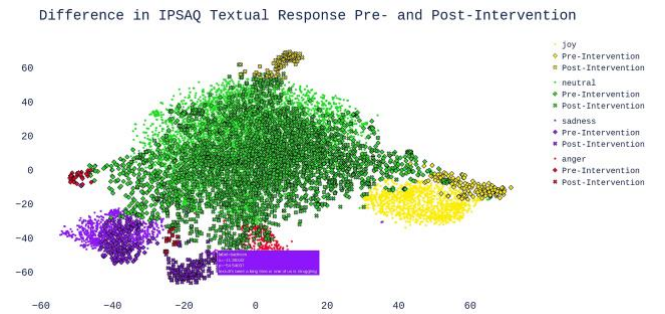

Fig. 4. Visualization of a deep learning algorithm capturing the relationship between user-generated text and predicted emotions, with each point representing an emotion-labeled sentence; small dots represent training data showing the predicted baseline regions for each emotion.

to which they attribute their personal experiences to situational, interpersonal, or personal variables. No statistically significant changes in survey response types were observed. However, participants did provide increased personal and interpersonal attributions (i.e., experiences being attributed to persons and personal characteristics, such as personal histories, rather than to situational phenomena, such as the weather or the time of day). Notably, the IPSAQ presents both positive ("your friend thinks you're honest") and negative ("your friend thinks you're selfish") scenarios to participants. In the present study, we examine the effects of these components both separately and together, but found no significant comparative differences in participant responses.

To explore whether narratives of invisible disability helped to improve user attitudes towards PWIDs (as well as others whose actions may be unusual without attribution), we leveraged deep learning techniques (BERT; [61]) to determine whether affect cues within user-provided IPSAQ responses (attempts to causally support imaginary social interactions whose causes were not provided) shifted as a result of our intervention. For this, we extracted term embeddings from IPSAQ responses, grouped them based on their corresponding emotion labels using Google's GoEmotions dataset [62], and fine-tuned a pre-trained BERT model with the four most prevalent emotion labels within our dataset (*joy, sadness, neural, anger*) to accurately capture the nuances of shifting

emotional language use. To visualize these affective-linguistic cues, we reduce the dimensionality of the data using the t-distributed stochastic neighbor embedding (t-SNE) algorithm, which retains key information while reducing the complexity of the data. Among these emotion labels, we found insignificant changes in the use of *neutral* language, noticeable co-occurrences of *joy* and *sadness* pre-intervention, and noticeable post-intervention shifts toward expressions of *anger*.

E. Participant Reflections

Most participants (n = 96) chose to provide reflections outlining their own experiences as they related to story prompts. Participant reflections included terms that related to affect, emotion, and tone; to identify changes in affective states over time, these terms were extracted and measured using LIWC, with term frequencies later plotted to identify potential relationships between narrative-specific features (e.g., themes) and participant-reflection linguistic features. LIWC was also used to identify relationships between affective-linguistic features extracted from participant reflections, with subsequent correlation analysis revealing highly statistically significant ($p < .001$) positive correlations between several affective-linguistic and topical features. In particular, the presence of affectively oriented language was positively correlated with language relating to *analysis*, *acquisition*, *pro-social behavior*, and both *physical* and *mental wellness*, with *positive-emotion language* showing the strongest effect sizes. Additional significant correlations were observed between language relating to *fulfillment* and *fatigue* as well as language relating to *analysis* and *clout*—language indicating that participants felt confident in their statements.

In examining affective-linguistic features of narrative-form intervention prompts, additional insights arose. Narratives were shown to positively stimulate affective-linguistic expression, with affective and emotion word use tending to increase in relative frequency over the course of the intervention. A clear hierarchy of term types also emerged, showing a predominant focus on affect process words (e.g., *laughing*, *crying*) and a secondary focus on related descriptive adjectives (e.g., *happy*, sad).

Overall term frequencies were also evaluated to identify reflection topics. Overall, reflections tended to relate personal experiences to larger behavioral themes irrespective of population (e.g., "people" in general); participants also used terms relating to meaning-making (e.g., "life," "understand"). Comparably, terms relating to disability (e.g., disabled, disabilities) decreased in frequency over time. Notably, the number of participant reflections decreased over time, generally reflecting trends in listening as participants were given the option to skip certain stories (starting with the fourth story, whose condition topic was multiple sclerosis), but also correlating with the volume of affective words used in responses.

