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Are effort-based decision-making tasks worth the effort?—A study on the associations between effort-based decision-making tasks and self-report measures

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Abstract

Objectives: Amotivation is a common symptom in various mental disorders, including psychotic or depressive disorders. Effort-based decision-making (EBDM)-tasks quantifying amotivation at a behavioral level have been on the rise. Task performance has been shown to differentiate patient groups from healthy controls. However, findings on indicators of construct validity, such as the correlations between different tasks and between tasks and self-reported/observer-rated amotivation in clinical and healthy samples have been inconclusive.

Methods: In a representative community sample ($N = 90$), we tested the construct validity of the Deck Choice Task, the Expenditure for Rewards Task and the Balloon Task. We calculated correlations between the EBDM-tasks and between the EBDM-tasks and self-reported amotivation, apathy, anticipatory pleasure, and BIS/BAS.

Results: Correlations between tasks were low to moderate ($0.198 \leq r \leq 0.358$), with the Balloon Task showing the largest correlations with the other tasks, but no significant correlations between any EBDM-task and the self-report measures.

Conclusion: Although different EBDM-tasks are conceptualized to measure the same construct, a large part of what each task measures could not be accounted for by the other tasks. Moreover, the tasks did not appear to substantially capture what was measured in established self-report instruments for amotivation in our sample, which could be interpreted as questioning the construct validity of EBDM-tasks.

KEYWORDS
amotivation, depression, effort-based decision-making, negative symptoms, psychosis, validation study

1 | INTRODUCTION

Amotivation, defined as reduced goal-directed behavior, decreased initiation, and less persistence in activities (Strauss et al., 2012) is considered a core symptom of negative symptoms in psychosis and depression (Bobes et al., 2010; Zhang et al., 2016) and a prevalent symptom in other mental disorders such as autism (Damiano et al., 2012) and substance use disorders (Leventhal et al., 2008) as well as in the context of various neurological disorders such as Alzheimer's disease, Parkinson's disease or following traumatic brain

injury (Husain & Roiser, 2018). Besides, amotivation levels have been postulated to be continuously distributed from apparently healthy individuals to those with the fully developed clinical symptom (large population samples: Petitet et al., 2021; depression: Schrader, 1997; psychotic disorders: Kaiser et al., 2011). On an etiological level, amotivation is also considered a driving mechanism of both negative symptoms in psychosis (Gard et al., 2007; Wolf et al., 2014) and anhedonia in depression (Halahakoon et al., 2020; Tran et al., 2020). Furthermore, amotivation has been shown to account for reduced levels of functioning and quality of life in patients (Blanchard et al., 2015; Fervaha et al., 2014; Foussias et al., 2011, 2014). However, progress in understanding these mechanisms is currently hampered by a lack of valid measures to assess amotivation across the continuum from healthy to pathological levels of amotivation.

Amotivation has predominantly been assessed by self-rating or clinicians' ratings based on structured interviews and observed behavior. However, these two methods show only moderate correlation (Engel & Lincoln, 2017; Llerena et al., 2013; Park et al., 2012). Moreover, their validity has been found to vary (Trémeau et al., 2012), possibly due to biases in both self-report (e.g., self-concepts, self-stigmatization, social desirability, lack of self-awareness) and observer-report (e.g., stereotypes associated with the diagnosis, difficulties in separating low functioning from amotivation or in differentiating expressive from motivational negative symptoms in psychosis). Therefore, a recent approach utilizes standardized computerized paradigms that require effort and intentional goal-directed behavior to arrive at an unbiased, behavioral assessment of amotivation. These paradigms are based on an effort-cost-computation that balances out the individual effort to achieve a goal (i.e., goal-directed behavior) and its potential reward (Young & Markou, 2015). Effort-based decision-making (EBDM)-tasks measure how much effort a person is willing to exert for a given reward: Participants choose between a difficult and an easy way to perform a physically or cognitively demanding task over the course of several trials. For either choice, completion of a trial yields a monetary reward, but the easy choice is rewarded with a small sum, whereas the difficult choice is rewarded with varying higher sums. Thus, EBDM-tasks enable to directly quantify reduced goal-directed behavior in a controlled setting (e.g., by the number of times the difficult way is chosen). Moreover, these tasks are suited to dismantle the underlying effort-cost computation by separately analyzing the influence of different factors (e.g., probability and amount of reward), which renders them versatile tools both to measure and to study clinical (Green et al., 2015; Horan et al., 2015) and subclinical amotivation (Chong et al., 2016).

