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We've got a situation here! – How situation-perception dimensions and appraisal dimensions of emotion overlap

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ABSTRACT

Recently, situation researchers have developed taxonomies of situation-perception dimensions, also called situation characteristics. Situation-perception dimensions reflect how individuals psychologically interpret situations and predict subsequent behaviour. Similarly, in appraisal theories of emotion, appraisal dimensions have helped to understand how individuals evaluate situations according to their goals, and how these evaluations lead to emotions and subsequent behaviours. Surprisingly, thus far these two lines of research have hardly been linked. To reduce potential jangle fallacies, we examine the conceptual and empirical correspondence between situation perception and appraisal in daily-life situations (Study 1) and in emotional situations (Study 2). In each study, 550 UK participants recalled a recently experienced situation and rated the situation on ten situation-perception dimensions and on ten appraisal dimensions. The findings reveal overlap between situation perception and appraisal in five higher-order dimensions: Valence, Task-related effort, Familiarity, Negative interaction, and Positive interaction. Additionally, situation perception and appraisal overlap in predicting experienced emotions. Together, these findings suggest that there is considerable overlap between situation perception and appraisal, and that it may be worthwhile to link these two research fields.

1. Introduction

In recent years, situation research has generated many new insights into how aspects of situations and people interact to together determine human behaviour. This stream of literature has revealed that especially people's perceptions of situations, together with people's characteristics, influence their behaviour (Bedford-Petersen & Saucier, 2021; Funder, 2016; Mischel & Shoda, 1995; Parrigon et al., 2017; Sherman et al., 2015; Ziegler et al., 2019). Situation perceptions, also called psychological perceptions of situations (Horstmann & Ziegler, 2019) or psychological situation characteristics (Rauthmann et al., 2020), reflect how people interpret the combination of multiple objective features of the physical environment (i.e., situation cues; Funder, 2016; Horstmann & Ziegler, 2019). Recently, multiple researchers have identified the most relevant psychological aspects that people consider when interpreting a situation, and have developed taxonomies that reflect these relevant situation-perception dimensions (e.g., Parrigon et al., 2017; Rauthmann et al., 2014). The various existing taxonomies of situation perception seem to mostly converge on the contents of these situation-

perception dimensions (Rauthmann et al., 2020).

Interestingly, research on how people interpret situations also features within emotion research, investigating how interpretations of situations may evoke different emotions in different people (Frijda, 1987; Lazarus, 1991; Roseman, 1984; Scherer, 1982; Smith & Ellsworth, 1985). Appraisal theories of emotion describe how people interpret situations that are relevant to their goals or well-being based on a limited set of appraisal dimensions (Frijda, 1987; Moors et al., 2013; Roseman, 1984; Scherer, 1999; Smith & Ellsworth, 1985). The unique combinations of these appraisal dimensions then generate specific emotions, which, in turn, have been shown to predict many different behaviours in a large variety of situations (Angie et al., 2011).

Both situation-perception theories and appraisal theories of emotion focus on how people psychologically interpret (objective) situations. Multiple authors have suggested that situation-perception theories and appraisal theories of emotion may conceptually show some overlap, and have argued that research is necessary to conceptually and empirically examine the correspondence between these theories (Chung et al., 2021; Horstmann et al., 2020; Saucier, 2020). Yet, to the best of our

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knowledge, no research has investigated the conceptual and empirical correspondence between situation perceptions and appraisals.

The current research aims to reveal to what extent situation-perception dimensions and appraisal dimensions correspond. We compare the dimensions on both a theoretical and empirical level and examine their similarities and differences. We thereby focus on the most prominent existing taxonomies of situation perception and of appraisal. Moreover, on an empirical level the current research investigates the shared variance of situation-perception dimensions and appraisal dimensions for both daily-life and emotional situations, and their relevance in predicting experienced emotions. Together, these findings provide novel insights into both situation research and emotion research, and contribute to our understanding of how situations and personality interact in influencing behaviour.

1.1. Defining situation perception and appraisal

Situations are commonly defined as a set of momentary circumstances (Rauthmann et al., 2020) that people perceive subjectively (Funder, 2016), and that have the potential to activate a set of goal-directed behaviours (Funder, 2016; Mischel & Shoda, 1995; Rauthmann et al., 2014; Saucier, 2020; Yang et al., 2009). Most situation research has focused on situation perception, understood as the psychological interpretation of situation cues (Horstmann & Ziegler, 2019; Parrigon et al., 2017; Rauthmann et al., 2014; Yang et al., 2009). People interpret situation cues depending on their past experiences, personality traits (Funder, 2016; Mischel & Shoda, 1995), current affect (Edwards & Templeton, 2005; Horstmann & Ziegler, 2019) and goals (Edwards & Templeton, 2005; Yang et al., 2009). Situation perceptions subsequently influence people's motivations (Rauthmann, 2016), and behaviours (Bedford-Petersen & Saucier, 2021; Funder, 2016; Parrigon et al., 2017; Sherman et al., 2015; Ziegler et al., 2019).

Various taxonomies of situation perception have been developed, such as DIAMONDS (Rauthmann et al., 2014), CAPTION (Parrigon et al., 2017) and the Situation Five (Ziegler et al., 2019). These taxonomies seem to converge on the most common dimensions (Rauthmann et al., 2020). An integration of the two most often used taxonomies (i.e., the DIAMONDS; Rauthmann et al., 2014 and the CAPTION; Parrigon et al., 2017) has shown that there are in general seven situation-perception dimensions: *Tasks*, *Processing*, *Threat*, *Fun*, *Stress*, *Social-positive* and *Typicality* (Rauthmann et al., 2020). For a comprehensive overview of all situation-perception dimensions, Rauthmann et al. (2020) suggested to also include the dimensions of *Deception*, *Humor*, and *Mating*. We will focus on these ten situation-perception dimensions (Table 1).

When constructs are relatively new, such as the dimensions of situation perception, it is imperative to examine their connection to similar theoretical constructs (Kelley, 1927). Not connecting a new construct to similar constructs could introduce jangle fallacies (Kelley, 1927), which refer to the use of distinct terms for constructs that, in reality, are similar. Jangle fallacies can generate confusion about whether multiple constructs are distinct (Roeser et al., 2006), and can make research fields untransparent (Rauthmann et al., 2020). In the case of situation perception, we argue that jangle fallacies may exist between dimensions of situation perception and appraisal. Appraisal theories of emotion describe how people evaluate emotion-eliciting situations in relation to their goals or well-being (Frijda, 1987; Moors et al., 2013; Roseman, 1984; Scherer, 1999; Smith & Ellsworth, 1985). The combination of appraisal dimensions determines which emotion is felt, and the emotion then influences behaviour. Appraisal theories of emotion have been developed to organize and understand (the causes of) emotions. At the same time, these appraisals focus on how people interpret situations in the context of emotions.

