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Robin Umbra & Ulrike Fasbender

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How to Capture the Rage? Development and Validation of a State-Trait Anger Scale

Robin Umbra  and Ulrike Fasbender 

Business and Organizational Psychology, University of Hohenheim, Stuttgart, Germany

ABSTRACT

Our research seeks to contribute to the existing literature on emotion measurement and research by proposing a new anger metric that addresses limitations of previous scales. This metric shows promise in meeting modern standards and drawing from traditional methods, potentially impacting the study of emotions. Additionally, our study explores cross-cultural congruence in assessing anger between English and German speakers, revealing differences in state and trait anger assessment. We offer theoretical perspectives on these cultural variances and emphasize the importance of considering language nuances in cross-cultural emotion assessment. Furthermore, our research delves into the relationship between anger and other emotions within an affective space, suggesting support for the notion that emotions are composite constructs consisting of valence and activation. We also discuss alternative theoretical perspectives on emotion construction to enhance our understanding. Additionally, our study examines the intricate relationship between anger and different forms of aggression, highlighting the association between anger and various aggressive behaviors in work settings. Our findings underscore the influence of personal traits and situational factors on experiences of anger and aggression, offering insights into the relationships between emotional states, traits, and behavior.

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The wrath do thou sing, O goddess, of Peleus' son, Achilles [...]



– Homer (ca. 700 B.C.E./1928)


Throughout history, the significance of capturing the essence of anger in literature has been widely recognized by humans. In fact, anger has been documented as the first written word in Western literature, underscoring its enduring importance (Potegal & Novaco, 2010). As we progress into the twenty first century, anger continues to be depicted as an arousing and often negative emotion linked to perceptions of arbitrary, reckless, or malicious actions directed toward oneself or confidants (Lazarus, 1991). Despite this long-standing acknowledgment of anger's significance, there seems to be a decreasing emphasis on studying anger within the scientific community. Considering the extensive impact that anger can have on individuals, groups, and communities, it is imperative for scientists to prioritize understanding and effectively measuring this intricate emotion. Therefore, the development of precise methods for measuring anger could play a pivotal role in advancing research and enriching our comprehension of this crucial facet of human experience.

One potential reason for the decreasing emphasis on research regarding the measurement of anger could be the belief that existing tools are sufficient for measuring anger accurately. While previous research, as shown in Table 1,

offers support for this claim, we might want to consider the evolving nature of the world we live in. Developments in the scientific *Zeitgeist*, advancements in technology, changes in theoretical understanding of emotions, and improvements in methodological approaches suggest that a modest “renaissance” in anger measurement could be beneficial for researchers. This does not mean that existing measurement tools are obsolete or should be disregarded; rather, it suggests the importance of developing new tools that align with current standards while drawing inspiration from past methods. By adapting measurement techniques to suit our modern context, researchers could enhance the accuracy and ecological validity of their studies on anger.

With the recent developments in the scientific *Zeitgeist* (e.g., a progression toward open science; Foster & Deardorff, 2017; Lewis, 2012; Swan, 2007), technological advancements (e.g., increased availability of mobile phones and internet access, user-friendly survey apps; Comer & Wikle, 2008; Dhamdhare & Dovrolis, 2011; Mestdagh et al., 2023), developments in theory (including partial agreement between cognitivist, basic-emotion, and constructivist perspectives on emotion; Gendron & Barrett, 2009; Suri & Gross, 2022; Zachar, 2022), and advances in methodology (such as confirmatory factor analyses, multilevel modeling, multidimensional scaling, and new sampling techniques like experience

CONTACT Robin Umbra  robin.umbra@uni-hohenheim.de  Business and Organizational Psychology, University of Hohenheim, Stuttgart, Germany.

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Data and materials are shared openly as part of the publication of this article at https://osf.io/efy9r/?view_only=b6c40e32cbe64c0b8ae15451246bd869.

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Table 1. Self-report anger metrics.

Metric	Authors	Constructs	Complexity	Theoretical background	Statistical methods for scale development	Sensibility	Accessibility
Anger Assessment Metric	current	<ul style="list-style-type: none"> State anger Trait anger 	<ul style="list-style-type: none"> 4 items (state anger; terms) 4 items (trait anger; terms) 	<ul style="list-style-type: none"> Cognitive-motivational-emotive system model 	<ul style="list-style-type: none"> Single-level principal component analysis Single-level confirmatory factor analysis Multi-level confirmatory factor analysis Multidimensional scaling analysis Single-level exploratory factor analysis 	<ul style="list-style-type: none"> Between-person variance detectable Within-person variance detectable 	<ul style="list-style-type: none"> Open access
State-Trait Anger Scale	Spielberger et al. (1983)	<ul style="list-style-type: none"> State anger Trait anger 	<ul style="list-style-type: none"> 10 items (state anger; terms) 10 items (trait anger; sentences) 	<ul style="list-style-type: none"> Unknown (data-driven) 	<ul style="list-style-type: none"> Single-level exploratory factor analysis Single-level confirmatory factor analysis 	<ul style="list-style-type: none"> Between-person variance detectable Within-person variance detectable 	<ul style="list-style-type: none"> Publicly available
State-Trait Anger Expression Inventory	Spielberger (1999)	<ul style="list-style-type: none"> State anger Trait anger 	<ul style="list-style-type: none"> 15 items (state anger; terms & sentences) 10 items (trait anger; sentences) 	<ul style="list-style-type: none"> Unknown (data-driven) 	<ul style="list-style-type: none"> Single-level exploratory factor analysis Single-level confirmatory factor analysis 	<ul style="list-style-type: none"> Between-person variance detectable Within-person variance detectable 	<ul style="list-style-type: none"> Proprietary access
Positive and Negative Affect Schedule	Watson and Clark (1994)	<ul style="list-style-type: none"> State hostility Trait hostility 	<ul style="list-style-type: none"> 6 items (state hostility; terms) 6 items (trait hostility; terms) 	<ul style="list-style-type: none"> Circumplex model of emotion 	<ul style="list-style-type: none"> Single-level principal component analysis 	<ul style="list-style-type: none"> Between-person variance detectable Within-person variance detectable 	<ul style="list-style-type: none"> Publicly available
Profile of Mood States	McNair et al. (1992)	<ul style="list-style-type: none"> State anger-hostility Trait anger-hostility 	<ul style="list-style-type: none"> 7 items (state hostility; terms) 7 items (trait hostility; terms) 	<ul style="list-style-type: none"> Circumplex model of emotion 	<ul style="list-style-type: none"> Single-level exploratory factor analysis 	<ul style="list-style-type: none"> Between-person variance detectable Within-person variance detectable 	<ul style="list-style-type: none"> Publicly available
Facets of Emotional Experiences in Everyday Life Scale	Chung et al. (2022)	<ul style="list-style-type: none"> State anger Trait anger 	<ul style="list-style-type: none"> 16 items (state anger; terms) 16 items (trait anger; terms) 	<ul style="list-style-type: none"> Circumplex model of emotion Differential emotions model 	<ul style="list-style-type: none"> Single-level exploratory factor analysis Single-level confirmatory factor analysis Multi-level exploratory factor analysis Multi-level confirmatory factor analysis Single-level exploratory factor analysis Single-level confirmatory factor analysis 	<ul style="list-style-type: none"> Between-person variance detectable Within-person variance detectable 	<ul style="list-style-type: none"> Publicly available
Differential Emotions Scale	Izard (1982)	<ul style="list-style-type: none"> State anger Trait anger 	<ul style="list-style-type: none"> 3 items (state anger; terms) 3 items (trait anger; terms) 	<ul style="list-style-type: none"> Differential emotions model 	<ul style="list-style-type: none"> Single-level exploratory factor analysis 	<ul style="list-style-type: none"> Between-person variance detectable Within-person variance detectable 	<ul style="list-style-type: none"> Publicly available
Buss-Perry Aggression Questionnaire	Buss and Perry (1992)	<ul style="list-style-type: none"> Trait anger 	<ul style="list-style-type: none"> 7 items (sentences) 	<ul style="list-style-type: none"> Unknown (data-driven) 	<ul style="list-style-type: none"> Single-level exploratory factor analysis 	<ul style="list-style-type: none"> Between-person variance detectable 	<ul style="list-style-type: none"> Publicly available
Buss-Durkee Hostility Inventory	Buss and Durkee (1957)	<ul style="list-style-type: none"> Trait irritability 	<ul style="list-style-type: none"> 11 items (sentences) 	<ul style="list-style-type: none"> Unknown (data-driven) 	<ul style="list-style-type: none"> Single-level exploratory factor analysis 	<ul style="list-style-type: none"> Between-person variance detectable 	<ul style="list-style-type: none"> Publicly available
Novaco Anger Scale and Provocation Inventory	Novaco (2003)	<ul style="list-style-type: none"> Trait anger 	<ul style="list-style-type: none"> 25 items (sentences) 	<ul style="list-style-type: none"> Unknown (data-driven) 	<ul style="list-style-type: none"> Single-level exploratory factor analysis 	<ul style="list-style-type: none"> Between-person variance detectable 	<ul style="list-style-type: none"> Proprietary access
Anger Self-Report	Reynolds et al. (1994)	<ul style="list-style-type: none"> Trait anger 	<ul style="list-style-type: none"> 30 items (sentences) 	<ul style="list-style-type: none"> Unknown (data-driven) 	<ul style="list-style-type: none"> Single-level exploratory factor analysis 	<ul style="list-style-type: none"> Between-person variance detectable 	<ul style="list-style-type: none"> Publicly available
Angry Aggression Scale	Bjørnebekk and Howard (2012)	<ul style="list-style-type: none"> Trait anger 	<ul style="list-style-type: none"> 20 items (sentences) 	<ul style="list-style-type: none"> Quadrupartite typology of violence model 	<ul style="list-style-type: none"> Single-level exploratory factor analysis 	<ul style="list-style-type: none"> Between-person variance detectable 	<ul style="list-style-type: none"> Publicly available
Multidimensional Anger Inventory	Siegel (1986)	<ul style="list-style-type: none"> Trait anger 	<ul style="list-style-type: none"> 26 items (sentences) 	<ul style="list-style-type: none"> Unknown (data-driven) 	<ul style="list-style-type: none"> Single-level principal component analysis 	<ul style="list-style-type: none"> Between-person variance detectable 	<ul style="list-style-type: none"> Publicly available
Anger Disorders Scale	Digiuseppe and Tafraite (2004)	<ul style="list-style-type: none"> Trait anger reactivity 	<ul style="list-style-type: none"> 76 items (sentences) 	<ul style="list-style-type: none"> Unknown (data-driven) 	<ul style="list-style-type: none"> Single-level exploratory factor analysis 	<ul style="list-style-type: none"> Between-person variance detectable 	<ul style="list-style-type: none"> Proprietary access
Dimensions of Anger Reactions	Forbes et al. (2004)	<ul style="list-style-type: none"> Trait anger 	<ul style="list-style-type: none"> 7 items (sentences) 	<ul style="list-style-type: none"> Unknown (data-driven) 	<ul style="list-style-type: none"> Single-level principal component analysis Single-level confirmatory factor analysis Single-level exploratory factor analysis 	<ul style="list-style-type: none"> Between-person variance detectable 	<ul style="list-style-type: none"> Publicly available
Reaction Inventory	Evans and Stangeland (1971)	<ul style="list-style-type: none"> Trait anger elicitors 	<ul style="list-style-type: none"> 40 items (sentences) 	<ul style="list-style-type: none"> Unknown (data-driven) 	<ul style="list-style-type: none"> Single-level exploratory factor analysis 	<ul style="list-style-type: none"> Between-person variance detectable 	<ul style="list-style-type: none"> Publicly available
Anger Consequences Questionnaire	Diefenbacher et al. (1996)	<ul style="list-style-type: none"> Trait anger consequences 	<ul style="list-style-type: none"> 26 items (sentences) 	<ul style="list-style-type: none"> Unknown (data-driven) 	<ul style="list-style-type: none"> Single-level exploratory factor analysis 	<ul style="list-style-type: none"> Between-person variance detectable 	<ul style="list-style-type: none"> Publicly available
Anger Regulation and Expression Scale	Digiuseppe and Tafraite (2011)	<ul style="list-style-type: none"> Trait anger 	<ul style="list-style-type: none"> 23 items (sentences) 	<ul style="list-style-type: none"> Unknown (data-driven) 	<ul style="list-style-type: none"> Single-level exploratory factor analysis 	<ul style="list-style-type: none"> Between-person variance detectable 	<ul style="list-style-type: none"> Proprietary access