An initial study of five EBDM-tasks found that four out of five tested EBDM-tasks differentiate between individuals with psychosis and healthy controls (Reddy et al., 2015). The three tasks showing the largest differences between individuals with psychosis and healthy controls were the Deck Choice Task (Kool et al., 2010), the Balloon Task (Gold et al., 2013) and the Effort Expenditure for Rewards Task (EEfRT; Treadway et al., 2009). The Deck Choice Task is a cognitive task in which participants have to respond to numbers shown on cards of different color. Difficulty is varied using different instructions on how to correctly respond to the shown numbers depending on the card color (e.g., orange cards require decisions on whether the shown number is equal/unequal whereas blue cards require decisions on whether the shown number is smaller/equal or greater than 5). The Balloon Task is a physically demanding task. Participants are instructed to pump up balloons shown on a computer screen by alternately pressing two buttons. In each trial, participants choose between an easy and a difficult balloon that differ in the number of pumps required to become fully inflated. Finally, the EEfRT is also physically demanding and requires pressing a button.

So far, the EBDM-tasks' ability to discriminate between individuals with clinical amotivation (e.g., patients with schizophrenia or depression) and healthy controls (Reddy et al., 2015; Treadway et al., 2012; Yang et al., 2014) constitutes only a first indication of their validity in measuring amotivation. Beyond that, valid behavioral paradigms that claim to assess the same construct should correlate with one another as an indication of their ability to measure different levels of amotivation in a continuous manner. However, only few studies have examined the associations between different EBDM-tasks finding small to medium correlations (Horan et al., 2015; Luther et al., 2018) which indicates that the tasks might not assess entirely the same construct. Valid behavioral measures should also correlate with self-report measures of amotivation and related constructs, such as apathy, anticipatory pleasure, behavioral inhibition and behavioral activation. To date, EBDM-tasks showed a range from no to moderate correlations with self-reported amotivation and related constructs in samples with psychotic and affective disorders including depression, control groups and student samples (Barch et al., 2014; Fervaha et al., 2013; Luther et al., 2018; Ohmann et al., 2020, 2022; Zou et al., 2020). Although these findings question the construct validity of the EBDM-tasks, it has been argued that the heterogeneity in the selection of EBDM-tasks, outcome parameters, and external validation criteria assessed in previous research have provided a fragmented picture that potentially distorts the validation results (Hartmann-Riemer et al., 2018). Additionally, previous research seldom recruited representative samples (in terms of sociodemographic variables) and also rarely controlled for these variables, despite the fact that they have been shown to correlate with EBDM-task performance (e.g., gender: Treadway et al., 2009; Zou et al., 2020) and potentially affect behavior in different EBDM-tasks (e.g., due to differences in the subjective value of the monetary reward or the effort required to receive it). Furthermore, these studies rarely controlled for variables that are associated with clinical status and EBDM. For example, negative affective states have been linked to performance in the EEfRT in a community sample (Bryant et al., 2017) and thus may be driving differences in task performance between patients and healthy controls. Since many EBDM-tasks use a variation of reward probabilities, the willingness to take risks might be another factor that could influence decisions in EBDM-tasks. Thus, a thorough test of the validity of EBDM-tasks necessitates focusing on a range of promising EBDM-tasks simultaneously and validating them by analyzing their inter-correlations with relevant

measures of amotivation and related motivational constructs while taking potential confounders into account in a large enough sample that displays a continuum of amotivation levels.