Multiple appraisal theorists have established different taxonomies of appraisal dimensions (Frijda et al., 1989; Roseman et al., 1996; Scherer, 1999; Smith & Ellsworth, 1985). Appraisal theorists generally agree upon the appraisal dimensions of 1) Goal-relevance, 2) Goal-

Table 1
Description of ten situation-perception dimensions.

Overarching dimension	Measurement tool	Description
Tasks	DIAMONDS - Duty	Situation signals urgent actions are needed. There is more agency regarding the future event for the actor (as opposed to threat and stress)
Processing	DIAMONDS - Intellect	Situation requires some sort of deeper thinking (complex, difficult situations)
Threat	DIAMONDS - Adversity	Situation contains external threats, dangers, problems, and obstacles, some of which may be interpersonal in nature (e. g., mistrust, conflict)
Mating	DIAMONDS - Mating	Situation is conducive to sex, romance, and love
Fun	DIAMONDS - pOsitivity	Situation contains pleasant and fun events
Stress	DIAMONDS - Negativity	Situation contains dealing with (internal) negative events that may cause distress
Deception	DIAMONDS - Deception	Situation indicates a chance to be deceived or issues of mistrust
Social-positive	DIAMONDS - Sociality	Situation contains social interactions and relationships that are often pleasant
Typicality	CAPTION - Typicality	Situation is familiar or typical and has recurred in people's daily lives before
Humor	CAPTION - humOr	Situation is humorous or light-hearted (of both positive and negative valence)

We included dimensions from the DIAMONDS (Rauthmann et al., 2014) and the CAPTION (Parrigon et al., 2017) taxonomies.

congruence, 3) Pleasantness, 4) Fairness, 5) Novelty (or Unexpectedness), 6) Certainty, 7) Self-agency, 8) Other-agency, 9) Circumstance-agency, and 10) Coping-potential (which can consist of Power, Control, Emotion-focused Coping-potential, and Anticipated effort; Frijda et al., 1989; Roseman et al., 1996; Smith & Ellsworth, 1985).¹ In our research, we will focus on these 10 appraisal dimensions (Table 2).

When comparing the definitions of situation perception and of

Table 2
Description of ten appraisal dimensions.

Appraisal dimension	Description
Goal-relevance	The situation is important for people's goals
Goal-congruence	The situation fosters (hinders) people's goal(s)
Pleasantness	The situation is experienced as pleasant
Fairness	The situation (negative or positive) feels deserved
Novelty	The situation feels sudden, or novel compared to other situations
Certainty	The outcome of the situation is certain or predictable
Self-agency	People experience being the cause of the situation
Other-agency	People experience other people have caused the situation
Circumstance-agency	People experience circumstance has caused the situation
Coping-potential, which consists of	
Power	People experience power to influence the situation
Control	People experience control over the outcome of the situation
Emotion-focused Coping-potential	People experience they can regulate their emotional state via internal restructuring
Anticipated effort	People have to expend effort (physically or mentally)

We included all appraisal dimensions according to key appraisal theories of emotion (Frijda et al., 1989; Roseman et al., 1996; Scherer, 1999; Smith & Ellsworth, 1985).

¹ Different authors use different labels for similar appraisal dimensions. For reviews see (Moors et al., 2013; Schorr, 2001).

appraisal, the two seem similar, or at the least very related. Indeed, multiple authors have noted this conceptual similarity between situation perception and appraisal (Edwards & Templeton, 2005; Horstmann et al., 2020; Horstmann & Ziegler, 2019). Saucier even suggested that “appraisal theorists are, in a sense, situation-theorists of emotions” (2020, p. 16). In both streams of research, scholars interchangeably use the terms *perception* (Horstmann & Ziegler, 2019; Roseman et al., 1996), *construal* (Funder, 2016; Lazarus, 1991), *appraisal* (Edwards & Templeton, 2005; Frijda et al., 1989), *evaluation* (Parrigon et al., 2017; Scherer, 1999), and *interpretation* (Rauthmann et al., 2014; Smith & Ellsworth, 1985) of situations, thereby all referring to the process of how people interpret/appraise/evaluate situations. Also, the few existing studies on situation perception and emotions have found that situation-perception dimensions can relate to positive and negative affect (Horstmann et al., 2020; Horstmann & Ziegler, 2019; Parrigon et al., 2017), to experienced happiness (Sherman et al., 2015), and to other emotions (Chung et al., 2021). Thus, it might be possible that situation perception and appraisal are similar, and that there is overlap between their dimensions.

On the other hand, there are reasons to suggest that situation perception and appraisal may differ. The two sets of taxonomies have been developed with different research objectives. Situation-perception theories aim to understand how people differentially perceive and seek out situations in their daily life based on their previous knowledge, personality, current goals, and on their current affect. Appraisal theories of emotion, on the other hand, aim to understand how interpretations of situations generate affect or emotions. Consequently, taxonomies of situation perceptions have been developed by investigating how people interpret daily-life situations, whereas taxonomies of appraisals have been developed by investigating how people interpret (intense) emotional situations. These differences may have led to different understandings of how people interpret situations, and subsequently to qualitatively different taxonomies. This raises the question to what extent the dimensions of situation perception and of appraisal are similar or different.

1.2. Relations between situation-perception and appraisal dimensions

On a theoretical level, it is possible to deduce multiple similarities between the different dimensions of situation perception and appraisal. First, the situation-perception dimensions of Positivity, Negativity, Adversity and Deception seem to relate to the appraisal dimensions of Goal-congruence and Pleasantness. In all cases, the dimensions concern how positively or negatively a situation is perceived. In addition to valence, Negativity can be related to the appraisal of Coping-potential. Negativity indicates the experience of internally stressful situations that require coping (Lazarus, 1991), and has been empirically associated with experiencing emotions of low Coping-potential (e.g., fear and sadness; Chung et al., 2021).

Second, the situation-perception dimensions of Mating, Sociality, Adversity and Deception can be associated with the appraisal of Other-agency. Mating reflects to what extent a situation is charged sexually or romantically (Rauthmann et al., 2014). Sociality represents whether a situation allows people to pleasantly interact with others and to achieve social-affiliative goals (Rauthmann et al., 2014). Both Mating and Sociality thus indicate interpersonal situations and the presence of others in a situation (Saucier, 2020), and are negatively related to being alone (Rauthmann et al., 2014). Adversity represents threatening situations or interpersonal conflict with others (e.g., being blamed; Rauthmann et al., 2014). Deception reflects to what extent people perceive that others have deceived them in a situation. Both Adversity and Deception are negatively related to being alone (Rauthmann et al., 2014). Thus, all four situation-perception dimensions indicate the presence of

interpersonal situations that are brought about by other people. Similarly, the appraisal of Other-agency reflects to what extent other people caused or were responsible for a situation (Frijda et al., 1989; Roseman et al., 1996).