sampling; Muthén & Muthén, 2019; Hout et al., 2013; Gabriel et al., 2019), our current research is focused on creating a novel, pre-registered, and open-access anger metric that strives to meet current standards while also drawing inspiration from traditional approaches. The development of the metric was guided by theoretically-driven principles derived from the cognitive-motivational-emotive system model (CMESM; Lazarus, 1991; Smith & Lazarus, 1990) and research on metric development and validation by Hinkin (1998). In conducting three separate studies testing our metric, we sought to increase its validity and reliability across a range of theoretical contexts. We argue that our results may suggest some level of achievement in this pursuit. Through the inclusion of unique conditions based on theory, we were able to gather valuable insights into different emotion theories and uncovered empirical evidence that appears to support existing research.

In our current research, we argue that we have made four reasonable contributions to the existing literature on emotion measurement and research. Our work has resulted in the development of an anger metric that shows promise in meeting certain modern standards and drawing inspiration from traditional methods. Our metric also appears to address limitations of previous scales in terms of the measured constructs, metric complexity, theoretical background, statistical methods used for scale development, sensibility, and accessibility (see Table 1). Among other things, these limitations include a lack of state anger measurements, inclusion of confounding constructs in anger measurement, excessive complexity, absence of theoretical foundations and data-driven metric construction, lack of contemporary statistical methods used for scale development, issues with the detectability of within-person variance, and proprietary status. As such, we are cautiously optimistic about the potential for our metric to be adopted in important situations where understanding anger is crucial.

Second, our study may add to the existing literature on cross-cultural congruence in assessing anger between English and German speakers. The findings suggest that there may be some differences in the assessment of state anger and trait anger between the US and German cultures. While there are some similarities in momentary experiences of anger across cultures, there may be some cultural differences in the baseline levels of trait anger. We provide some theoretical perspectives on the potential reasons for this intercultural difference and highlight the importance of considering language nuances in assessing emotions across cultures. Therefore, the study's findings may provide some insight into the universality of emotions and the impact of cultural-semantic differences on assessing emotional states and traits from a basic-emotion theory perspective (Ekman & Cordaro, 2011; Ekman & Friesen, 1971; Russell et al., 2011).

Third, our study may also contribute to the existing literature on affect by examining the relationship between our assumed anger construct and other emotions, including hostility, joviality, serenity, and sadness, within the context of an affective space of emotion. The findings suggest that the constructivist assumption that emotions are composite

constructs consisting of valence and activation may hold some merit (Russell, 1980; Watson et al., 1988). However, we also discuss alternative theoretical perspectives that aim to enhance our understanding of the construction of emotions. As such, the study's findings may offer valuable insights into the compositionality of emotions and the assessment of emotional states and traits from a constructivist-emotion theory perspective.

Fourth, our research may also make a valuable contribution to the existing literature on aggression by exploring the intricate relationship between anger and aggressive behaviors. Our findings suggest that anger is broadly associated with various forms of aggression (verbal, property, and interpersonal aggression, as well as guilt induction, malicious humor, and social exclusion) in work settings to a similar extent. The results also highlight the balance between personal traits and situational factors in shaping experiences of anger and aggression, which is consistent with the general model of human aggression (Anderson & Bushman, 2002). Furthermore, our study sheds some light on the specific association between trait anger and verbal aggression and malicious humor. It suggests that trait anger may be uniquely linked to speech-mediated aggression and emphasizes the need for further theorizing and empirical research in this area (Forrest et al., 2005; Verona et al., 2008). As such, our study's findings may provide valuable insights into the relationships between emotional states and traits and behavior.

Theoretical background

From cognitive-motivational-emotive system model to construct measurement

We have devised a workflow to enhance the efficiency of the development and validation process, as depicted in Figure 1. Our approach is based on the CMESM, which provides a comprehensive and theory-based framework for comprehending anger and its associated factors. According to the model, a construct gauging anger should meet three criteria: (1) it should be essentially linked to a relational theme of arbitrary, reckless or malicious actions directed toward oneself or confidants, (2) it should be aligned with other negative and highly arousing emotions while diverging from positively valenced or low arousal emotions, and (3) it should positively relate to aggression. These criteria will guide the metric development process.

Criterion 1: item content consistent with the relational theme

The CMESM posits that anger is essentially linked to a relational theme of unjust or harmful actions toward oneself or confidants (Lazarus, 1991; Smith & Lazarus, 1990). Therefore, the content of any items intended to measure the construct of anger must be consistent with a definition (i.e., the essence) of anger that is grounded in this relational theme. We have endeavored to address this criterion through our item development and content validation procedures in Study 1.