To this aim, we examined the validity of three EBDM-tasks in a representative community sample. We hypothesized that task performance (i.e., the overall hard choices) (1) inter-correlates between the EBDM-tasks and (2) correlates with self-reported amotivation, apathy, anticipatory pleasure, behavioral inhibition and activation when sociodemographic factors, affective state and readiness to take risks are controlled for.

2 | METHOD

2.1 | Participants

A community sample of $N = 90$ was recruited using bulletins in various public places such as stations, supermarkets, public placement services and the online employment platform *Stellenwerk* of the Universität Hamburg. We aimed to recruit a sample representative of the German population, relying on the *Eurostat*'s latest available data from 2017. Categories were gender (male/female), age (39 and younger/40 and older), and level of education (lower/higher than high school certificate), resulting in eight cells for each of which a necessary number of participants (quota) was calculated and recruited. To be included, participants needed sufficient German language abilities in order to understand and work with the measures and tasks of the study.

2.2 | Measures

Amotivation was assessed with the German Version of the Motivation and Pleasure Scale—Self-Report (MAP-SR; Engel & Lincoln, 2016; Llerena et al., 2013). The MAP-SR consists of 15 items adapted from the Clinical Assessment Interview for Negative Symptoms (Kring et al., 2013). The items cover motivation and consummatory and anticipatory pleasure in the domains activities with family, partner or friends, hobbies and work (e.g., "In the past week how much effort have you made to actually do things with other people?"). Participants rate all items on 5-point scales from 0 to 4. Higher mean scores (average response) reflect more amotivation. The validity and reliability of the German MAP-SR ($\alpha = 0.88$; Engel & Lincoln, 2016) is comparable to its original version (Llerena et al., 2013).

Apathy was measured using the German Apathy Evaluation Scale self-report version (AES-S; Lueken et al., 2006; Marin et al., 1991). The AES-S contains 18 items (e.g., "Getting things started on my own is important to me") that are scored on 4-point scales. Higher scores reflect more apathy. Its reliability ($\alpha > 0.86$, test-retest reliability $r > 0.76$) and convergent validity ($r = 0.72$ with the clinician rating scale version) are good (Marin et al., 1991).

Trait anticipatory pleasure was measured with the German version of the Temporal Experience of Pleasure Scale—anticipatory subscale (TEPS-ANT; Engel et al., 2013; Gard et al., 2006). The TEPS-ANT includes 10 items (e.g., "when ordering something of the menu, I imagine how good it will taste"). The German version has shown to have good psychometric properties with an internal consistency of $\alpha = 0.69$ for this subscale (Engel et al., 2013).

Behavioral inhibition and activation were measured using the German version of the Behavioral Inhibition and Activation System Scales (BIS/BAS; Carver & White, 1994; Strobel et al., 2001). Both scales consist of 12 items that include statements about personal traits, preferences and behavior. The two scales of the German version have shown good internal consistencies (Strobel et al., 2001).

As a first control variable, current affect was assessed using the German version of the Positive and Negative Affect Scales (PANAS; Breyer & Bluemke, 2016; Watson et al., 1988). In the PANAS, participants rate their current feelings on 20 items with 5-point scales. The items describe 10 positive affective states (e.g., "Strong") and 10 negative affective states (e.g., "Nervous") that are added up to the PANAS positive score and the PANAS negative score.

As a second control variable, we assessed willingness to take risks using the R-1 Scale (Beierlein et al., 2014). On this single-item scale participants are asked to rate their willingness to take risks on a 7-point scale. The R-1 has shown to reflect the construct of readiness to assume risks (Beierlein et al., 2014).

2.3 | EBDM-tasks

The three EBDM-tasks were modified for this study setting by translation into German and exchange of Dollar values into Euro.