Third, the situation-perception dimension of Duty can be associated with the appraisals of Goal-relevance and of Anticipated effort (sub-dimension of the appraisal of Coping-potential). Duty - or Importance in the CAPTION taxonomy (Parrigon et al., 2017) - reflects the extent to which a situation affords people to achieve certain important tasks through goal-oriented action and is often related to work situations (Rauthmann et al., 2014). It embodies an orientation towards the future (Rauthmann et al., 2020) and has been linked to Goal-relevance (Parrigon et al., 2017). The appraisal of Goal-relevance indicates to what extent a situation is important for people's goals or concerns (Smith & Ellsworth, 1985). The appraisal of Anticipated effort reflects to what extent people feel that they have to do something in a situation and relates to their level of activation (Smith & Ellsworth, 1985). Thus, the situation-perception dimension of Duty seems to relate to the appraisals of Anticipated effort and of Goal-relevance in that people anticipate to achieve important goals through future action.

Fourth, the situation-perception dimension of Intellect may relate to the appraisals of Certainty and of Anticipated effort (subcomponent of Coping-potential). Intellect refers to perceiving complex situations that require deeper thinking. These intellectually engaging situations are likely to elicit discovery or deprivation motives resulting in a state of curiosity and information seeking behaviour (Jach et al., 2021). Interestingly, an appraisal of Uncertainty, the extent to which people feel they do not clearly understand what is happening and what will happen in a situation, can also result in deprivation motives, experienced curiosity, and exploration/information search behaviour (Noordewier & van Dijk, 2020). Therefore, Intellect and Certainty may play similar roles in the process of generating discovery and deprivation motives and subsequent curiosity. Moreover, seeking and understanding information (e.g., when feeling curious) are two important types of expending cognitive effort (Niebaum et al., 2022). Cognitive effort, together with physical effort, is part of the appraisal of Anticipated effort - whether people feel they have to do something (Smith & Ellsworth, 1985). Therefore, Intellect may be related to Certainty (negatively) and to Anticipated effort.

Finally, the situation-perception dimension of Typicality seems to be negatively related to the appraisal of Novelty. Typicality reflects to what extent a situation is perceived as common and straightforward (Parrigon et al., 2017). In emotion research, the appraisal of Novelty has been categorized as appraisals of unusualness/unexpectedness (Roseman et al., 1996; Scherer, 1982) or (un)familiarity (Frijda et al., 1989). Both Typicality and Novelty thus indicate the relative (in)frequent occurrence of a situation compared to previously experienced situations.

In summary, on a theoretical level there seems to be overlap between multiple situation-perception dimensions and multiple appraisal dimensions. The current research will empirically examine to what extent such an overlap indeed occurs. Since both situation perception and appraisal have been linked to experienced affect or emotion, we will also examine whether and how situation-perception and appraisal dimensions differ in predicting experienced emotions. In two studies, participants were asked to recall a situation and to rate the situation based on situation-perception dimensions and on appraisal dimensions. As situation perception has been developed by investigating people's interpretation of naturally occurring daily-life situations and appraisal dimensions by investigating people's interpretation of emotional situations, we will study both naturally occurring daily-life situations (Study 1) and emotion-causing situations (Study 2). The research questions, study design, power-analysis, exclusion criteria and analyses of both

studies were pre-registered on the Open Science Framework at <https://osf.io/2kq5/registrations>. All materials and methods matched the preregistration unless indicated otherwise.²

2. Method

2.1. Participants

In both studies 1 and 2, 550 participants were recruited through convenience sampling on the online-survey platform Prolific Academic. Participants were rewarded £2.00 for their participation. Participants were eligible for both studies when speaking English, living in the United Kingdom, and having an approval rate above 90% on Prolific Academic. Participants from study 1 could not take part in study 2. A power analysis indicated a required sample size of 475 to detect effects in the factor-structure of each taxonomy individually (i.e., 10 latent and 40 (39) observed variables for situation perception (appraisal), effect-size = 0.2, $1-\beta = .8$, $\alpha = .05$).

In study 1, 553 participants took part in an online study on Prolific Academic about the perceptions of daily-life situations. 553 out of the 625 participants who started the study completed the study (88%). Every day of one calendar week, an equal number of participants completed the study, resulting in a total sample of 553 participants. Participants were excluded from the analyses when they failed a directed query attention-check. In total 2.7% of the participants was excluded, resulting in a final sample-size of 542 participants ($M_{age} = 38.1$, $SD_{age} = 12.5$, 60.5% female).

In study 2, 552 participants took part in an online study on Prolific Academic about the perceptions of emotional situations. 552 out of 655 participants (84%) completed the study. Participants were excluded from the analyses when they failed one of two directed query attention-checks. In total 0.36% of participants was excluded, resulting in a sample-size of 550 participants ($M_{age} = 39.8$, $SD_{age} = 13.1$, 63.6% female).

2.2. Procedure

In study 1, after signing an informed consent, participants were asked to recall a situation they had experienced the day before during a randomly-assigned two-hour timeslot (8 a.m.–10 a.m., 12 p.m.–2 p.m., 4–6 p.m. or 8–10 p.m.). Following situation research, we included different times and different days of the week to produce a diverse range of naturally occurring situations (Parrigon et al., 2017; Rauthmann et al., 2014). Participants were provided a definition of a situation as “a combination of a time, place, other people around, a specific activity you perform, and feelings you feel”. Participants were instructed to remember the situation as vividly as possible and to describe the situation shortly in terms of their location (where?), interaction partners (who?), and activities of both self and interaction partners (what?; for full instructions see supplementary materials). Participants then rated to what extent they had experienced 20 emotions in that situation on a 7-point Likert scale (1 = “not at all”, 7 = “very strongly”). They next rated the described situation on 10 situation-perception and 10 appraisal dimensions. The presentation order of the scales and of dimensions within each scale was counterbalanced across participants.

The procedure of study 2 was almost identical to that of study 1. This time, however, participants recalled a recently experienced situation in which they felt a strong emotion. Such autobiographical recall

procedures have been used widely in emotion research (de Hooge et al., 2008; Siedlecka & Denson, 2019). Participants recalled a situation in which they experienced strong emotions (positive or negative) and wrote about what happened in this situation (full instruction in supplementary materials). Similar to study 1, participants described the emotional situation shortly in terms of their location (where?), interaction partners (who?), and activities of both self and interaction partners (what?).