Criterion 2: convergence and divergence in relation to affective composition

The CMESM describes anger as an emotion characterized by negative valence and high arousal (Lazarus, 1991; Smith & Lazarus, 1990). In addition, the CMESM also suggests that emotions with similar valence and arousal tend to align with each other, while those with opposite attributes tend to diverge. Accordingly, we would expect our construct to be more closely aligned with other negative and highly arousing emotions, and less so with positive or low arousal emotions.

To determine which emotions align or diverge from our construct, we rely on the constructionist account of emotion (Russell, 1980; Watson et al., 1988). This account categorizes emotions based on valence and arousal, resulting in four different combinations of affective compositions represented in distinct “affective quadrants.” By selecting emotions from each quadrant, we should be able to determine which emotions are more closely aligned with our construct and which are not, providing a spatial differentiation for analysis. Based on previous research within this framework (Watson & Clark, 1994), we identify hostility (negative valence, high arousal), joviality (positive valence, high arousal), sadness (negative valence, low arousal), and serenity (positive valence, low arousal) as relevant emotions, as shown in Figure 2 (in the online supplemental).

We expect our construct to be located in the affective quadrant characterized by negative valence and high arousal (Lazarus, 1991; Smith & Lazarus, 1990; Watson & Clark, 1994). Based on the assumption that emotions with similar valence and arousal tend to align with each other, we hypothesize that our construct will converge with hostility and diverge from joviality, serenity, and sadness (Hypothesis 1).

It is important to note that constructivist accounts do not single out anger specifically but instead include it in the emotion of hostility, along with disgust (Russell, 2017; Watson & Clark, 1994). To validate a construct measuring anger, it would be beneficial to incorporate other constructs that have previously measured anger. In accordance with the assumption that emotions with similar valence and arousal

tend to align with each other (Lazarus, 1991; Smith & Lazarus, 1990), we hypothesize that our construct will also align with the emotion of anger (Hypothesis 2). We have endeavored to address these hypotheses and the criterion of convergence and divergence in relation to affective composition through our construct validation procedure in Study 2.

Criterion 3: relation to aggression

As per the CMESM, there is a positive relation between anger and aggression (Lazarus, 1991; Smith & Lazarus, 1990), as demonstrated in Figure 3 (in the online supplemental). Aggression can be classified into two types - direct and indirect (Archer, 2004; Archer & Coyne, 2005; Bryant & Smith, 2001). Direct aggression includes overt and hostile actions taken by one person toward another, such as verbal aggression, property aggression, or interpersonal aggression (Verona et al., 2008). Indirect aggression, on the other hand, involves covert and hostile behaviors like guilt induction, malicious humor, and social exclusion (Forrest et al., 2005). Based on the CMESM proposition of anger being positively related to aggression, along with prior research on aggression categories, we hypothesize that our construct will also exhibit a positive association with verbal aggression, property aggression, interpersonal aggression, guilt induction, malicious humor, and social exclusion (Hypothesis 3). We have tried to address this hypothesis and the criterion of relation to aggression through our predictive validation procedure in Study 3.

Further theory-related factors to consider

State-trait character and fluctuations

In this manuscript, our primary focus is on the conceptual construct of state anger. However, we argue that it is imperative to also consider the conceptual construct of anger that reflects one's predisposition to experience the state anger construct, which is known as trait anger. This is crucial because some theorists (Frijda, 1987; Lazarus, 1991; Steyer et al., 2015) would argue that state anger can only be considered a momentary experience of anger when the

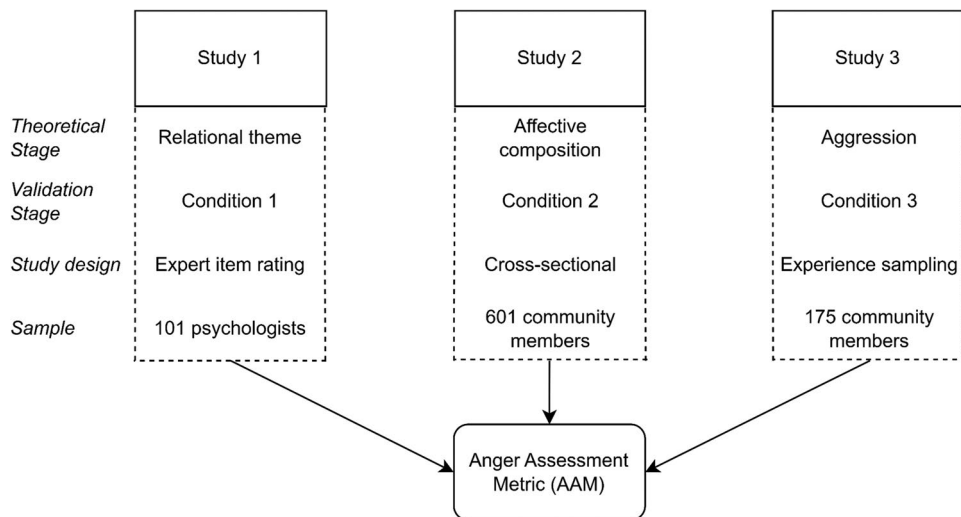


Figure 1. Overview of studies.

predisposition of experiencing this emotion is taken into account. Hence, we aim to incorporate a trait anger measure in our metric and use it to integrate the assumptions of the- orists in Study 3.

Additionally, it is noteworthy that various theories pertaining to emotions (James, 1884; Moors et al., 2013; Russell, 1980) suggest a general requirement of a state metric that is capable of precisely measuring a given “state.” This requirement necessitates that natural fluctuations are observed within people when assessed by said metric. Consequently, we intend to address this requirement by examining whether our measure exhibits similar within-person fluctuations in Study 3.

Item quantity

In the pursuit of developing and validating a state metric for utilization in experience sampling contexts, we address the issue of determining the number of items that should be included in our metric. As per the theoretical understanding of emotions (Lazarus, 1991; Smith & Lazarus, 1990), they are latent constructs and cannot be directly observed by the person. Therefore, a metric that only includes one observable construct would not be sufficient to precisely capture the latent construct of anger.

Resorting to analytics, a confirmatory factor analysis, which endeavors to approximate latent constructs through observable indicators, requires that at least three items are necessary to indicate a latent construct (Depaoli, 2021; Geiser, 2020). In addition, four items would be adequate to test the latent model fit of the construct. Hence, our goal is to devise a metric that comprises four items.

Item quality

In order to develop an accurate measure of the latent construct of anger, it is necessary to determine which observable component of an emotion is suitable to approximate anger (i.e., the item quality). In examining the CMESM, there are four primary options to consider: the appraisal itself, the physiological changes that accompany the emotion, the action tendency (impulse), and the feeling state (affect) of anger. While reducing item length and ensuring ease of participant response are important reasons to consider, theoretical reasons also weigh in favor of the use of the affect component in our measure.

While self-reporting and the use of “feeling” words to measure emotion have been met with some reservations in the emotion literature (Frijda, 2009; Kagan, 2010; Picard, 2010), we argue that this method provides the best theoretical means of measuring the latent construct of an emotion. This is because the self-reported feeling state of an emotion by a participant is conceptually regarded as the most comprehensive representation of the emotional experience as a whole (James, 1884; Lazarus, 1991; Russell, 1980). In theory, the affective component should encompass the participant’s appraisal, as well as their experience of the physiological changes and changes in action tendency associated with the emotion. Based on this theoretical reasoning, we intend to use affective items in our measure.

Response anchors

It may be imperative to take into account the response anchors of our measurement instrument. Our construct comprises different levels of intensity along with within-person fluctuations and between-person differences (Lazarus, 1991; Smith & Lazarus, 1990). For this reason, a metric from low expression to high expression should be preferred over a binary measure of no/yes, with respect to measurement accuracy (Casper et al., 2020). All variables used in our studies align with this argumentation, and thus we confine our anchor metrics for each variable to a 5-point measure.

Moreover, it is worthwhile to consider the possibility that different response anchors may be necessary to measure our state and trait construct. Typically, emotional states are measured in terms of intensity (Potegal et al., 2010; Spielberger et al., 1983; Watson & Clark, 1994), which presumably comprises a latent construct containing valence and arousal (Russell & Carroll, 1999). Conversely, emotional traits are measured in terms of frequency (Potegal et al., 2010; Spielberger et al., 1983; Watson & Clark, 1994), which presumably comprises a latent construct containing the level of predisposition (Frijda, 1987). Therefore, it may be fitting to use intensity response anchors for our state metric and frequency response anchors for our trait metric, given these considerations.