F. Correlation Analysis

Correlation analysis revealed additional statistically significant ($p < .05$) correlations among a wide range of variables examined in this study. We observed highly significant positive correlations both pre- and post-intervention between *self-compassion* and *attitudes to disability*; *state empathy ratings* and both the *agreeableness* and *compassion*; and *compassion* and *self-compassion*. Expanding this test to incorporate LIWC scores of participant reflection statements, we observed additional correlations between language relating to *cognition* and *health*; *state empathy* ratings and language relating to *illness, need* and *fatigue*. Negative emotion words were also highly correlated with language relating to the physical body and illness. Language relating to *anxiety* was also highly correlated with *substance*-related words. Correlation analysis also showed highly significant positive correlations between *age* and the *conscientiousness* and *extraversion* personality traits, and negative correlations between *age* and the *neuroticism* personality trait. Age was also negatively correlated with linguistic references to *fulfillment* and *mental processes*. State empathy ratings were very highly correlated with pre- and post-intervention compassion ratings and highly correlated with post-intervention ratings on self-compassion. Strong and highly significant negative associations were found between *all-or-nothing* and *analytic* language. Pre-intervention self-compassion ratings were negatively correlated with end ratings on the CAT, with lower starting ratings seeing the greatest improvements (defined as the ability to *not* make all-or-nothing assumptions of disability status on the basis of visual cues). While a slight positive correlation was found between *state empathy* and CAT reports —with higher state empathy ratings being associated with greater improvements in the CAT. Higher starting ratings on the CAT were seen to forecast higher changes post-intervention, such that the greatest changes tended to be observed in participants with already-higher CAT ratings.

Additional correlations were observed when accounting for the number of stories with which participants chose to engage; the number of reflections participants chose to provide; and the total combined word count of optional participant reflections. The number of stories heard was found to correlate with language relating to *authenticity*, *cognitive processes*, *insight*, *death*, *acquisition*, and *extraversion*, but not with the *extraversion* personality trait. The number of reflections provided was correlated with language relating to *authenticity*, *cognition*, *negative emotion*, *morality*, and *health*. The total combined *word count* in participant reflections was correlated with the personality traits of *neuroticism* and *openness*. *Word count* was also positively correlated with language relating to *authenticity* and negatively correlated with language relating to *morality* and post-intervention ratings of *compassion*. Unexpectedly, *word count* was not found to be significantly associated with linguistic references to *fatigue*. Participant responses showed expected co-occurrences of language relating to *health*, *illness*, *substances*, the *physical body*, and *mental states*.

State empathy ratings were very highly correlated with pre- and post-intervention compassion ratings and highly correlated with post-intervention ratings on self-compassion. Pre-intervention self-compassion ratings were negatively correlated with end ratings on the CAT, with lower starting ratings on CAT seeing the greatest improvements, with improvements defined as the ability to *not* make assumptions of disability status on the basis of visual cues. While a slight positive correlation was found between *state empathy* and

CAT reports —with higher state empathy ratings being associated with greater improvements in the CAT. Higher starting ratings on the CAT were found to forecast higher changes post-intervention, such that the greatest changes tended to be observed in participants who were already rating higher.

Ratings on all scales, including state empathy, were marginally higher for participants who reported identifying as PWDs or PWIDs when compared against participants without disabilities (PWODs), but no difference was observed between PWDs and PWIDs. Against our expectations, we did not observe significant differences among PWODs, PWDs, or PWIDs in the Attitudes to Disability scale at baseline.

G. Narrative Annotations & Inductive Coding

Human coders annotated story prompts (n = 9) to identify the presence of features known to induce affective state shifts as well as those documented to be prevalent within disability narratives; these features included *accommodation*; *advocacy*; *hope*; *compassion*; *trauma*; *anger*; *gratitude*; *stigma*; *joy*; *diagnosis*; *survival*; *meaning-making*; *fear*; and *loss*. Among the selected narratives, *gratitude* was the most salient feature (n = 7); followed by *compassion* n = 6); *advocacy* (n = 5); *diagnosis* (n = 5); and *meaning-making* (n = 5).

Inductive coding of participant reflections revealed that participants were deeply involved with meaning-making processes, relating the experiences depicted in story prompts to their own life situations, conditions, and experiences with disability. Participants touched upon topics and themes present within story prompts (i.e., support, gratitude, advocacy, fear, acceptance) as well as feelings of loneliness and a desire to find others to empathize with their own experiences; experiences with acceptance and feelings of being misunderstood by others; the importance of empathy; the consequences of being improperly judged; the value of sharing difficult experiences with others; and the need for greater respect and understanding of human difference.

IV. DISCUSSION

Several findings are worthy of discussion. Correlations between negative emotion words and the physical body and illness may highlight participants' efforts to relate to difficult subjects expressed in story prompts; likewise, correlations between *anxiety* and *substances*—paired with qualitative observations that reflections frequently discussed medication adherence, which was not thematic within story prompts—may indicate participants' impulse to transfer meaning from the stories to their own lives, applying their own life contexts to make sense of the experiences presented. Likewise, highly statistically significant associations between positive affect terms (e.g., *happy*, *excited*) and language relating to *analysis*, *physical health*, and *wellness* may indicate shifts toward positive affect states in response to reflection behaviors.