2.3.1 | Deck Choice Task

The Deck Choice Task (Kool et al., 2010) includes 36 trials for each of which participants make the choice of either playing an easy or a hard "deck" of cards. Each deck consists of 10 cards that have one of two colors (orange and blue) and are numbered from 1 to 9. While playing one deck, cards are shown successively and participants have to make quick decisions based on the number and color of the presented card. Blue cards require to make a judgement on whether the number on that card is smaller (press left button) or higher equal five (press right button). Orange cards require making a judgement of whether the displayed number is an even number (press left button) or uneven (press right button). The "easy decks" contain cards with only one color and participants receive a low reward of 0.10 €. The hard decks include cards of both colors and the reward varies (in this case from 0.10 to 0.40 €). We used an adapted version of the original task previously used for testing individuals with schizophrenia (Reddy et al., 2015). In this adapted version, the respective rewards are presented alongside each deck and are received regardless of the correctness of the required judgements. This change from the original setup (i.e., having to get a certain percentage correct to get a reward) prevents that those that cannot do well change preference

to the "easier" decks irrespective of their motivation levels. Thus, the adapted Deck Choice Task is more comparable to both other EBDM-tasks, which require physical effort. In this study, participants received half the sum of the earnings from chosen decks from all trials. The Deck Choice Task used in this study was implemented in *Presentation*.

2.3.2 | Balloon Task

In the Balloon Task (Gold et al., 2013), participants are instructed to choose between an easy and a hard way to pop a balloon that was presented on a computer screen. The easy way requires 20, the hard one 100 times alternately pressing two buttons on the computer keyboard in order to fully inflate the balloon. The easy way is rewarded with 1.00 € and the hard way is rewarded with 3.00–7.00 €. Independent of the choice, the winning chance was 100% in one half of the trials and 50% in the other half. The respective rewards and the probability of obtaining them are presented alongside each balloon. In this study, participants received 5% of the total sum of the rewards they had obtained by their choices. The Balloon Task used in this study was implemented in *E Prime*.

2.3.3 | Effort Expenditure for Rewards Task

In the EEfRT (Treadway et al., 2009), successful completion of easy trials requires 30 button presses with the dominant index finger in 7 s, while hard trials require 100 button presses with the non-dominant ring finger in 21 s. Easy trials are rewarded with 1.00 €, whereas rewards for hard trials vary (low = 1.24–2.00 €; medium = 2.01–3.00 €; high = 3.01–4.12 €). The probability to receive the reward is also varied across trials (low = 12%, medium = 50%, high = 88%). The EEfRT's total duration is exactly 20 min. Therefore the number of trials varies (45–90 trials). The final payment is based on four randomly chosen successful trials. The EEfRT used in this study was implemented in the *Matlab Psychotoolbox*.

2.3.4 | EBDM-task outcomes

Since the Deck Choice Task only varies reward sums across trials it offers four outcomes: percentage of hard choices at the four levels of reward (0.10 €, 0.20 €, 0.30 € and 0.30 €). In the Balloon Task both levels of reward and probability are varied. It offers 10 different outcomes: percentage of hard choices in the five levels of reward (3.00 €, 4.00 €, 5.00 €, 6.00 € and 7.00 €) in trials with a 50% or a 100% chance of reward. The EEfRT provides six outcomes: the percentage of hard choices at a 12%, 50%, 88% chance of reward and the percentage of hard choices at a low (1.24–2.00 €), medium (2.01–3.00 €) and high (3.01–4.12 €) level of reward. For all three tasks we used the percentage of hard choices across all trials as the main outcome. For a more detailed analysis of associations between EBDM-tasks and questionnaires, we used the percentages of hard choices depending on probability and level of reward.

2.4 | Procedure

First, all questionnaires including demographics were administered, followed by the three EBDM-tasks in random order. Finally, participants received monetary compensation consisting of a fixed value of 10.00 € and the money that was rewarded to them in the three tasks, which ranged from 1.24 € to 7.17 € for each task.