Language and cross-culturalism

The basic-emotion accounts of emotion theory (Ekman & Cordaro, 2011; Ekman & Friesen, 1971; Russell et al., 2011) suggest the universality of certain emotions, indicating that some emotions are experienced similarly across diverse cultures. Anger, for instance, is considered a universal/basic emotion by basic-emotion theorists, implying that the creation of an anger metric capable of evaluating the anger experience of different cultures would bring incremental practical and theoretical value. Such an approach would not only expand the applicability of the metric but also enable us to somewhat test the basic-emotion assumption concerning anger through invariance tests between two cultures. In this context, our objective is to develop a bilingual (English-German) anger assessment metric and employ it to examine the basic-emotion assumption regarding anger in both US and German cultures in Study 2.

Experience sampling context

To enhance the practicality of our metric in experience sampling scenarios, it is crucial to validate it in such circumstances and with samples that are intrinsic to these contexts. The primary aim of this validation approach is to acquire samples that could be somewhat generalized to the general (working) population, particularly within worksite settings, as our metric is intended for this purpose. For this objective, the participant pool will mainly consist of currently employed full-time workers aged between 18 and 67 years, who work a 35-h weekly schedule, have a regular 9 to 5 job, and work with coworkers.

Transparency and openness

Before pre-registration, the exploratory content validation stage (Study 1) was finished. The hypotheses, research, and analysis plans for Studies 2 and 3 have been preregistered on the Open Science Framework and can be accessed at https://osf.io/bnwfd/?view_only=c03e97b0fc2d4516ac3591a03fe0d969 (Study 2) and https://osf.io/68vuq/?view_only=d85b81f060bf4c439d2aec5f5b841f35 (Study 3). Data summaries and analysis codes will be provided in the same directory upon publication.

Study 1

The primary objective of Study 1 is to construct and validate items that effectively measure the concept of anger as per the CMESM (Condition 1). This approach posits that anger is inherently associated with a relational theme of unjust or harmful actions perpetrated against oneself or confidants. In this study, we aim to gather and analyze expert quantitative ratings of our developed items to enhance the likelihood that these items' content aligns with the definition of anger and conforms to the theoretical framework.

Method

Selection and procedure

To generate terms related to anger, we reviewed the relevant literature, including works by Lazarus (1991) and American English and German dictionaries. Our primary criteria for extracting terms were that they needed to be adjectives, synonymous with or related to the concept of anger, describe an affect, and be categorized as terms describing both a state and a trait. Ultimately, we developed 47 items based on these criteria.

To ensure accuracy in all studies, we translated items from American English to German using the back-translation method, as detailed by Brislin (1970). A native American English-speaking psychologist assisted us in the translations.

We recruited academic staff with a postgraduate degree in psychology as subject matter experts for the present study. The target sample size was 100, as determined by consulting Kass and Tinsley (1979). According to Kass & Tinsley, a principal component analysis (PCA) requires an item-to-participant ratio of at least 1:5. All participants held academic ranks ranging from research assistant to full professor. We contacted eligible participants *via* their university email, which was publicly available on the university website from June to July 2022. We excluded participants who did not respond to the full survey or indicated that they misunderstood the instructions in the post-survey feedback. Ultimately, a sample size of 101 was achieved.

Measures

In our study, we provided the participants with a German definition of anger, which was based on the relational theme of arbitrary, reckless or malicious actions directed toward oneself or confidants (Lazarus, 1991). Our aim was to ask the participants to rate the 47 German items based on their

clarity and fit with the definition. To measure conceptual fit and clarity, we employed a metric adapted from Schriesheim et al. (1993) with response options ranging from 1 (not at all) to 5 (completely). Additionally, we provided a residual option for participants who were unsure.

Analytic strategy and data diagnostics

We began by extracting items with a mean conceptual fit score of at least 3, indicating sufficient alignment with our conceptual definition of anger (Schriesheim et al., 1993). This step reduced the initial pool of 47 items to 15 items, after removing items such as grumpy, vengeful, and annoyed. We then examined the clarity scores and feedback sections of our survey to identify items that were ambiguous or unclear. As a result, we removed three items (infuriated, incensed, and indignant), which were deemed ambiguous by the participants. This left us with a final set of 12 items.

To analyze the data for these 12 items, we used R version 4.1.2 (R Core Team, 2022) and employed R-methodology PCA and Q-methodology PCAs with a principal component regression estimator (Hinkin, 1998; Meyer & Buchta, 2022; Revelle, 2022). Additionally, we conducted data diagnostics recommendations to confirm the quality of our data (Field et al., 2012). According to the statistical analysis, the item scores appeared to follow a negatively skewed beta distribution. This observation suggests that the conceptual fit was generally high for the 12 items (Cullen & Frey, 1999). Consequently, we can assert that the use of our data to inform the metric development was appropriate.

Results and discussion

Bartlett's test produced a significant result for the 12 items ($\chi^2(66) = 478.64, p < .001$). The Kaiser-Meyer-Olkin statistic indicated good sampling adequacy ($MSA = .74$; Hutcheson & Sofroniou, 1999), and the determinant of the correlation matrix was greater than .00001 ($|R| = .0065$). Additionally, all standardized item loadings on a common component were above 0.40 in both R- and Q-methodology PCAs, implying some degree of content validity (Hinkin, 1998).

The main objective of Study 1 was to develop and validate items that effectively measure the concept of anger, as per the CMESM (Condition 1). During this study, expert quantitative ratings were gathered and analyzed to ensure that the content of the developed items aligns with the definition of anger and conforms to the theoretical framework. Based on our findings, we can conclude that the twelve items we derived through our item development process may sufficiently align with the definition of anger and provide support for Condition 1. Our investigation indicates that our construct should to an adequate degree be essentially linked to a relational theme of arbitrary, reckless or malicious actions directed toward oneself or confidants.

Study 2

The primary objective of Study 2 is to examine the connection between our anger construct and other emotions based

on their valence and arousal levels. In doing so, we intend to leverage the constructionist account of emotion to determine whether our anger construct aligns with and deviates from theoretically predefined emotions (Russell, 1980; Watson & Clark, 1994) in a proper manner (Condition 2). Our hypothesis is that our construct will align with emotions that are characterized by negative valence and high arousal, such as hostility, and diverge from emotions with distinct affective compositions, such as joviality, serenity, and sadness. Furthermore, we plan to substantiate our construct by integrating other constructs that have been used previously to measure anger and hypothesize that anger will also align with our construct. In summary, our ultimate goal is to provide a comprehensive understanding of the relationship between our construct of anger and other emotions within the wider framework of affective composition.

Method

Selection and procedure

In order to assess the alignment and deviations of our anger construct with respect to theoretically predefined emotions, we conducted a correlational study. Our study aimed to not only examine the inter-emotional alignment but also to test the comparability of our anger construct between two distinct cultures, i.e., the US and Germany. Our participant pool consisted of people aged between 18 to 67 years, who were native speakers of their country's primary language, resided and worked in their respective countries, and worked at least 35 h a week. To determine the appropriate sample size for each country, we referred to the recommendations of Comrey and Lee (1992), which suggested 300 participants for each country. In September of 2022, we partnered with an ISO 20252-certified panel provider for market, opinion, and social research to gather our samples. Our participants were remunerated with 3.00 EUR for their participation. To ensure a sufficient degree of data quality (Burchett et al., 2023), we included attention checks (...please select "a little" if you're paying attention), with participants being screened out if they failed these.

The US sample consisted of 301 participants, while the German sample had 300 participants. In the American sample, 49.8% of the participants were male ($n=150$), 49.5% were female ($n=149$), and 0.7% identified as non-binary ($n=2$). The age of participants ranged from 21 to 67 years ($M=43.12$, $SD=13.24$), while their weekly working hours ranged from 35 to 80 ($M=41.15$, $SD=6.31$). Similarly, in the German sample, 50.3% were male ($n=151$), and 49.6% were female ($n=149$), with no participants identifying as non-binary. The age range of the German sample was 18 to 66 years ($M=43.67$, $SD=11.35$), and their weekly working hours ranged from 35 to 55 ($M=39.76$, $SD=3.05$).

Our surveys used a randomization technique to address common method bias (Doty & Glick, 1998). Participants were randomly assigned to one of two test batteries, with the first battery containing all state measures and the second battery containing all trait measures. After completing the first battery, participants were presented with the second battery. Additionally, we randomized the order of measures

within both batteries and the order of items within the Anger Affect Metric.