2.3. Measures

2.3.1. Situation-perception dimensions

Ten dimensions of situation perception from Rauthmann et al.'s (2020) overview were measured with the eight dimensions from the DIAMONDS taxonomy (Duty, Intellect, Adversity, Mating, Positivity, Negativity, Deception, Sociality; Rauthmann et al., 2014) and two dimensions from the CAPTION short form taxonomy (Typicality and Humor; Parrigon et al., 2017; Table 1). For each DIAMONDS dimension, participants rated four items (e.g., “A job needs to be done”). For the two CAPTION dimensions, participants rated four adjectives (e.g., “regular”). As recommended (Rauthmann et al., 2014), all situation-perception dimensions were measured on 7-point Likert-scales (1 = “does not describe the situation at all”, 7 = “totally describes the situation”; supplementary table 1).

All scale-development analyses were conducted on the data of Study 1 (daily-life situations). The factor structure of situation-perception dimensions replicated previous research with good fit and all dimensions showed good internal consistency. Confirmatory Factor Analysis with the Lavaan package 0.6–9 (Rosseel, 2012) in R (R Core Team, 2020) and Robust Maximum Likelihood estimation, showed a fairly good fit of the 10-factor model; RMSEA = .060, SRMR = .070, CFI = .92, IFI = .92 (supplementary figures 1 and 3). All situation-perception dimensions showed good internal consistency ($.72 < \alpha_{mean} > .97$, supplementary table 5).

2.3.2. Appraisal dimensions

The 10 appraisal dimensions were developed based on four appraisal theories of emotion (Frijda et al., 1989; Roseman et al., 1996; Scherer, 1999; Smith & Ellsworth, 1985; supplementary table 2). We combined the items from these four key appraisal theories of emotion, and incorporated all qualitatively different items for each appraisal dimension. Consequently, the number of items per dimension differed across appraisal dimensions. All items were rephrased such that participants rated whether a statement described the situation they were in (e.g., “I had control over the situation”) on a 7-point Likert-scale (1 = “does not describe the situation at all”, 7 = “totally describes the situation”).

Since the measure of appraisal dimensions integrated multiple existing measures, we first validated this measure (supplementary results). Based on a Principal Component Analysis with orthogonal rotation (Varimax), we removed 10 out of 39 items: all three items of the Fairness dimension cross-loaded on multiple factors, and seven items of this nine-factor solution loaded poorly (factor-loading < 0.50) on their focal factor (relevance_1, novelty_3, novelty_5, certainty_3, certainty_4, coping_3, coping_7; supplementary tables 3 and 4). The resulting nine factors Valence, Novelty, Coping-potential, Anticipated effort, Other-agency, Certainty, Goal-relevance, Circumstance-agency, and Self-agency together explained 67% of the total variance. Although Pleasantness and Goal-congruence loaded together on one Valence factor, they represented separate factors in further analyses because of their individual theoretical contributions. This factor structure differed from the hypothesized structure in two ways. First, the Fairness factor was deleted, and second, Anticipated effort, as a subdimension of Coping-potential, was added as a separate factor. This resulted in a factor solution with 10 appraisal dimensions. Confirmatory Factor Analysis with Robust Maximum likelihood estimation showed that this 10-factor model fitted fairly well; χ^2/df ratio (369) = 942.1, $p < .001$; RMSEA

² Diverging from our pre-registration for study 1, we used Generalized Procrustes Analysis instead of Canonical correlation to examine the joint-factor structure of situation-perception and appraisal dimensions. We only excluded participants failing the first attention-check (directed query) and not the second, because this logical statement appeared, in hindsight, to be interpretable in multiple ways.

= .067, SRMR = .075, CFI = .92, IFI = .92 (supplementary figures 2 and 4). All appraisal dimensions, except for goal-relevance, showed decent-to-good reliability (supplementary table 5). The Goal-relevance appraisal showed lower split-half reliability ($r_{SB} = .57, p < .001$) because it consisted of two items. Thus, we continued with a factor solution of 10 appraisal dimensions.

2.3.3. Emotions

Ten positive and 10 negative emotions were selected based on the existing emotion literature, in which appraisal theories of emotion have been used to study specific emotions (Frijda et al., 1989; Roseman et al., 1996; Scherer, 1999; Smith & Ellsworth, 1985). The selected emotions reflected diverse combinations of the appraisal dimensions of Goal-congruence/Pleasantness, Agency, Coping-potential, Certainty, Novelty and Anticipated effort. Furthermore, these selected emotions are widely studied and have clear idiosyncratic patterns of appraisal and action-tendencies (Frijda et al., 1989). The following 10 negative emotions were measured (presented here in alphabetical order): Anger, Dislike, Disappointment, Frustration, Fear, Jealousy, Sadness, Shame, Guilt and Regret. Moreover, we measured the 10 positive emotions Challenge, Excitement, Gratitude, Hope, Joy, Love, Pride, Relief, Satisfaction and Surprise.

2.4. Data-analysis

Generalized Procrustes analysis (GPA) from the FactoMineR package (Lê et al., 2008) explored the number of higher-order factors that were shared between situation-perception dimensions and appraisal dimensions in a consensus-space, equally weighing each taxonomy. This consensus-space was derived from rotating and scaling the composite scores of the 10 dimensions from both taxonomies. The consensus matrix of factor-loadings was then Varimax rotated to achieve interpretable simple structure (Kiers, 1997; Steenkamp et al., 1994). Higher-order dimensions were selected based on the percentage of consensus variance they explained. The label of each selected higher-order factor was identified from the lower-level dimensions that had factor-loadings > 0.50 on the higher-order factor (Dijkstra & Punter, 1990). Hereby, Generalized Procrustes Analysis allowed to identify which dimensions were shared between the two taxonomies in a consensus space and which dimensions were not shared.

To test whether and how situation perception and appraisal differed in predicting experienced emotions, multiple regression analyses on the merged dataset of studies 1 and 2 explored how well each experienced emotion was predicted by a model of situation-perception or a model of appraisal dimensions. An F-test then compared to what extent the predictive power (R^2 values of experienced emotions) differed between the situation-perception and appraisal models.³

3. Results and discussion

3.1. Results study 1 - overlap between situation perception and appraisal in daily-life situations

In study 1, participants appeared more prone to recall positive daily-life situations than negative daily-life situations (see descriptive statistics of Negativity, Positivity, Goal-congruence and Pleasantness in supplementary table 5). The 'negative' dimensions of Negativity, Adversity, and Deception showed lower medians compared to the other dimensions, and the 'positive' situation-perception dimension of Positivity and the appraisal dimensions of Pleasantness and Goal-congruence showed relatively higher medians. The situation-perception dimensions of Deception, Adversity and Humor, and the appraisal of Certainty were skewed in study 1 (supplementary table 5). A 10-

dimensional consensus space explained 76% of variance between the two factor structures of situation perception and appraisal. Four higher-order dimensions (Table 3) explained 60% of this total variance (a minimum percentage in factor-analysis; Hair et al., 2010; p. 109). Each of these four higher-order dimensions was a combination of at least one situation-perception and one appraisal dimension. These four dimensions together covered 10 lower-level dimensions of situation perception and of appraisal. The interpretation and labelling of these four higher-order dimensions resulted in the four higher-order dimensions of Valence, Positive interaction, Task-related effort, and Familiarity (Table 4).

