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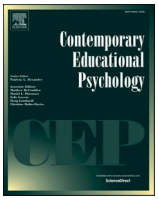

The relationship between teachers' stress and buoyancy from day to day: Two daily diary studies

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ABSTRACT

Despite the pertinence of teachers' buoyancy to 'everyday work', existing studies do not investigate buoyancy in close proximity to everyday experiences. Nor does existing research longitudinally investigate teachers' buoyancy and how it relates to stress. This paper describes two quantitative daily diary studies on this relationship. Study 1 includes a relatively large sample of teachers (N = 151), compared to the number of days that they were followed (T = 15). Study 2 includes relatively few teachers (N = 10), but follows them for an extended period of time (T = 61). Both studies tested hypotheses regarding the extent to which teachers' stress and buoyancy beliefs vary – and carry over – from day to day and the extent to which teachers' buoyancy beliefs and stress experiences co-occur and predict each other from day to day and from teacher to teacher. Results showed that both teachers' buoyancy beliefs and stress experiences varied and carried over significantly from day to day, although carryover effects were small. The relationship between buoyancy beliefs and stress was negative from teacher to teacher and concurrently from day to day. However, cross-lagged effects between both constructs from day to day were not significant. These results imply that both teachers' buoyancy beliefs and stress are malleable, state-like constructs to a considerable extent, but their dynamics likely occur on a timescale that is smaller than daily.

1. Introduction

Teachers' emotions are relevant for classroom processes, student outcomes, and teachers' psychological experiences at work (Frenzel et al., 2009; 2015; 2016; Keller et al., 2014; Pekrun et al., 2017). While positive emotions (e.g., enjoyment and pride) seem to be common among teachers, negative emotions (e.g., anxiety and anger) are salient and impact teachers' functioning and lives (Keller et al., 2014; Pekrun et al., 2017). In part, this is because teachers around the world experience work stress from their primary tasks (Hooftman, et al., 2015; Johnson et al., 2005; Kyriacou, 2001; Verhoeven et al., 2003; Walker et al., 2019). These stress experiences coincide with negative stress emotions that, in turn, are associated with higher burnout and intentions to quit the profession, and lower quality teaching behaviour (e.g., Harmsen et al., 2018; Wang et al., 2022). As such, it is important to study how teachers' stress experiences can be prevented or remedied.

Teachers' stress experiences are partly due to daily hassles that they have to deal with, such as managing students' misbehaviour or not having enough time to complete work (Day & Hong, 2016; Schmidt et al., 2017). To reduce the effect of daily hassles on teachers' stress experiences, it seems important that teachers experience buoyancy; the capacity to successfully overcome (i.e., bounce back from) setbacks and challenges that are typical for the ordinary course of everyday work (Martin & Marsh, 2008a; Parker & Martin, 2009). This is because teachers higher in buoyancy report less anxiety and stress (Collie, 2021; Martin & Marsh, 2008a).

However, despite the pertinence of teachers' buoyancy to 'everyday work', existing studies do not investigate buoyancy in close proximity to everyday experiences. Nor does existing research longitudinally investigate teachers' buoyancy and how it relates to stress. Rather, research has investigated how differences in self-reported buoyancy between teachers explain differences in their stress, well-being, and engagement (Collie, 2021; Martin & Marsh, 2008a; Parker & Martin, 2009). In doing so, research to date has approached buoyancy as a trait that does not

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vary within teachers. At the same time, teachers' stress and related experiences (i.e., exhaustion, negative affect and negative emotions) are shown to vary from day to day (Lavy & Eshet, 2018; Schmidt et al., 2017) and moment to moment (Goetz et al., 2015; Junker et al., 2021). This could suggest that the capacity to deal with stressors too, not only varies from teacher to teacher, but also within teachers. Moreover, as self-reports on traits are based on identity related beliefs (Robinson & Clore, 2002), existing studies have arguably measured teachers' *beliefs* in being able to successfully overcome setbacks and challenges, instead of their *capacity* to do so (Putwain et al., 2023). These beliefs can be argued to offer proactive protection against stress (i.e., stress-resistance), but they do not convey the reactive capacity to bounce back from stress (i.e., stress-recovery) (Putwain et al., 2023; Montpetit et al., 2010).