Measures

For Watson and Clark (1994) items, we adopted item translations used in Grühn et al. (2010) and utilized Breyer and Bluemke (2016) German introduction stem and response options. Response options for these items ranged from 1 (very slightly or not at all) to 5 (extremely).

Anger. As part of the assessment of state anger (AAM), four items were selected from the twelve Anger Affect Metric - State submetric items, using theory-driven item reduction and invariance tests, as detailed in the following Analytic Strategy section. The four items were designed to measure anger in the present moment, with the statement "Right now, I feel angry" being one of them ($\omega = .95$). Participants rated their responses on a metric from 1 (not at all) to 5 (extremely). Additionally, we used Spielberger et al. (1983) 10-item State Anger Metric (STAS) to evaluate various dimensions of state anger, with an example item being "I am mad" ($\omega = .97$). Participants were required to rate their responses on a Likert metric ranging from 1 (not at all) to 4 (very much so). Trait anger (AAM) was evaluated using four items from the Anger Affect Metric - Trait submetric, such as the statement "In general, I feel angry" ($\omega = .91$). Participants rated their responses on a metric from 1 (never) to 5 (always). We also employed Spielberger et al. (1983) 10-item Trait Anger Metric (STAS) to assess trait anger, such as the statement "When I get mad, I say nasty things" ($\omega = .93$). The response options ranged from 1 (never) to 5 (always). Finally, trait anger was also measured using the Buss-Perry Aggression Questionnaire (BPAQ; Buss & Perry, 1992), which included the statement, "I sometimes feel like a powder keg ready to explode" ($\omega = .90$). Participants rated their responses on a metric from 1 (extremely uncharacteristic of me) to 5 (extremely characteristic of me) using the German translations of the BPAQ items as developed by Werner and Collani (2004).

Hostility. To assess state hostility we used a 6-item metric developed by Watson and Clark (1994) that includes statements like "Right now, I feel hostile" ($\omega = .96$). Trait hostility was measured using an 8-item metric created by Buss and Perry (1992), with one of the items being "I sometimes feel that people are laughing at me behind my back" ($\omega = .92$). Responses were rated on a metric of 1 (extremely uncharacteristic of me) to 5 (extremely characteristic of me). Werner and Collani (2004) provided the German translations for the items.

Joviality. An eight-item metric developed by Watson and Clark (1994) was utilized to measure state joviality. An example of an item that assesses state joviality is "Right now, I feel cheerful" ($\omega = .96$). The same metric was used for evaluating trait joviality. A representative item for trait joviality is "In general, I feel cheerful" ($\omega = .97$).

Serenity. A three-item metric was utilized to assess state serenity, developed by Watson and Clark (1994). One example of an item concerning state serenity is, “Right now, I feel calm” ($\omega = .94$). The same metric was used for the evaluation of trait serenity, with an example item being, “In general, I feel calm” ($\omega = .94$).

Sadness. To assess the level of sadness experienced by a person, a 5-item metric developed by Watson and Clark (1994) was utilized. An example of a state sadness item from the metric is, “Right now, I feel sad” ($\alpha = .96$). The same metric was also employed to evaluate trait sadness, with an item such as “In general, I feel sad” ($\omega = .96$).

Analytic strategy

For our statistical analysis, we utilized R version 4.1.2 (R Core Team, 2022) and applied a weighted least square mean and variance adjusted (WLSMV) estimator. To capture our latent constructs and their corresponding relations in a theory-aligning manner, we employed confirmatory factor analyses.

In our first step, we utilized confirmatory factor analyses to reduce items from 12 to the desired four. We took into account the PCA results from Study 1 and examined various combinations of four-item CFAs of our 12 items, utilizing chi-square difference tests, comparative fit indexes, root-mean square errors of approximation, squared root-mean errors, as well as Akaike and Bayesian Information criteria. After considering all of these factors, we found that the best fitting models for both state- and trait-metrics were the items “angry,” “furious,” “riled up,” and “mad,” which were confirmed cross-culturally once we substituted the German translation for the word “furious” from “rasend” to “zornig,” as presented in Table 2. Finally, we tested for invariance between the American English and German metrics (van de Schoot et al., 2012). We found scalar invariance for the state metric and metric invariance for the trait metric, as presented in Table 3 (in the online supplemental). Consequently, we merged the two samples for subsequent analyses.

In the subsequent phase of our study, we focused on evaluating the extent of convergent validity. To conduct this evaluation, we adopted the assessment approach presented by Cunningham et al. (2001). As per this approach, for our anger construct to demonstrate a sufficient degree of convergent validity, it should be related to other similar measures. We considered this criterion fulfilled if the 95% confidence interval between two factors’ correlation coefficient (ϕ) does not encompass null.

However, we recognized that relying solely on correlational coefficient results may not provide adequate evidence for a meaningful level of convergent validity (Carlson & Herdman, 2012; Cheung & Wang, 2017; Duckworth & Kern, 2011). Hence, we added a second criterion also derived from Cunningham et al. (2001). According to this criterion, all convergence-related constructs should tap into a common meta-construct. In other words, we explored whether the first-order constructs of anger and hostility were also linked to a common second-order factor. This second-order factor could be considered an emotional meta-construct that both

anger and hostility are part of. We deemed this criterion satisfied if all standardized factor loadings of first-order factors onto a common second-order factor had 95% confidence intervals with lower limits greater than 0.40 (Hinkin, 1998).

In the subsequent phase of our study, we undertook an evaluation of the degree of discriminant validity of our anger construct. For this purpose, we adopted the assessment approach proposed by Rönkkö and Cho (2020). Our objective was to show that our anger construct was not strongly related with other dissimilar measures. According to the recommended cutoff values of Rönkkö and Cho (2020), we considered this requirement as fulfilled if the 95% confidence interval between two factors’ correlation coefficient (confidence interval[ϕ ; 95%]) did not include 0.80 or -0.80 .

However, we again acknowledged that relying solely on correlational coefficient results, which are also relatively large (Cohen, 1988), may not provide adequate evidence for a meaningful level of discriminant validity (Cheung & Wang, 2017; Shaffer et al., 2015). Therefore, we included a second criterion to our evaluation, which was also derived from Rönkkö and Cho (2020) approach. As per this particular criterion, our main objective was to show that the measurement instrument used by us more accurately measures the construct of anger than other measures that are assumed to measure different constructs. In other words, we explored whether the addition of the explanatory power of another measure, dissimilar from our anger measure (e.g., a measure for joviality), would add measurement accuracy to the modeling of our anger construct. We considered this criterion as fulfilled if an unconstrained model, whereby the interfactor correlations were unconstrained, fit the data significantly better than its nested constrained model, whereby the interfactor correlation was constrained to the cutoff values recommended by Rönkkö and Cho (2020; ϕ constrained to ± 0.80).

As a final step in our research, we sought to heuristically evaluate the proposed circumplex model, which was presented in Figure 2 (in the online supplemental). To achieve this, we conducted a multidimensional scaling analysis on the distance-transformed correlation matrix of our investigated constructs (R Core Team, 2022). We then visually plotted their positions relative to one another on a 2-dimensional affective grid.

Results and discussion

The findings presented in Table 4 (in the online supplemental) include statistical values such as means, standard deviations, omega reliabilities, and correlations among the focal variables. The AAM State submetric (AAM-S; $\chi^2(2) = 0.20$, $p = 0.91$, CFI = 1.00, RMSEA = 0.00, SRMR = 0.01, and $\lambda_{\min} = 0.68$) and AAM Trait submetric (AAM-T; $\chi^2(2) = 0.55$, $p = 0.76$, CFI = 1.00, RMSEA = 0.04, SRMR = 0.01, and $\lambda_{\min} = 0.65$) presented with exact model fit. The study’s convergent validity analysis indicates strong correlation coefficients between the factors, with range[ϕ] values showing between 0.62–0.93. Furthermore, all standardized factor loadings of first-order factors onto a common second-order factor had lower limits greater than 0.40. These results lend support to a sufficient degree of convergent validity of our metric.

In terms of discriminant validity, our analysis showed that the correlation coefficients between two factors exhibit a predetermined level of discriminance ($-.80 < \text{confidence interval}[\phi; 95\%] < .80$). Additionally, each unconstrained model fit the data significantly better than its nested constrained model. These results lend support to a sufficient degree of discriminant validity of our metric.

Our research findings on the level of convergent and discriminant validity of the metric are further substantiated by the multidimensional scaling analysis represented in Figures 4 and 5 (in the online supplemental). Although the results of our spatial differentiation analysis are somewhat heuristic in nature, they appear to be consistent with our assumed circumplex research model and do not contradict the quantitative results.