2.5 | Data analysis

We used R 3.5.1 and SPSS 22 for our analysis. For our main analyses we used the full sample of participants. All analyses were repeated after excluding the subsample of inflexible responders who always chose the hard task. Findings on this subsample are only reported when they diverge from the full sample. For the validation of the tasks, we first examined Pearson-correlations between the overall percentages of hard choices (main outcome) of the three tasks. Next, we examined correlations between the questionnaires with each tasks' main outcome and with all additional task outcomes (percentages of hard choices depending on probability and level of reward). Additionally, partial correlations between each task's main outcome and questionnaires were calculated with age, gender, level of education, past or present mental disorder, current affect, and willingness to take risks as control variables and are reported if they diverge. We further examined correlations between the questionnaires to evaluate the magnitude of correlations between the self-report measures to validate the EBDM-tasks according to the multitrait-multimethod-method (Campbell & Fiske, 1959).

3 | RESULTS

3.1 | Preliminary analysis and sample characteristics

Sample characteristics and descriptive data are shown in Table 1. Eight participants reported a diagnosis of a mental disorder in the past (depression, panic disorder, social phobia, and anorexia) and four reported a current one (depression, OCD, ADHD, and schizophrenia).

As can be seen in Figure 1, ratios of hard to easy choices in the EBDM-tasks increased with the level and probability of reward.

Two participants dropped out during the study due to fatigue, one at the beginning of the first task, the other at the beginning of the last task. In two further cases one task could not be carried out due to technical problems. Thus, values from two participants were missing for each task (i.e., 0.4% missing values). Two incidents of inflexible responding (i.e., always choosing the hard task) were recorded, both of which pertained to the Balloon Task.

TABLE 1 Sample characteristics and descriptive data

Sample characteristics	*M* or number	*SD*
Sex (male/female)	42/48	-
Age	36.19	14.74
Years of education	14.02	3.12
Mental disorder (non/past/present)	78/8/4	-
Assessment battery		
Amotivation (MAP-SR)	1.31	0.55
Apathy (AES-S)	11.69	6.49
Anticipatory pleasure (TEPS-ANT)	4.17	0.86
Behavioral inhibition system (BIS)	18.71	4.10
Behavioral activation system (BAS)	41.09	4.93
Positive affect (PANAS)	32.83	5.96
Negative affect (PANAS)	13.19	3.92
Readiness to assume risk (R-1)	4.52	1.24

Abbreviations: AES-S, Apathy Evaluation Scale, self-report; BAS, Behavioral Activation System Scale; BIS, Behavioral Inhibition System Scale; MAP-SR, Motivation and Pleasure Scale, self-report; PANAS, Positive and Negative Affect Schedule; R-1, Short Scale of Readiness to Assume Risk-1; TEPS-ANT, Temporal Experience of Pleasure Scale, Anticipatory Pleasure subscale.

3.2 | Construct validity of the EBDM-tasks

3.2.1 | Associations between the EBDM-tasks and possible confounders

Negative affect significantly correlated with an increased percentage of overall hard choices in the EEfRT ($r = 0.214$, $p = 0.045$), but not in the other two tasks. Similarly, willingness to take risks significantly correlated with more hard choices in the EEfRT ($r = 0.230$, $p = 0.031$). Moreover, male participants chose significantly more hard trials than women in the EEfRT ($r = 0.294$, $p = 0.005$). Finally, higher age significantly correlated with fewer hard choices in the Deck Choice Task ($r = -0.484$, $p < 0.001$), but not in the Balloon Task or EEfRT. Neither level of education nor past or present mental disorders were associated with any task outcome.

3.2.2 | Associations between the EBDM-tasks

The correlations between the three tasks' main outcomes were significant for the EEfRT and the Balloon Task ($r = 0.358$, $p < 0.001$) as well as for the Deck Choice and Balloon Task ($r = 0.292$, $p = 0.006$), but not for the EEfRT and Deck Choice Task ($r = 0.198$, $p = 0.067$). The pattern of significance did not change after Bonferroni correction and after controlling for age, gender, level of education, past or present mental disorder, current affect and willingness to take risks.