Studying teachers' stress, buoyancy beliefs and their relationship over multiple days would allow for empirically substantiated conclusions about aspects of the nature of teachers' stress and buoyancy. It can show to what extent buoyancy beliefs are state-like, in addition to being trait-like. This provides information about their malleability and, hence, the extent to which they can be targeted through interventions. Moreover, it can inform practice (e.g., direct supervisors) on how quickly teachers bounce back from stressful experiences, by showing how much stress carries over from one day to the next. Higher carryover suggests that teachers bounce back from stressful experiences less quickly. Finally, it can also demonstrate whether teachers' buoyancy beliefs and perceived stress influence each other over time, and their relative causal dominance (Hamaker et al., 2015). Such insight is important for determining whether interventions for teachers should focus on increasing buoyancy beliefs, decreasing stressors, or both (cf., Martin et al., 2013). Therefore, this paper investigates the following research questions:

RQ 1: To what extent do teachers' stress and buoyancy beliefs vary – and carry over – from day to day?

RQ 2: To what extent do teachers' buoyancy beliefs and stress experiences co-occur and predict each other from day to day and from teacher to teacher?

1.1. Teachers' stress

This study conceptualizes teachers' stress by focusing on a particular emotional stress response; anxiety. This is in line with Kyriacou (2001) who defines teachers' stress as a negative emotional experience resulting from an aspect of teachers' work. It is also in line with the cognitive theory of stress and coping (Lazarus & Folkman, 1984), which proposes that stress results after appraising a situation as personally significant and exceeding resources for coping. Stress then manifests itself as a negative emotional experience, in addition to physical responses such as an increased heartbeat (Junker et al., 2021; Von der Embse et al., 2015). Anxiety is an especially characteristic emotional stress response that results from appraising an upcoming situation as threatening and outside one's control (Folkman, 2013; Frenzel et al., 2009; Keller et al., 2011). This emotion is prevalent among – and salient for – teachers (Frenzel et al., 2009; 2015; 2016). Teachers' anxiety is characterized by feelings of worry, nervousness and tension related to their everyday work. Anxiety is experienced in everyday classroom situations (Frenzel et al., 2009; 2015), for example from a lack of student discipline (Frenzel et al., 2009), which teachers encounter relatively frequently in their lessons (Schmidt et al., 2017).

1.2. Teachers' buoyancy

As noted above, teachers' buoyancy refers to teachers' capacity to successfully overcome setbacks and challenges that are typical of the ordinary course of everyday work (Martin & Marsh, 2008a; Parker & Martin, 2009). Buoyancy is often further conceptualized by comparing it to resilience (Martin & Marsh, 2008a,b, 2009). Resilience refers to a capacity to deal successfully with acute and severe adversities, such as violence, which are often isolated events that only few teachers have to face (Collie et al., 2021). Buoyancy, on the other hand, describes the ability to recover from difficulties and pressures that most teachers have to deal with on a day-to-day basis, such as competing deadlines and student misbehaviour. As such, teachers' buoyancy concerns problem focused coping in response to everyday hassles, stressors, and strains (Martin & Marsh, 2008b) and is also referred to as teachers' 'everyday resilience' (Martin & Marsh, 2008a; Parker & Martin, 2009). Another way in which teachers' buoyancy is theorized to differ from resilience concerns its proactive role in dealing with stressors. That is, whereas resilience enables teachers to deal with severe adversities after they occur, buoyancy enables teachers to proactively prevent everyday setbacks and challenges from escalating into major adversities (Martin & Marsh, 2009).

The latter suggests that, in line with reasoning in existing empirical work (Collie, 2021; Martin & Marsh, 2008a), buoyancy beliefs would negatively predict teachers' experiences of stress over time. However, the reverse may be true as well. That is, daily variations in teacher's buoyancy beliefs could be expected, for example, because the number of hassles that teachers have to deal with, or their severity, varies from day to day (Schmidt et al., 2017). If teachers experience an overload in these hassles, their beliefs in their capacity to deal with them could decrease. Likewise, daily variations in sleep quality may cause daily differences in teachers' beliefs in their capacity to overcome daily hassles. Such differences could partly explain research results that show a negative relationship between teachers' daily sleeping quality and their daily stress experiences (Poon et al., 2019).

As such, stress experiences that teachers go through may also negatively impact subsequent buoyancy beliefs. In fact, among students, the relationship between buoyancy beliefs and manifestations of stress (e.g., (test) anxiety), has been argued and shown to be bidirectional over time. Martin and colleagues (2013) found that buoyancy beliefs and anxiety negatively impact each other over the course of one year, controlling for previous levels in each. Putwain and his colleagues (2015) showed that the same is true over the course of three months.