The main objective of Study 2 was to investigate the association between our anger construct and other emotions based on their valence and arousal levels. In doing so, we aimed to utilize the constructionist account of emotion to determine whether our anger construct is in alignment with and deviates from theoretically predefined emotions (Russell, 1980; Watson & Clark, 1994) in a theory-congruent manner (Condition 2). Based on our findings, we could infer that the data collected in our study seem to support Hypotheses 1 and 2. Thus, our study suggests that our construct should be properly aligned with other negative and highly arousing emotions while diverging from positively valenced or low arousal emotions, thus corroborating Condition 2.

Study 3

The main objective of Study 3 is to evaluate and substantiate the theoretical proposition that our hypothesized anger construct is positively linked with various types of aggression, including direct and indirect aggression (Condition 3). To achieve this objective, we plan to explore how anger, as a component of the CMESM, is interrelated with different forms of aggression, such as verbal aggression, property aggression, interpersonal aggression, guilt induction, malicious humor, and social exclusion (Forrest et al., 2005; Lazarus, 1991; Verona et al., 2008). To investigate these relationships, we intend to employ an experience sampling

procedure, acknowledging theoretically relevant within-person fluctuations and between-person differences. Our ultimate aim is to offer a comprehensive understanding of the link between our anger construct and aggression within the context of everyday life.

Method

Sample and procedure

To evaluate the association between the anger construct and aggression and to consider the natural fluctuations within and between the constructs, we conducted a time-lagged experience sampling study. This study was part of a larger research project, and additional information can be found in the data transparency appendix (in the online supplemental). The objective was to obtain a sample that could be somewhat generalized to the general (working) population, particularly in worksite contexts, given our metric's intended purpose. As a result, the participant pool was limited to native German speakers aged 18 to 67 who worked at least 35 h a week, beginning their workday between 7 am and 9 am, had frequent contact with coworkers, and were actively employed during the survey weeks. Gabriel et al. (2019) and Scherbaum and Ferrerter (2009) informed the determination of the target sample size in this study. Their results revealed a minimum Level 2 sample of 83 people and a minimum Level 1 sample of 835 person-day measurement points. Our multilevel power analysis, guided by Scherbaum & Ferrerter, supports these level-specific sample sizes.

In March 2023, we collected data for ten consecutive workdays employing a panel provider certified by ISO 20252. The study began with a baseline survey, followed by morning surveys at 11 am and afternoon surveys at 4 pm each workday. To ensure a sufficient degree of data quality (Burchett et al., 2023), we included attention checks (... please select "a little" if you're paying attention) within the baseline survey, with participants being screened out if they failed these. We did not include attention checks during the experience sampling part of our study, given the already high participant burden (Gabriel et al., 2019). Nevertheless, we also tested for response bias with a social desirability metric (Burchett et al., 2023; Stöber, 2001).¹ The research collected data from 175 people, resulting in 1,256 person-day observations, which exceeded standard sample size norms for experience sampling (Gabriel et al., 2019). Of the 175 participants, 54% were male, and their ages ranged from 24 to 67 years ($M = 44.12$, $SD = 9.97$). The weekly working hours of participants ranged from 35 to 60 h ($M = 40.00$, $SD = 3.15$).

Measures

We employed a 5-point Likert metric for cases without explicit instructions ranging from 1 (never) to 5 (always). Our item selection was based on their respective

Table 2. Anger assessment metric (AAM).

Anger Assessment Metric – State (AAM-S)	
English Items	German Items
<i>not at all – a little – moderately – very – extremely</i>	<i>gar nicht – ein bisschen – mittelmäßig – sehr – extrem</i>
Right now, ...	In diesem Moment, ...
1. ... I feel angry.	1. ... fühle ich mich wütend.
2. ... I am furious.	2. ... fühle ich mich zornig.
3. ... I am riled up.	3. ... fühle ich mich aufgebracht.
4. ... I feel mad.	4. ... fühle ich mich sauer.
Anger Assessment Metric – Trait (AAM-T)	
English Items	German Items
<i>never – rather infrequently – some of the time – quite often – always</i>	<i>nie – eher selten – manchmal – ziemlich oft – immer</i>
In general, ...	Im Allgemeinen, ...
1. ... I feel angry.	1. ... fühle ich mich wütend.
2. ... I am furious.	2. ... fühle ich mich zornig.
3. ... I am riled up.	3. ... fühle ich mich aufgebracht.
4. ... I feel mad.	4. ... fühle ich mich sauer.

¹Our hypothesized results remained consistent regardless of the inclusion of the social desirability control variable.

factor-loading matrices.² In Study 3, we measured and analyzed all 12 state and trait anger items from Study 2 using multilevel confirmatory factor analysis. This was done to confirm the 4-item structure that was identified in Study 2. Given the confirmatory results (AAM-S: $\chi^2(4) = 1.81$, $p = 0.77$, CFI = 1.00, RMSEA = 0.00, $SRMR_{within} = 0.00$, $SRMR_{between} = 0.01$; AAM-T: $\chi^2(2) = 0.52$, $p = 0.77$, CFI = 1.00, RMSEA = 0.00, $SRMR_{between} = 0.01$), only the analyses based on the 4-item structure are discussed in this study.

State anger. Our morning survey assesses state anger using the 4-item Anger Affect Metric - State submetric. An example of a state anger item is “Right now, I feel angry” ($\omega_{between} = .93$; $\omega_{within} = .94$). The response options range from 1 (not at all) to 5 (extremely).

Verbal aggression. Verbal aggression is measured in the afternoon survey by employing three items from a metric developed by Verona et al. (2008). For instance, a sample item used to gauge verbal aggression is “Today, since filling out the last questionnaire, I cursed another person out” ($\omega_{between} = .87$; $\omega_{within} = .88$).

Property aggression. In the afternoon survey, we utilize three items from a metric developed by Verona et al. (2008) to gauge property aggression. One of the items on this metric reads as follows: “Today, since filling out the last questionnaire, I damaged another person’s property” ($\omega_{between} = .91$; $\omega_{within} = .91$).

Interpersonal aggression. In the afternoon survey, we gauge interpersonal aggression using three items from a metric developed by Verona et al. (2008). An illustrative example of an item for interpersonal aggression is “Today, since filling out the last questionnaire, I hit, kicked, or pushed another person” ($\omega_{between} = .90$; $\omega_{within} = .90$).

Guilt induction. In the afternoon survey, we gauge the perpetration of guilt induction by implementing three items sourced from a metric developed by Forrest et al. (2005). An exemplar item about guilt induction is “Today, since filling out the last questionnaire, I used emotional blackmail on another person” ($\omega_{between} = .87$; $\omega_{within} = .88$).

Malicious humor. In our afternoon survey, we assess the level of malicious humor using four items from a metric developed by Forrest et al. (2005). One example item we use to measure malicious humor is, “Today, since filling out the last questionnaire, I used sarcasm to insult another person” ($\omega_{between} = .87$; $\omega_{within} = .88$).

Social exclusion. In our afternoon survey, we utilize four

items from a metric developed by Forrest et al. (2005) to measure social exclusion. One such item about social exclusion is as follows: “Today, since filling out the last questionnaire, I excluded another person from a group” ($\omega_{between} = .91$; $\omega_{within} = .92$).

Control – trait anger. There is a possibility that our sampling interval may be considered too large, leading to the argument that the morning assessment of anger is more indicative of trait-based anger instead of momentary state-based anger. We turn to state-trait theory (Steyer et al., 1999, 2015), which postulates that the “true” state-relation is the result of the difference between the relation between a trait and a state and the relation between two states. Thus, if we consider the relationship between state anger and interpersonal aggression, and account for the variance predicted by trait anger, we should arrive at the “true” state relation between state anger and interpersonal aggression. Hence, our baseline survey assesses trait anger using the 4-item Anger Affect Metric - Trait submetric. An example of a trait anger item is “In general, I feel angry” ($\omega_{between} = .81$). The response options range from 1 (never) to 5 (always).