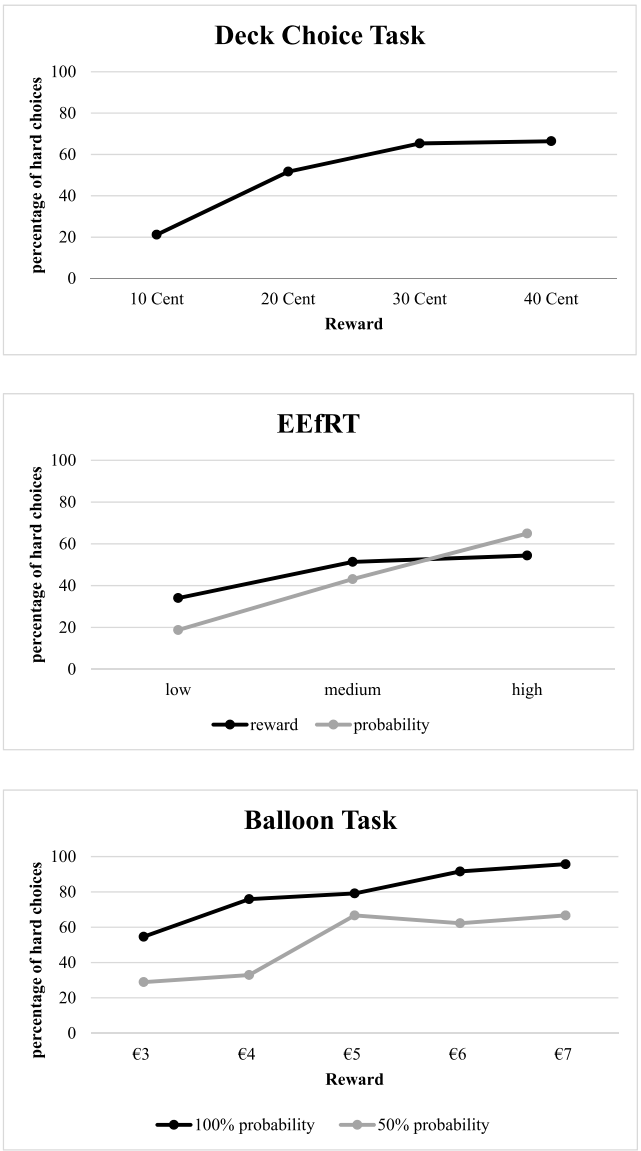

FIGURE 1 Percentage of hard choices across reward and probability levels for three tasks

3.2.3 | Associations between EBDM-tasks and motivation questionnaires

As can be seen in Table 2, there were no significant correlations between any of the tasks' main outcomes with any of the self-report-constructs used for validation. Again, the pattern of significance did not change after Bonferroni correction and after controlling for age, gender, level of education, past or present mental disorder, current affect and willingness to take risks. Scatterplots for each participant's mean MAP-SR score and total percentage of hard choices in each of the three tasks can be seen in Figures A3–A5 in the Appendix. In a more detailed analysis of all additional EBDM-task outcomes (i.e., percentages of hard choices depending on probability and level of reward) and all questionnaires that can be seen in Tables A3–A6 in the Appendix, seven out of 140 possible associations were significant

TABLE 2 Correlations between effort-based decision-making tasks and questionnaires

	Deck Choice Task	EEfRT	Balloon Task
Amotivation (MAP-SR)	−0.07	−0.04	−0.18
Apathy (AES-S)	−0.17	−0.07	−0.06
Anticipatory pleasure (TEPS-ANT)	−0.13	−0.09	0.02
Behavioral inhibition system (BIS)	−0.14	0.02	0.01
Behavioral activation system (BAS)	0.03	0.04	0.10
Positive affect (PANAS)	−0.09	−0.02	0.10
Negative affect (PANAS)	−0.08	0.21	0.18
Readiness to assume risk (R-1)	0.11	0.23	0.13