Expecting bidirectional relationships between teachers' buoyancy and stress experiences is in line with the conservation of resources theory (Hobfoll, 2011) and the broaden and build theory (Fredrickson & Joiner, 2018). Both theories suggest a gain spiral that results from obtaining, fostering and protecting (resources that contribute to) well-being and positive emotions and a loss spiral that results from losing these, or experiencing their negative counterparts. As such, buoyancy as a resource can lead to decreased stress in teachers, which further increases their buoyancy. On the other hand, experiencing stress can also reduce teachers' buoyancy beliefs, which, in turn, increases the likelihood of experiencing stress.

1.3. Present research

This paper's research questions are answered through two quantitative daily diary studies. Daily diary studies include a design in which participants are assessed once per day over a defined period (Gunthert & Wenze, 2012), in this study through a brief set of questionnaire items. Study 1 includes a relatively large sample of teachers, compared to the number of days that they were followed. Study 2 includes relatively few teachers, but follows them for an extended period of time. This adds to the potential of this paper to infer about day-to-day dynamics of teachers' buoyancy beliefs and their relationship with stress, both with respect to a large sample of teachers and time-points. Both studies allow for testing hypotheses regarding the extent to which teachers' stress and buoyancy beliefs vary – and carry over – from day to day (i.e., research question one) and the extent to which teachers' buoyancy beliefs and stress experiences co-occur and predict each other from day to day and from teacher to teacher (i.e., research question two).

Based on the literature discussed in the previous section, we expect that:

1) Teachers' stress and buoyancy beliefs vary significantly from day to day (RQ 1)
2) The relationship between teachers' buoyancy beliefs and perceived stress on the same day is negative (RQ 2)
3) Previous day buoyancy beliefs negatively predict stress on the next day, controlling for previous day stress (RQ2)
4) Previous day stress negatively predicts buoyancy beliefs on the next day, controlling for previous day buoyancy (RQ2)
5) Teachers who report higher average buoyancy beliefs from day to day, report lower average stress from day to day (RQ2)

Finally, regarding the carryover effects of teachers' stress and buoyancy beliefs from one day to the next (RQ1), we do not formulate specific hypotheses. Carryover effects describe how individuals' current states depend on their prior states. If these effects are high, it means that individuals restore equilibrium less quickly after being perturbed and are thus more stable regarding constructs under study (Hamaker et al., 2018). Currently, it is unclear to what extent stress and buoyancy beliefs predict themselves within teachers. On the one hand, teachers could experience one or two stressful situations on a particular workday and be unable to let go of the resulting stress before the next day starts. This would result in high carryover effects of stress. On the other hand, such situations could occur very many times per day, for example from lesson to lesson or even within lessons and teachers could deal with stress before the next lesson. This could imply no day-to-day carryover of stress at all. Similarly, buoyancy beliefs could represent a stable conviction of being able to deal with everyday setbacks and challenges, or they could be more situation specific. As such, regarding the carryover effect of stress and buoyancy from day to day, this study is exploratory.

2. Study 1

The aim of Study 1 was to test our hypotheses over a relatively large number of teachers. In addition, it served to evaluate the dimensionality, reliability, and convergent validity of a daily work buoyancy scale (DWBS).

2.1. Method

Sample The sample for this study was acquired through an advertisement in a professional magazine for Dutch teachers. This advertisement resulted in the participation of a schoolboard that includes six secondary schools. These secondary schools, together, provide the full range of educational tracks in the Dutch secondary school system and teach over 2500 students, typically aged 12 to 18 years old. At these schools, 279 teachers are employed.

These teachers were asked to participate in this study during (online) staff meetings. At these meetings, the purpose and procedure of the study were explained and any questions that teachers had were answered. Specifically, teachers were told that the study included filling out a traditional self-report questionnaire (which was used for validation of the daily questionnaire) and installing a smartphone application during the staff meeting. Subsequently, they were informed that, two weeks after the staff meeting, they would be asked to fill out short daily questionnaires every evening on workdays for three weeks (i.e., 15 workdays). Finally, teachers were assured that participation was confidential, voluntary, and that they could discontinue their participation at any time.

The final sample included $N = 151$ teachers, who completed the traditional questionnaire and at least one daily questionnaire. The number of days on which these teachers returned a daily questionnaire ranged from 1 to 15 ($M = 7.14$, $SD = 4.21$). The total number of filled out daily questionnaires was $N = 1269$. Based on the fact that the average number of days that teachers worked on a weekly basis was 4.03 (i.e., 80.69 % of a full-time workweek), the expected number of daily questionnaires was $N = 1828$. As such, the daily response rate was 69.42 %. On average, participating teachers were 42.50 years old ($SD = 11.34$) and had 13.99 years of teaching experience ($SD = 9.78$). The percentage of females in the sample was 53.90 %.