Analytical strategy

We used R version 4.2.2 (R Core Team, 2022) for data preparation and Mplus version 8.4 (Muthén & Muthén, 2019) for data analysis. The data had a hierarchical structure with person-day observations (Level-1) nested within people (Level-2; Hayes, 2006). We used multilevel structural equation modeling to account for variability between people and person-day observations. The model included random intercepts and random slopes to capture variable effects between participants (Hamaker & Muthén, 2020). In our estimation process, we employed Bayesian inference and utilized a Gibbs sampler algorithm estimator (Depaoli, 2021), assuming data non-normality and model intractability. To capture our latent constructs and their corresponding relations in a theory-aligning manner, we employed confirmatory factor analyses. We used two Markov chains with over 24,900 iterations of the Markov-Chain-Monte-Carlo algorithm. For uncertainty assessment, we used 95% highest density intervals for the posterior distributions (Kruschke et al., 2012). We evaluated model convergence using a 1.10^3 Gelman-Rubin potential metric reduction factor and visually inspected trace and autocorrelation plots (Depaoli, 2021; Gelman et al., 2013). Our models had diffuse priors, resulting in results similar to maximum likelihood estimation (cf. Depaoli, 2021). Our analysis replicated the data diagnostic criteria used in Studies 1 and 2 and found no abnormalities.

²We removed one item from each metric measuring guilt induction, verbal aggression, property aggression, and interpersonal aggression due to inadequate model fit. Supplementary analyses confirm that the results remain consistent regardless of this change.

³We had to increase the factor from 1.02 to 1.10 to ensure consistent convergence of the models. Although this adjustment was necessary to improve accuracy, our results remained comparable.

Results and discussion

Preliminary analyses

Table 5 (in the online supplemental) presents the statistical analysis of study variables that includes means, standard deviations, interclass correlation coefficients, omega reliabilities, and correlations. The state anger submetric showed high within- and between-person reliability with high omega values. We conducted confirmatory factor analyses for the proposed factor structure, and the hypothesized model was found to be a good fit as shown in Table 6 (in the online supplemental). We conducted constrained confirmatory factor analyses to evaluate the degree of discriminant validity. The hypothesized model outperformed the constrained models.

Main analyses

Table 7 (in the online supplemental) displays the outcomes of the Bayesian multilevel structural equation modeling, presenting the direct effects. State anger was positively related with verbal aggression ($E(\gamma) = 0.33$, $E(\sigma) = 0.06$, 95% CI [0.22, 0.44], $p < .001$), property aggression ($E(\gamma) = 0.34$, $E(\sigma) = 0.03$, 95% CI [0.28, 0.40], $p < .001$), interpersonal aggression ($E(\gamma) = 0.29$, $E(\sigma) = 0.03$, 95% CI [0.24, 0.34], $p < .001$), guilt induction ($E(\gamma) = 0.37$, $E(\sigma) = 0.04$, 95% CI [0.30, 0.44], $p < .001$), malicious humor ($E(\gamma) = 0.36$, $E(\sigma) = 0.04$, 95% CI [0.29, 0.43], $p < .001$), and social exclusion ($E(\gamma) = 0.46$, $E(\sigma) = 0.05$, 95% CI [0.37, 0.54], $p < .001$).

The primary objective of Study 3 was to assess and substantiate the theoretical proposition that our anger construct is positively linked to various types of aggression, including direct and indirect aggression (Condition 3). We adopted an experience sampling procedure to examine these relationships, taking into account both within-person fluctuations and between-person differences. Based on the evidence gathered from our study, we could deduce that the data collected supports Hypotheses 3. Therefore, our study findings seem to indicate that our construct is positively related to aggression, thus corroborating Condition 3.

General discussion

This study aimed to create and validate a new state-trait anger metric using a 3-study approach. The methodology was based on the cognitive-motivational-emotive system model (CMESM; Lazarus, 1991; Smith & Lazarus, 1990), which suggests that an anger metric should meet three specific criteria: (1) it should be closely connected to a relational theme of arbitrary, reckless or malicious actions directed toward oneself or confidants, (2) it should correlate with other negative and high arousing emotions while differing from positive or low arousal emotions, and (3) it should be positively associated with aggression. These guidelines helped shape the development of the metric, which was tested in three separate studies, each corresponding to a different stage of the process. Through this iterative process, it seems that we were able to increase the validity and reliability of our new metric in various contexts, while also providing insights into different accounts of emotion theory that align with previous research.

Theoretical implications

The validation process did reveal some significant theoretical implications that warrant attention. In Study 1, as we developed items for the metric, we were surprised to find that approximately 60% of the terms commonly used by laypeople in everyday interactions did not adequately reflect the emotion of “anger.” This finding raises two important points: firstly, despite starting with a large number of anger-related words (47), the final selection of only 12 words suggests that there may be a limited number of words in the German language that truly capture the concept of anger theoretically. Secondly, the further reduction to only four items implies that there may be even fewer words that empirically reflect anger in both English and German. While this in itself may not be a significant issue, it does raise concerns about the validity and reliability of some prior metrics that include anger-related terms not supported by our data (e.g., Rohrmann et al., 2013; Spielberger, 1999; Spielberger et al., 1983). This calls into question their effectiveness in accurately measuring anger as an emotion.

However, when considering items that seem to measure anger somewhat accurately both theoretically and empirically, it appears that there is some level of cross-cultural congruence between the US and Germany regarding anger, although there seem to be some challenges. In Study 2, it is evident that there is scalar invariance in the assessment of state anger for both US and German participants, but only metric invariance for trait anger. This suggests that the experience of momentary anger is somewhat similar between English and German speakers, supporting the idea of universality of emotions across cultures as proposed by basic emotion theorists (Ekman, 1970; Ekman & Cordaro, 2011; Ekman & Friesen, 1971).

Nonetheless, the results for trait anger indicate a potential intercultural discrepancy. While this does not contradict basic-emotion theory, which focuses on states rather than traits (Russell et al., 2011), it raises questions about why such a difference could exist. Examining the invariance tests for the trait subscales, it appears there is variance in the intercepts of items #2 (... I am furious/... fühle ich mich zornig) and #3 (... I am riled up/... fühle ich mich aufgebracht). This suggests that the baseline levels of furious and riled up may differ between English and German speakers, or that there is a semantic distinction between expressions like “I am” and “I feel” in English compared to their German counterpart of “Ich fühle mich.” It may be beneficial to consider using “Ich bin” in German as a closer equivalent to “I am” in English for some trait items to improve cross-cultural congruence.

Delving deeper into Study 2, we observe that the assumed relationship between our anger construct and the emotions of hostility, joviality, serenity, and sadness appears to be appropriate based on heuristic analysis. This suggests that the idea that emotions can be constructed from a blend of valence and activation is supported to some extent by our findings. While we cannot definitively say that the x- and y-scales of Figures 4 and 5 (in the online supplemental) align precisely with valence and arousal (Castelfranchi &

Miceli, 2009; Frijda, 2009), as our objective was to capture the broader concept of emotions rather than their specific components, the visual representation, in line with our initial assumptions and hypotheses, lends some credence to the constructivist perspective (Russell, 1980; Watson et al., 1988). However, it is important to consider alternate theoretical perspectives, which suggest that the two components represented in our diagram could also reflect the merging of valence and action readiness (Frijda, 1987), appraisal and arousal (Moors et al., 2013), or a combination of these factors (Dewey, 1894; James, 1884; Reizenzein & Stephan, 2013).

Moving on to Study 3, we delve into three potential theoretical implications stemming from our research findings. The first implication seems to be that anger appears to be equally strongly related to both direct and indirect forms of aggression, as well as to each specific type of aggression within these categories. This suggests that anger is broadly associated with various types of aggression in work settings to a similar extent. This finding is somewhat surprising, as one might expect the organizational environment to serve as a buffer between anger and aggression (Diefendorff et al., 2011; Domagalski & Steelman, 2007; Moran et al., 2013), particularly in promoting indirect forms of aggression over direct forms (Duffy et al., 2002, 2006; Hershcovis, 2011).

The one notable exception seems to be that anger shows a stronger positive relationship with social exclusion compared to interpersonal aggression. This discrepancy could be explained by the idea that these two forms of aggression exist at opposite ends of a plausible deniability spectrum (Cormac & Aldrich, 2018; Pinker et al., 2008; Poznansky, 2022). Interpersonal aggression is overt and easily observable (Bryant & Smith, 2001; Buss & Perry, 1992), while social exclusion is more covert and could be denied more easily (Forrest et al., 2005). Employees might be more inclined to engage in social exclusion as a way to manage anger in the workplace because this could allow for greater face-saving opportunities compared to interpersonal aggression (Brown & Garland, 1971; Carson & Cupach, 2000; Pattison, 2014). While our data support this line of reasoning to some extent, further research is needed to confirm these conclusions.

Moving on to the second implication, the between-person and within-person variabilities appear to be evenly matched, as indicated by all intra-correlation coefficients hovering around 50%. This suggests that around half of the variance in the occurrence of anger and various forms of aggression, whether direct or indirect, is related to personal traits, while the other half is related to interactions within specific situations. While this balance may not be surprising given past nature-nurture debates (Angoff, 1988; Botero, 2012; Mason & Capitanio, 2012), it underscores the significant role that people's perceptions of day-to-day interactions play in shaping their experiences of anger and aggression, on par with their inherent traits. As such, the results of our study also align with the general model of human aggression, which suggests that aggression is related equally to both personal characteristics and situational factors (Anderson & Bushman, 2002).