The first higher-order dimension brought together aspects of the Valence of a situation. The situation-perception dimensions of Positivity and Negativity and the appraisals of Pleasantness and Goal-congruence together formed this Valence dimension. The second higher-order dimension could be summarized as experiencing *Positive interaction* in a situation. It consisted of the situation-perception dimension of Sociality and of the appraisal of Other-agency. The third higher-order dimension reflected *Task-related effort*. It integrated the situation-perception dimension of Duty and the appraisal of Anticipated effort. Finally, the fourth higher-order dimension indicated perceived *Familiarity* of a situation. It consisted of the situation-perception dimension of Typicality (negatively) and the appraisal of Novelty.

Most, if not all, of the remaining six higher-level dimensions consisted mainly of one lower-level situation-perception or of one appraisal dimension. The situation-perception dimensions of Humor, Intellect, Adversity, and Deception and the appraisal dimensions of Circumstance-agency and Goal-relevance seemed to represent unique dimensions (Table 4). Additionally, the lower-level situation-perception dimension of Mating and the appraisals of Certainty, Coping-potential and Self-agency did not load strongly on any of the higher-order dimensions. This indicated that there are some unique elements to situation perception and appraisal.

3.2. Results study 2 - overlap between situation perception and appraisal in emotional situations

In study 2, participants appeared more prone to recall negative emotional situations than positive emotional situations (see descriptive statistics of Negativity, Positivity, Goal-congruence and Pleasantness in supplementary table 5). The 'negative' dimension of Negativity showed higher medians compared to the other dimensions, and the 'positive' situation-perception dimension of Positivity and the appraisal dimensions of Pleasantness and Goal-congruence showed relatively lower medians. In contrast to study 1, the situation-perception dimensions of Deception and Adversity and the appraisal dimension of Certainty were not skewed in study 2 (supplementary table 5).

Study 2 replicated the dimension pattern found in study 1. A 10-dimensional consensus space explained 71% of the variance shared between the two factor-structures of situation perception and appraisal. Six higher-order dimensions explained 61% of this total variance (Table 5). Each of these six higher-order dimensions was a combination of at least one situation-perception and one appraisal dimension. These six higher-order dimensions covered 14 lower-level dimensions of situation perception and of appraisal. Again, the four dimensions Valence, Task-related effort, Familiarity and Positive interaction were identified (Table 6). As in study 1, Valence consisted of the situation-perception dimensions of Positivity and Negativity and of the appraisal dimensions of Pleasantness and Goal-congruence. Task-related effort again comprised the situation-perception dimension of Duty and the appraisal of Anticipated effort. Once more, Familiarity combined the situation-perception dimension of Typicality and the appraisal of Novelty.

Study 2 extended the pattern of study 1 by showing that the *Interaction* dimension further unfolded into a positive and a negative equivalent. The higher-order *Negative other* dimension was comprised of

³ This exploratory analysis was not pre-registered.

Table 3

Variance explained by each higher-order dimension in a Generalized Procrustes Analysis with 10 composite situation-perception dimensions and 10 composite appraisal dimensions for study 1.

	Consists of dimensions		Consensus (%)	Cumulative consensus (%)	Residus (%)	Total (%)	Consensus/total (%)
	Situation perception	Appraisal					
1. Valence	Positivity	Goal-congruence	30.25	30.25	2.24	32.49	93 %
	Negativity	Pleasantness					
2. Positive interaction	Sociality	Other-agency	13.38	43.63	4.42	17.80	75 %
3. Task-related effort	Duty	Anticipated effort	10.44	54.08	3.67	14.11	74 %
4. Familiarity	Typicality	Novelty	6.04	60.12	1.78	7.82	77 %
Dimension 5	Mating	Circumstance-agency	3.74	63.86	2.78	6.52	57 %
Dimension 6		Goal-relevance	3.15	67.00	2.30	5.45	58 %
Dimension 7	Humor		2.97	69.97	2.39	5.36	55 %
Dimension 8	Intellect		2.65	72.62	1.97	4.63	57 %
Dimension 9	Adversity	Coping-potential	1.71	74.34	1.26	2.98	58 %
Dimension 10	Deception	Adversity	1.59	75.92	1.26	2.84	56 %
Total			75.92		24.08	100.00	

Note the consensus variance represents the variance shared between the two factor-structures. The residus represent the error variance this higher-order dimension introduces. Consensus/total indicates a relative contribution of each dimension while aiming for a parsimonious model. Dimensions one to four are labelled.

Table 4

Factor-loadings (correlations) of the lower-level dimensions of situation-perception dimensions/appraisal dimensions on ten higher-order dimensions, resulting from the Generalized Procrustes Analysis for study 1.

	Valence	Positive interaction	Task-related effort	Familiarity	Dimension 5	Dimension 6	Dimension 7	Dimension 8	Dimension 9	Dimension 10
A: Goal-congruence	0.86	0.07	-0.09	0.23	-0.07	0.02	-0.16	-0.03	0.14	-0.03
A: Pleasantness	0.86	0.05	-0.20	0.21	-0.06	-0.03	0.08	0.20	0.08	0.20
SP: Negativity	-0.81	0.02	0.17	-0.15	0.12	0.28	0.03	0.08	-0.20	-0.12
SP: Positivity	0.76	0.17	-0.23	0.17	-0.01	0.21	0.25	0.18	0.08	0.18
A: Self-agency	<i>0.45</i>	-0.45	0.19	0.39	0.00	0.22	0.19	-0.24	-0.07	0.26
SP: Sociality	0.25	0.81	-0.05	0.07	0.12	0.15	0.06	0.14	0.01	0.14
A: Other-agency	-0.11	0.70	0.04	-0.07	-0.02	-0.01	0.45	-0.01	-0.16	-0.16
SP: Duty	-0.15	-0.01	0.87	0.01	0.03	0.13	-0.05	0.11	0.08	0.04
A: Anticipated effort	<i>-0.34</i>	-0.08	0.71	-0.13	0.04	0.10	0.00	0.24	-0.23	-0.10
SP: Typicality	0.19	0.00	-0.05	0.89	-0.11	-0.13	0.00	0.05	0.04	0.09
A: Novelty	<i>-0.32</i>	-0.01	0.03	-0.84	0.05	0.01	0.10	0.01	-0.13	-0.09
A: Circ.-agency	-0.27	0.04	0.08	-0.17	0.79	0.09	0.04	0.05	0.15	-0.10
SP: Mating	0.24	0.44	-0.07	0.02	<i>0.50</i>	-0.04	0.00	0.03	-0.41	0.19
A: Goal-relevance	-0.03	0.08	0.16	-0.10	0.05	0.85	-0.06	0.06	-0.06	-0.02
SP: Humor	0.05	0.15	-0.04	-0.05	0.04	-0.05	0.78	0.08	-0.03	-0.11
SP: Intellect	0.13	0.13	0.28	0.03	0.06	0.07	0.10	0.79	-0.06	-0.06
SP: Adversity	-0.26	0.13	0.15	-0.07	-0.14	0.10	0.11	0.05	-0.61	-0.08
A: Coping-potential	<i>0.44</i>	0.08	0.26	0.22	-0.06	0.03	0.09	-0.02	0.55	0.28
SP: Deception	-0.19	0.24	0.27	-0.03	0.10	0.20	0.10	0.01	-0.23	-0.63
A: Certainty	0.16	0.26	0.17	0.23	0.04	0.12	-0.16	-0.09	0.01	0.59