Abbreviations: AES-S, Apathy Evaluation Scale, self-report; BAS, Behavioral Activation System Scale; BIS, Behavioral Inhibition System Scale; MAP-SR, Motivation and Pleasure Scale, self-report; PANAS, Positive and Negative Affect Schedule; R-1, Short Scale of Readiness to Assume Risk-1; TEPS-ANT, Temporal Experience of Pleasure Scale, Anticipatory Pleasure subscale.

before Bonferroni correction (between $r = 0.210$ and $r = 0.326$). The pattern of significance did not change after controlling for age, gender, level of education, past or present mental disorder, current affect and willingness to take risks.

3.2.4 | Associations between motivation questionnaires

There were significant correlations between several of the self-report measures ranging from $r = 0.302$ to $r = 0.629$. We found a large correlation between apathy and amotivation and medium correlations between behavioral activation system and apathy as well as anticipatory pleasure. We found small to medium correlations between positive and negative affect ratings on the PANAS with self-reported amotivation and apathy. Further details can be seen in Table A6 in the Appendix.

3.3 | Additional analyses

Exclusion of inflexible responders did not change any of the results.

4 | DISCUSSION

In our community sample, the Balloon Task was moderately correlated with the Deck Choice Task and the EEfRT whereas these two tasks were not significantly correlated. Outcomes of the three EBDM-tasks were not correlated with self-reported amotivation, apathy, anticipatory pleasure, behavioral inhibition or activation system even after taking potential confounders into account. Taken together, the findings show that the three EBDM-tasks did not overlap as much as expected and therefore that the tasks might not measure entirely the same of what is assessed in established self-report measurements for amotivation.

Regarding the construct validity in terms of associations between the different EBDM-tasks, we found that the correlations between the tasks' main outcomes only reached significance for the Balloon Task with the other two tasks. Horan et al. (2015) also found that the Balloon Task was moderately correlated with the EEfRT and the Deck Choice Task, whereas correlations between the Deck Task and the EEfRT were only small. Our study further extends these findings by using three EBDM-tasks and ruling out confounding effects of sociodemographic variables and other potential confounders. Taken together, the findings suggest that the tasks tap into a singular construct, albeit with large task-specific variance. The specific task variance is likely to stem from various sources, including task differences regarding motivational endurance (15 min in the Deck Task vs. 30 min in the Balloon Task), differences in the type of effort required (e.g., high cognitive effort in the Deck Task and physical effort in the EEfRT) and the task differences in the requirement for fast processing in decisions (decision times are limited in the EEfRT). As Culbreth et al. (2018) pointed out, the great range of levels of reward that are displayed in trials of the different tasks (0.10 € in the Deck Task vs. 7.00 € in the Balloon Task) could further explain these differences. The combination of a relatively high reward and 100% probability might have led to comparatively high percentages of hard choices in some trials in the Balloon Task as compared to the mean of hard choices across trials in both other tasks and might be one reason why the shared variance is rather small. Nevertheless, our results tentatively suggest that the Balloon Task captures the central aspects of the construct best.

Regarding the second aspect of the EBDM-tasks' construct validity, the associations between the tasks' outcomes and self-reported amotivation and related motivational constructs, we found no significant correlations with any of the three tasks. This is in line with some of the previous research in depression (Treadway et al., 2012; Yang et al., 2014) and a meta-analysis with schizophrenia samples by Luther et al. (2018) that yielded a small, non-significant correlation between self-reported amotivation and EBDM-tasks based on two primary studies. Whereas a few prior studies found small

relationships between self-report (particularly anticipatory pleasure; Geaney et al., 2015; Yang et al., 2014) and EBDM-task performance, we provide further evidence that the EBDM-tasks do not tap into the same aspect of goal-directed behavior as the currently established self-report instruments for amotivation and related constructs.