Concluding our investigation with the third implication, our findings suggest a positive relationship between trait anger and daily perpetration of aggression. However, it should be noted that not all relations between trait anger and aggression constructs appear to be significant, particularly when considering the influence of state anger. Specifically, when taking state anger into account, trait anger only shows a positive relationship with verbal aggression and malicious humor. This raises questions about the nature of the relationship between trait anger and different forms of aggression and underscores the need for further theorizing and empirical research to understand why trait anger specifically relates to verbal aggression and malicious humor.⁴

Upon closer examination, it appears that both verbal aggression and malicious humor involve the sole expression of aggression through speech (Forrest et al., 2005; Verona et al., 2008), rather than other means of aggression. This may suggest that trait anger may be uniquely linked to the likelihood of engaging in speech-mediated aggression. However, this hypothesis requires further investigation and empirical validation, as current research and conceptual models have not tested this line of reasoning.

Practical implications

Our study's findings suggest that anger is a highly individualized emotional response among employees and can vary significantly from day to day. Managers should be attentive to potential correlates for anger, which often involve perceptions of unfair treatment or malicious behavior directed toward oneself or others (i.e., its relational theme; Lazarus, 1991; Smith & Lazarus, 1990). It may be important for leaders to promote a work culture that encourages respectful communication and relationships between employees (Carmeli et al., 2015; Gerpott et al., 2020; van Quaquebeke & Eckloff, 2010). Failing to do so may lead to increased instances of aggression, which is likely to have negative consequences (Geddes & Callister, 2007; Hershcovis et al., 2007; Hershcovis & Barling, 2010). To address this issue, leaders could use our research metric to gauge the levels of anger among their team members and implement interventions, such as anger-management training (Lochman et al., 2004; Morland et al., 2021; Schat & Kelloway, 2006), to help mitigate the potential for anger-related aggression.

Limitations and future research directions

To ensure accurate interpretation of the results, it is crucial to acknowledge the limitations of our research. One of the limitations we encountered was the possibility of common method bias, which was introduced by self-report measures

⁴It may be important to consider that our focus has shifted from examining the overall occurrence of various aggression constructs to exploring the specific relationship between trait anger and some aggression constructs. The lack of significant relationships between trait anger and other forms of aggression should thus not invalidate our previous implications regarding the variance distribution between person- and situation-level constructs.

(Doty & Glick, 1998). To address this concern, we implemented randomization in Study 2, and collected predictor and outcome variables at different times in Study 3 (Podsakoff et al., 2003). However, it would be beneficial for future research to incorporate additional perspectives such as other-report or dyadic data. Therefore, it would be useful to gather input from acquaintances, relatives, colleagues, and supervisors regarding the focal individual's conduct with the assistance of our metric.

When considering the results of Study 2 as a whole, it becomes clear that the correlations with our criterion variables provide more support for convergent validity than for discriminant validity. Despite conducting two additional tests to assess discriminant validity, namely the model comparison test and heuristic multidimensional scaling analysis, the high correlations observed suggest some overlap of our constructs (Campbell & Fiske, 1959; Hinkin, 1998).

It is imperative to note that our findings from Study 3 should not be taken as evidence for causality (Doty & Glick, 1998). Although our objective was not directly to assess causality, but rather to examine the relationship between anger and aggression, the use of time-lagged sampling and the structural equation modeling methodology may imply a certain degree of assumed causality. It seems plausible that the direction of the assumed relations could be reversed, implying that aggression could have also led to feeling angry. As such, alternative explanations that may have contributed to the observed relations cannot be ruled out. To address this concern, it is advisable to control for the previous measurement point for each aggressive subcategory in future studies. Additionally, conducting experimental studies could provide valuable insights into testing causal assumptions. An experimental study that manipulates the experience of anger could help determine whether the emotion uniquely leads to increased levels of direct and indirect aggression. An ethical evaluation is required to ensure that participants do not experience any harm.

Our study implemented a time-based sampling strategy, which has limitations. The sampling intervals we used could be considered quite large, which means that we may have overlooked event-based variance due to fixed sampling intervals (Trull & Ebner-Priemer, 2009). To mitigate this potential bias, we accounted for trait anger while estimating the relations between anger and aggression subtypes. However, we suggest that future research may consider introducing random survey prompts during a predetermined time window throughout a day to overcome the limitations of our current sampling strategy.

Another potential limitation of Study 3 could be the presence of a floor effect. Specifically, a significant portion of participants reported various forms of aggression at relatively low frequencies (range from 9.06% to 28.57%). Verbal aggression was reported by 26.98% of participants in 20.21% of cases, property aggression by 15.07% in 10.20% of cases, interpersonal aggression by 11.11% in 9.06% of cases, guilt induction by 28.57% in 16.40% of cases, malicious humor by 29.37% in 20.31% of cases, and social exclusion by 25.40% in 18.30% of cases. While these percentages suggest that the occurrence of aggression was relatively low, ranging from

one to five percent, which aligns with established psychological theories (Archer, 2004; Lazarus, 1991; Smith & Lazarus, 1990), it is possible that this skewed distribution may have influenced the statistical outcomes of our analyses. To address this potential limitation, it is recommended that future studies replicate our research in populations known to have a high predisposition toward aggression. If similar findings are obtained, it would enhance the credibility of our results. Alternatively, if the results diverge significantly, it may be necessary to explore other factors like individual aggression tendencies (Buss & Perry, 1992) to better understand the nature of aggressive behavior within daily life.

Furthermore, we missed the opportunity in Study 3 to distinguish between the different sources and targets of anger experiences, such as organizational members, non-organizational members, or unidentifiable entities. While this oversight should not discredit our findings, future research could be enhanced by including these measures to determine if the connections between anger and aggression differ depending on the sources and targets of anger experiences, as might be suggested by the CMESM (Lazarus, 1991; Smith & Lazarus, 1990).

In our study, we did not collect information on the racial or ethnic backgrounds of participants across any of our samples, which has limited our ability to assess possible race/ethnicity group differences. Past research has shown that variations in racial and ethnic groups can have a significant impact on the outcomes of studies (Mabry & Kiecolt, 2005; Mauss et al., 2010), and incorporating this information into future research projects may provide a more comprehensive understanding of anger. Therefore, we suggest that future studies consider including these variables to better account for possible between-person differences.

Finally, in our studies, we exclusively used the newly proposed anger scale and did not compare it with any other existing anger scales. This lack of comparison raises questions about the quantitative degree of incremental validity our scale may offer over others. Demonstrating incremental validity is an important step in validating a new scale (Haynes & Lench, 2003; Hunsley & Meyer, 2003). Therefore, future research should consider conducting comparative studies to assess our scale against existing ones in terms of internal consistency, model fit, parsimony, and predictive validity. It could be beneficial for future research to adopt methodologies similar to those employed by Barger (2002) and adhere to the guidelines outlined by Hunsley and Meyer (2003) and Haynes and Lench (2003) when conducting these comparative assessments.

Future researchers could further enhance the results of our study by addressing these limitations. In addition, delving deeper into unanswered questions, such as experimenting with different compositions in circumplex models, examining how the work environment influences the connection between anger and aggression, and investigating the distinctive link between trait anger and speech-mediated aggression, could lead to a more comprehensive understanding of these crucial topics. Another intriguing aspect that has not been previously mentioned in the manuscript is the subjective experience of anger by a person, including how

anger is appraised by the person themselves. This topic has been explored in prior research (Harmon-Jones et al., 2011; Howard, 2017) and could provide valuable insights into the multifaceted emotion anger. Further studies in these areas have the potential to shed more light on anger and its relationship with aggression in everyday situations.

Conclusion

In conclusion, our endeavor to develop an anger metric has been a journey filled with both insights and obstacles. By integrating theories of emotion, we hope to have added valuable insights to the current understanding of anger and its relationship to behavior. While our efforts mark only the initial stages of this project, we are hopeful to witness the widespread adoption of our metric in key situations where knowledge of anger is essential. We approach this task with humility, appreciative of the chance to make a modest yet potentially meaningful impact on the study of emotions.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Open scholarship



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ORCID

Robin Umbra  <http://orcid.org/0000-0003-1419-6633>

Ulrike Fasbender  <http://orcid.org/0000-0001-6711-5732>

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