Note “SP” – situation-perception, “A” – appraisal.

Factor-loadings are rotated with Varimax rotation and Kaiser normalization. High factor-loadings (>0.50) are bold-faced. Moderate factor-loadings (>0.30) are italicised.

the situation-perception dimension of Deception and of the appraisal dimension of Other-agency. The higher-order *Negative self* dimension was comprised of the situation-perception dimension of Adversity and of the appraisal of Self-agency. The higher-order *Positive interaction* dimension consisted of the situation-perception dimension of Sociality and of the appraisal of Goal-relevance (Table 6). Study 2 thus unwrapped different ways in which people perceive interaction situations, thereby focusing on whether a situation is positive or negative and who is/are responsible for the situation.

Regarding the remaining four higher-level dimensions, two seemed to consist of a unique situation-perception or appraisal dimension, and two showed additional overlap between the taxonomies. As in study 1, the situation-perception dimension of Intellect showed to be unique (Table 6). We also replicated a higher-order dimension consisting of the situation-perception dimension of Mating and the appraisal dimension of Circumstance-agency. Diverging from study 1, the appraisal dimension of Coping-potential seemed to represent a unique dimension of appraisal. Finally, study 2 showed an additional higher-order dimension consisting of the situation-perception dimension of Humor and the appraisal dimension of Certainty (negatively). Thus, two remaining

dimensions were consistent across both studies, and two remaining dimensions were inconsistent.

3.3. Comparing the higher-order structure of daily-life and emotional situations

Study 1 provided some first insights into the degree to which situation-perception and appraisal dimensions overlap. It appeared that four higher-order dimensions, namely Valence, Positive interaction, Task-related effort, and Familiarity, captured dimensions of both situation perception and of appraisal, and that these four dimensions collectively explained 60% of variance of these two taxonomies. Moreover, six dimensions appeared to reflect unique dimensions of situation perception (Humor, Intellect, Adversity, and Deception) or of appraisal (Circumstance-agency and Goal-relevance).

Study 2 replicated and extended the findings of study 1. For both daily-life situations and emotional situations, there appeared an overlap between situation-perception and appraisal dimensions in the four higher-order dimensions of Valence, Task-related effort, Familiarity, and Positive interaction. Moreover, in both studies 1 and 2 Intellect

Table 5

Variance explained by each higher-order dimension in a Generalized Procrustes Analysis with 10 composite situation-perception dimensions and 10 composite appraisal dimensions for study 2.

	Consists of dimensions		Consensus (%)	Cumulative consensus (%)	Residus (%)	Total (%)	Consensus/total (%)
	Situation perception	Appraisal					
1. Valence	Positivity	Goal-congruence	20.91	20.91	3.59	24.50	0.85
	Negativity	Pleasantness					
2. Negative other	Deception	Other-agency	13.48	34.38	3.58	17.06	0.79
3. Task-related effort	Duty	Anticipated effort	9.65	44.04	3.72	13.37	0.72
4. Negative self	Adversity	Self-agency	6.55	50.59	3.65	10.20	0.64
5. Familiarity	Typicality	Novelty	6.13	56.71	2.32	8.45	0.73
6. Positive interaction	Sociality	Goal-relevance	4.40	61.11	3.68	8.08	0.54
Dimension 7	Intellect		3.52	64.62	2.80	6.31	0.56
Dimension 8	Mating	Circumstance-agency	2.82	67.44	2.47	5.28	0.53
Dimension 9	Humor	Certainty	2.13	69.57	1.62	3.74	0.57
Dimension 10		Coping-potential	1.79	71.36	1.21	3.00	0.60
Total			71.36		28.64	100.00	

Note the consensus variance represents the variance shared between the two factor-structures. The residus represent the error variance this higher-order dimension introduces. Consensus/total indicates a relative contribution of each dimension while aiming for a parsimonious model. Dimensions one to six are labelled.

Table 6

Factor-loadings (correlations) of the lower-level dimensions of situation-perception dimensions/appraisal dimensions on all ten higher-order dimensions, resulting from the Generalized Procrustes Analysis for study 2.

	Valence	Negative Other	Task-related effort	Negative Self	Familiarity	Positive interaction	Dimension 7	Dimension 8	Dimension 9	Dimension 10
A: Pleasantness	0.94	0.07	-0.05	0.05	-0.06	0.04	0.03	-0.07	-0.01	0.09
SP: Positivity	0.89	0.01	0.03	0.05	-0.16	0.10	-0.08	-0.03	0.02	-0.01
SP: Negativity	-0.75	-0.12	0.24	-0.08	0.09	0.22	-0.02	-0.01	0.05	-0.38
A: Goal-congruence	0.70	0.23	-0.22	0.08	-0.02	0.10	0.32	0.06	-0.14	0.21
A: Other-agency	-0.02	-0.87	-0.02	-0.14	-0.02	-0.07	0.10	-0.05	0.08	0.00
SP: Deception	-0.24	-0.77	0.16	0.04	-0.02	0.08	0.03	0.11	0.06	0.00
SP: Duty	-0.05	-0.02	0.80	0.12	-0.05	0.02	-0.01	-0.02	-0.10	0.30
A: Anticipated effort	-0.24	-0.10	0.69	0.03	0.00	0.12	0.23	0.06	0.08	-0.11
A: Self-agency	0.26	0.17	0.10	0.79	-0.07	0.01	-0.07	-0.05	-0.10	0.11
SP: Adversity	-0.36	-0.44	0.13	0.53	-0.12	-0.03	0.17	0.12	0.34	-0.08
SP: Typicality	0.06	-0.12	0.09	0.01	-0.88	-0.10	-0.02	0.05	0.00	0.10
A: Novelty	-0.16	-0.06	0.03	-0.09	0.84	-0.12	-0.12	0.05	0.06	-0.02
SP: Sociality	0.19	0.07	-0.05	0.04	-0.07	0.74	0.25	-0.14	-0.09	0.27
A: Goal-relevance	-0.08	-0.05	0.18	-0.03	0.04	0.69	-0.13	-0.11	-0.04	-0.22
SP: Intellect	0.11	-0.25	0.40	-0.05	-0.14	0.04	0.62	-0.06	-0.01	0.00
A: Circ. agency	-0.12	0.37	0.12	-0.19	0.05	0.02	0.24	-0.69	-0.02	-0.01
SP: Mating	0.12	-0.12	-0.09	0.13	-0.04	0.20	-0.10	-0.66	-0.04	-0.03
A: Certainty	0.09	-0.03	0.10	-0.01	-0.25	0.16	-0.08	-0.08	-0.73	0.15
SP: Humor	0.04	-0.31	0.09	-0.07	-0.22	0.06	-0.14	-0.02	0.64	0.21
A: Coping-potential	0.31	-0.02	0.18	0.08	-0.11	-0.01	0.01	0.04	0.00	0.74