A number of reasons can be discussed that might explain the discrepancy between the (somewhat) inter-correlated EBDM-tasks on the one hand and the inter-correlated questionnaires that aim to tap into amotivation on the other. First, the tasks assess a very specific behavior whereas the questionnaires require an individual's report of a very wide range of potential behaviors. Second, EBDM-tasks assess behavior at one given point in time, whereas self-report instruments require to retrospectively evaluate a longer time-span, ranging from 1 week in the MAP-SR (Llerena et al., 2013) to 4 weeks in the AES-S (Marin et al., 1991). Third, the types of rewards and the type of motivated behavior strongly differ between the two assessment methods: In EBDM-tasks only small monetary rewards are provided for a very specific behavior (i.e., button pressing or a cognitive task) whereas daily life activities require a wide range of behaviors and offer a large spectrum of potential rewards. Fourth, EBDM-tasks include instant feedback (EEfRT and Deck Choice Task provide immediate feedback on whether a trial was completed successfully) and reinforcement (EEfRT and Balloon Task provide feedback on whether the sum of money is earned). In daily life activities, however, reinforcement is commonly more delayed which necessitates generating, maintaining, and updating mental representations of future rewards. The immediate reinforcement in the tasks might even interfere with the construct they promote to measure. These discrepancies all raise the question whether EBDM-tasks measure a practically relevant facet of approach behavior that reflects goal-directed behavior in daily life.

To further explore this question, the associations between the EBDM-tasks and goal-directed behavior or behavioral markers such as activity levels in everyday life (using ecological momentary assessments) need to be tested. So far, only one study explored this association (Moran et al., 2017) and found motivation levels in daily life to not only correlate with the EEfRT outcomes, but also to predict them significantly better than retrospective self-reports of amotivation and interview-based assessments. To address the aspect of reinforcement in EBDM-tasks as a possible explanation for discrepancies between self-reported behavior in daily life and EBDM-tasks, the variation of an EBDM-task with delayed reward would helpful.

Limitations of this study include the sample recruitment: even though we opted for a community sample representative of the German population in terms of gender, age and education, the recruitment process itself (participants had to be at least motivated enough to apply to a university study participation) is likely to have prevented representativeness in terms of motivational levels, with a bias towards the more motivated. This may have limited the ability to find correlations between the constructs. However, the variance of amotivation (MAP-SR) in our sample was comparable to the variance in its clinical validation sample with our samples' mean being half a standard deviation below the validation data (Engel & Lincoln, 2016). Another limitation is that all questionnaires were based on self-report. Although it has been show that interview-based amotivation scores shown similarly low correlations with the EBDM-tasks (Luther et al., 2018), it would have been an advantage to have included observer-instruments.

In sum, EBDM-tasks seem to tap into a common motivational construct. However, our study provided further evidence for the conclusion that these tasks do not tap into the construct of amotivation as it is currently captured in self-report measures. At this point, however, we need more information to draw conclusions as to whether this divergence is due to the EBDM-tasks being a more or a less valid indicator of behavioral amotivation than self-report questionnaires. Hence, we advocate for the further exploration of the construct validity of EBDM-tasks.

AUTHOR CONTRIBUTIONS

Katharina Renz and Tania Lincoln designed the study. Katharina Renz managed the literature searches and statistical analyses. Katharina Renz wrote the first draft of the manuscript. Björn Schlier advised on the validation strategy. Tania Lincoln and Björn Schlier revised the manuscript. All authors contributed to and have approved the final manuscript.

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CONFLICT OF INTEREST

None of the authors have a conflict of interest including any financial, personal or other relationships with other people or organizations within 3 years of beginning the work submitted that could inappropriately influence, or be perceived to influence, their work.

DATA AVAILABILITY STATEMENT

None of the data or materials for the experiments reported here is available.

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