Associations between the number of stories heard and participant language relating to *authenticity*, *cognitive processes*, and *insight*, in particular, may further suggest that story engagement helped to facilitate active and engaged meaning-making processes. Likewise, the number of

reflections that a participant provided was a strong indicator of the participant expressing *negative emotion* words that may have helped to contextualize the experiences that they shared as reflections of those that were provided. The fact that CAT ratings improved the most for participants who were already rating highly in the CAT may indicate that the intervention was not able to effectively reach participants most in need of intervention, or it may indicate that the CAT should be redesigned for clarity—with some participants understanding the test prompts clearly while others did not.

IPSAQ results showed that participants made more personal and interpersonal attributions, and fewer situational attributions, post-intervention, possibly due to participants reflecting on the nature of their and others' experiences, which may lead to fewer unfounded assumptions of others. Similarly, CAT results indicated that participants, post-intervention, made fewer assumptions of others' lack of disability, mental health, or behavioral health condition status on the basis of visual cues. Compassion scales showed slight but not statistically significant increases in compassion towards both others and towards oneself. Since compassion was believed to be a central mechanism for changes in both attitudes toward disability and assumption-making, we believed that compassion scales would show robust differences to match changes in CAT ratings. These findings may indicate that, while of interest, compassion is not a primary mechanism in assumption-making.

The fact that required stories led to greater state empathy ratings may indicate that optional engagement plays a role in state empathy, or simply that state empathy was highest at the onset of the intervention while participants were least fatigued. The high number of participant reflections, and the significant average length of participant reflections, may otherwise be a strong indicator of positive engagement with the intervention.

Positive associations between word count of participant reflections and post-intervention (but not pre-intervention) ratings of compassion may indicate that willingness to provide reflections; the relevance of reflections; or the personal impacts of particular reflection activities played a role in the improvement of compassion ratings for some participants. Our results also suggest that story curation plays a strong role in reflection function and quality, with particular kinds of both cognitive and affective expressions arising in response to different stories, and different stories clearly eliciting a greater depth of responses (e.g., stories about autism and bipolar disorder elicited both the most reflection statements and the most affectively oriented statements). High associations between state empathy and pre- and post-intervention compassion ratings may indicate that compassion for others is an essential facilitator in bringing about feelings of empathy within the present context. Likewise, the relationship between *state empathy*, *compassion*, and the personality trait of *agreeableness* may indicate that *compassion* and *agreeableness* served as catalysts for engagement with story prompts, and subsequently, more positive *state empathy* ratings. Finally, strong and highly statistically significant negative associations between *all-or-nothing* and *analytic* language may indicate that the intervention worked as intended: reducing all-or-nothing views of disability status with personal reflection mediating this shift. Deep learning results

showing post-intervention shifts towards *anger*, likewise, may indicate that participants were engaged in constructive renegotiations of their own behavioral schema, reorienting themselves for potential future behavioral changes on the basis of shifting perspectives resulting from intervention engagement.

Overall, these findings suggest that engagement with narratives of invisible disability was able to facilitate constructive reflection and meaning-making processes for participants, although it remains unclear whether these processes directly contributed to shifts in participants' perceptions of disability status on the basis of available visual cues. Our results also suggest that one's willingness to engage in reflection may play a key role in the ability to reflect empathetically with narrative content.

V. CONCLUSION

Findings from this study suggest that a scalable, digital intervention combining affect induction and narrative reflection may be effective at reducing the impacts of visual assumption mechanisms relating to health and disability status inferences; improving attitudes toward PWDs; and reducing reliance on abstract disability constructs when seeking to understand or empathize with the experiences of PWDs. This study also suggests that affect, compassion, and empathy play essential roles in the mitigation of harmful assumption mechanisms affecting PWDs.

Future work in this area should accommodate a wide variety of participants whose experiences with disability may be diverse. Participants' past experiences with PWDs and PWIDs should be considered to impact participant outcomes. Future studies may wish to test the present intervention approach with social constructs beyond disability; evaluate this approach with different populations and subpopulations; and explore the impacts of narrative features (e.g., characterization, tense, verb use) on participant outcomes.

ETHICAL IMPACT STATEMENT

Several ethical considerations arose in the course of this work. Our study lasted anywhere between 45 minutes to 1.5 hours for some participants, with financial incentives randomized rather than guaranteed. Under normal circumstances, this might present ethical challenges relating to participant recruitment and compensation [63]. In our case, we did not plan or foresee that most of our study participants would identify as PWDs. Had this been expected, it is possible that the Institutional Review Board (IRB) would have required additional safeguards to ensure the protection and ethical management of research work relating to these participants– although researcher responsibilities may extend well beyond the limited requirements imposed by IRBs [64]. It is also possible that, had we foreseen that the majority of our participants would identify as PWDs, we would have significantly altered our study design to decrease the length of the study and guarantee financial incentives for all participants, since PWDs are nearly twice as likely to live in poverty when compared with the general population [65]. Bots, presenting as true research participants, also presented an ethical risk to the study by potentially decreasing the likelihood of true human participants receiving incentives that

were offered randomly by raffle. While bot removal is effective, there are currently no known methods to guarantee the human status of digitally recruited and seemingly engaged research participants.

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