Note "SP" – situation-perception, "A" – appraisal.

Factor-loadings are rotated with Varimax rotation and Kaiser normalization. High factor-loadings (>.50) are bold-faced. Moderate factor-loadings (>.30) are italicised.

appeared to be a unique dimension of situation perception. In addition to Study 1, Study 2 also revealed that situation-perception and appraisal dimensions showed an overlap in the evaluation of negative interaction situations, whether caused by oneself (*Negative self*) or by other people (*Negative other*). The constitution of these interaction dimensions differed between daily-life (study 1) and emotional (study 2) situations. These differences could be attributed to the skewness in the lower-level dimensions that formed these Negative interaction dimensions; The situation-perception dimensions of Adversity and Deception were too skewed to appear as overlapping dimensions in study 1, but not in study 2. All in all, these findings suggest that future research is needed to further delve into the (potential) overlap between interaction or interpersonal situation-perception and appraisal dimensions across different kinds of situations.

3.4. Overlap in predicting emotions

Thus far, we have not examined whether situation-perception and appraisal dimensions show overlap in their capacity to predict specific emotions. Since both appraisal dimensions (Frijda, 1987) and situation-

perception dimensions (Chung et al., 2021) have been found to predict experienced emotions, we investigated whether both situation-perception and appraisal dimensions can predict experienced emotions. In study 1, participants mostly experienced positive and hardly negative emotions, and vice versa in study 2 (supplementary table 6). We therefore merged study 1 and study 2 into one dataset. In this merged dataset, most experienced emotions were normally distributed (supplementary table 6; except for Jealousy, Guilt, Shame and Regret). Multiple regression analyses for each of the 20 measured emotions showed that the model of situation-perception and the model of appraisal dimensions performed equally well in predicting emotions (Fig. 1; supplementary table 7). The adjusted R^2 values of these 20 emotions did not differ between the situation-perception and appraisal models ($F(1, 38) = 0.30, p = .59$).⁴ Thus, situation-perception and

⁴ Note that the non-normality in Jealousy, Shame, Guilt and Regret may have impacted the absolute R^2 values of these emotions, but did not impact the difference in R^2 values of emotions between the situation-perception and appraisal models. An F-test excluding these skewed emotions (i.e., Jealousy, Shame, Guilt and Regret) resulted in a similar finding ($F(1, 30) = 0.37, p = .55$).

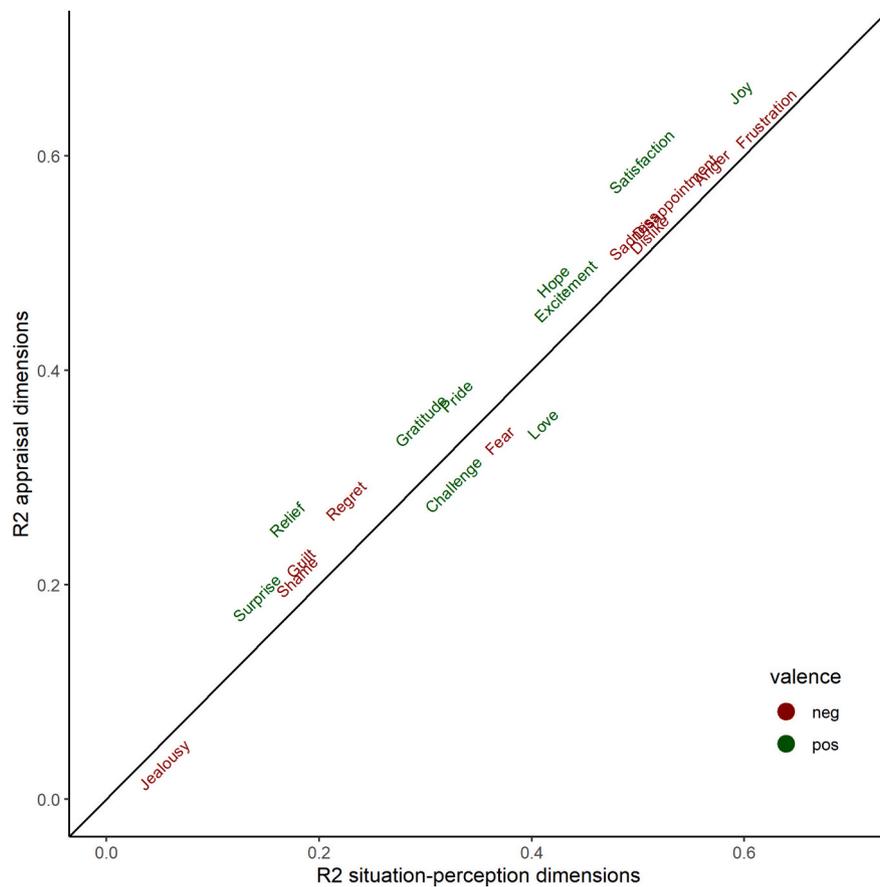


Fig. 1. Adjusted R^2 values per emotion plotted for the situation-perception model (x-axis) and appraisal model (y-axis). Note For emotions on the diagonal line, the R^2 value of the situation-perception and appraisal models is equally high. For emotions plotted above (below) the diagonal, the R^2 value of the appraisal (situation-perception) model is higher.

appraisal dimensions also seem to overlap in predicting the emotions that people experience.

4. General discussion

The current research sought to answer to what extent situation perception and appraisal are similar or different. The two have been developed for different purposes and have investigated different kinds of situations, but they both seem to focus on people's interpretation of situations and may thereby reflect a jangle fallacy. Together, our theoretical and empirical analysis of the two taxonomies reveal that situation perception and appraisal show quite some overlap; More than half of the variance in situation-perception and appraisal dimensions can be condensed in four to six fundamental dimensions, stable across different kinds of situations (everyday mundane experiences and strong emotional experiences). Although both approaches have made their unique contributions to the understanding of how people interpret and respond to situations, the present research reveals that situation perception and appraisal of emotion also show similarities. Thus far, these two research fields have gone unintegrated, and their communality underexploited, which may lead to 'jangle'.

4.1. Theoretical and practical implications

The current findings identify stable components that are at the core of how people interpret both daily-life and emotional situations. Across both studies, we found that the interpretation of a situation as being positive or negative (Valence), as being familiar or not (Familiarity), as requiring effort or not (Task-related effort), and as being related to other

people or not (Interaction) are the essential overlapping dimensions between situation perception and appraisal. The dimensions of Valence, Familiarity, and Task-related effort seem to reflect how people interpret situations in relation to their present goals, past experiences, and future expectations, respectively. As goals and past experiences represent aspects of a person (Edwards & Templeton, 2005), it again emerges that the interpretation of situations and personality are closely connected (Funder, 2016; Horstmann et al., 2020).

Interestingly, our findings reveal that situation perception and appraisal may strengthen each other in the analysis of how people interpret the interactive or interpersonal aspects of situations. Across varying types of interpersonal situations, situation-perception dimensions appeared to focus on the presence of other people and on the activities others perform. Appraisal dimensions, on the other hand, reflected evaluations of who was responsible for these interpersonal situations. As such, situation perception refers more to a descriptive element in which people describe what is going on in situations, while appraisal refers more to an evaluative element in which people judge how situations relate to themselves and their goals. The constitution of these interpersonal aspects seems to vary somewhat depending on the situation (daily-life or emotional situations). In all cases, interpersonal aspects of situations seem important, and the complementarity between situation perception, as descriptive elements, and appraisal, as evaluative elements, can enrich our understanding of how people interpret interpersonal situations.

More practically, the current findings provide a nexus between situation perception and appraisal. They illustrate the direct links between situation-perception and appraisal dimensions, which allows both situation and emotion researchers to draw in literature from the other field.

For situation and personality researchers, the current findings reveal that especially a focus on the appraisal-dimensions of Self-, and Other-agency may be interesting to include. For emotion researchers, the present findings show that the unique situation-perception dimension of Intellect may be worthwhile to further investigate. Moreover, the current research underlines how both situation perception and appraisal can predict experienced emotions. This finding can spur the interest of situation and personality researchers to examine how situation perception can predict experienced emotions following from situations. Emotion researchers could employ the link between situation perception and appraisal to advance the specification of experienced emotions. Thus, the links between situation-perception and appraisal dimensions can expand both the fields of situation and emotion research.

4.2. Limitations and future research

There are at least two limitations to the current research that are worth discussing. First, our findings are dependent on how the dimensions from both research domains have been formulated in measurements of the taxonomies. We used the most validated measures for the situation-perception dimensions (the DIAMONDS; Rauthmann et al., 2014 and the CAPTION; Parrigon et al., 2017 taxonomies), but even these measures may not capture the full range of situation-perception dimensions. For example, the measurement of Humor now focused on its negative aspect (e.g., *childish*), whereas it may also include a more positive aspect (e.g., *playful*; Parrigon et al., 2017). Furthermore, there was no existing, validated measure that includes all appraisal dimensions. We therefore developed an integrated measure of appraisal dimensions from multiple appraisal theories of emotion. Measures of appraisal dimensions show overlap (Moors et al., 2013; Schorr, 2001), but differ somewhat across authors. The current research combined all dimensions and items and validated a 10-factor solution of appraisal dimensions. This 10-factor solution excluded a Fairness dimension, because all Fairness items cross-loaded on multiple dimensions. Fairness might be an important dimension for emotion researchers to understand and differentiate among negative moral emotions (e.g., anger). Therefore, future research is poised to examine whether the current findings would hold across different measurements.

Second, the findings may not generalize beyond the sampled types of situations and emotions. Even though we used validated methods to generate as much diverse situations as possible, and we examined both daily-life and emotional situations, it may be possible that the current research did not cover theoretically relevant situations that occur infrequently (e.g., seeing other people suffer, being humiliated). The overlap between situation perception and appraisal, as well as the extent to which these taxonomies can predict experienced emotions, may be different for such situations. Therefore, future research could elucidate to what degree the current structure holds across different theoretically relevant situations and emotions.

Additionally, future research could investigate the different correlates and outcomes of how people interpret situations in different ways. Our research provides new insights into how people interpret situations, and future research could investigate how the current higher-order dimensions of situation interpretation relate to, for example, objective features of the environment (i.e., situation cues), to cognitive-affective processes (e.g., attention, motivation, or goal pursuit), or to behavioral tendencies. Moreover, future research could examine how our findings relate to individual characteristics using different research designs. Using repeated measures designs, experience-sampling methods, or multi-level analyses, for example, would allow researchers to investigate how the higher-order dimensions of situation interpretation link to personality traits. This might also relate to relationships between individual differences and emotional experiences. For example, higher trait conscientiousness may relate to stronger experiences of the emotion of challenge through the link between the situation-perception dimension of Duty (Horstmann et al., 2020; Rauthmann et al., 2020; Sherman et al., 2015) and the appraisal of

Anticipated effort (Tong, 2015). Thus, by bridging the fields of situation research and emotion research, our research hopefully opens up interesting avenues for research on interconnections between situations, personality, emotions, and behaviours.

5. Conclusions

In conclusion, situation perception and appraisal show quite some overlap. They hold a synergetic potential to advance our understanding of how people interpret interpersonal situations, and their demonstrated overlap provides a first nexus for both situation and emotion researchers in connecting theories on situations, emotions, personality and behaviour. It appears that the time is ripe to integrate situation and emotion research.

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Ethical approval statement

This research was approved by the Social Sciences Ethics Committee from Wageningen University & Research and complies with the Netherlands Code of Conduct for Research Integrity and the Declaration of Helsinki.

CRediT authorship contribution statement

Jurriaan J. Tekoppele: Conceptualization, Methodology, Investigation, Formal analysis, Writing - Original Draft, Review & Editing
Ilona E. De Hooze: Conceptualization, Methodology, Writing - Review & Editing, Funding acquisition, Supervision
Hans C. M. van Trijp: Conceptualization, Writing - Review, Supervision

Declaration of competing interest

The authors declare that they have no known competing financial or personal interests.

Data availability

Data will be made available on request.

Appendix A. Supplementary material

Supplementary material to this article can be found online at <https://doi.org/10.1016/j.paid.2022.111878>.

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