Measures and Procedure The daily questionnaire for this study was administered through a smartphone application that invited respondents to fill out the questionnaire via a push-notification at 5p.m. and sent a reminder at 9p.m. Both the invitation and the reminder were also sent to participants via e-mail. The questionnaire could also be completed on other devices than a phone (e.g., a computer). To ensure that each measurement occasion corresponded to the intended day, participants were prevented from completing questionnaires of any of the previous days.

Daily stress was measured by means of four items. One item referred to experienced stress in general and read "Today, I felt stressed because of work". The other three items referred to anxiety as a negative emotional stress response. These were based on the items from the state-part of the State-Trait Anxiety Inventory (Van der Ploeg et al., 1982) that had the highest loadings on a factor indicating the presence of anxiety. Specifically, these items read "Today, I was tense because of work", "Today, I felt nervous because of work", and "Today, I worried because of work" (Van Alphen et al., 2022). The items were rated by means of sliders. These sliders could move between values of zero (Completely disagree) and 100 (Completely agree). To reduce the number of items that teachers had to fill out, and to prevent boredom of having to fill out the same set of items every day, a planned missing data design was employed (Enders, 2022). This design contained that the item that refers to stress in general was presented every day, while from the other three items the application made a daily random selection of two items per respondent.

Daily buoyancy beliefs were measured by means of four items, which are presented in the right column of Table 1. These items concern an adaptation of the work buoyancy scale of Martin and Marsh (2008). The original questionnaire items are presented in the left column of the table. As can be seen from the table, the stem "Today, I was good at …" was added to the items to make them suitable for daily administration. Moreover, in line with advise to keep assessments in daily diary studies as brief, clear, and engaging as possible (Conner & Lehman, 2012; Cranford et al., 2006), items were shortened to reduce the burden of filling out the same questionnaire for several consecutive days. Items one and three from the original questionnaire were adapted further, in the sense that their phrasing (I don't let …) was replaced with the phrasing of the original items two and four (I'm good at …). This was done to make the items as uniform as possible and because negatively worded items are more difficult to interpret and require more cognitive resources to process (Chyung et al., 2018; Roszkowski & Soven, 2010). This also meant that other aspects of the wording of items two and four had to be adapted. In all, however, the content of the original items was retained (i.e., the items refer to teachers' capacity to handle work stress, work pressures, setbacks and retain confidence). Like the items on daily

Table 1
Items of Martin and Marsh's (2008) Work Buoyancy Scale and the Daily Work Buoyancy Scale.

Item	WBS	DWBS
1.	I don't let work stress get on top of me	Today, I was good at withstanding work stress
2.	I think I'm good at dealing with work pressures	Today, I was good at dealing with work pressures
3.	I don't let a bad performance or outcome at work affect my confidence	Today, I was good at retaining my confidence
4.	I'm good at dealing with setbacks at work (e.g., poor performance, negative feedback)	Today, I was good at dealing with setbacks

Note. WBS = work buoyancy scale, DWBS = daily work buoyancy scale.

stress, the DWBS items were rated by means of sliders that respondents could move between values of zero (Completely not applicable to me) and 100 (Completely applicable to me) and a planned missing data design was employed in administering this scale. Here, the first item in Table 1 was presented every day and respondents filled in a random selection of two of the other items.

Quality of measures. The reliability of the daily stress scale and the DWBS was evaluated through the multilevel confirmatory factor analysis procedure outlined by Van Alphen et al. (2022). This procedure accounts for the fact that daily measurements are nested within persons and allows for modelling within person differences across days and trait-like, stable, between person differences as separate factors. The approach also provides guidelines for assessing the reliability of daily questionnaire items to measure within and between person differences, respectively.

These analyses showed intraclass correlations between .28 and .41 for the four DWBS items and between .35 and .46 for the four daily stress items. Moreover, the results showed significant (co)variances between teachers in responses on these items. This indicated the necessity of multilevel modelling the data for both scales. Measurement models were specified at the within-teacher level, where all items of the DWBS and the daily stress scale loaded on their respective factors, while all (co) variances at the between-teacher level were estimated freely. These models fitted well to the data for the DWBS ($\chi^2(2) = 11.37$, $p < .01$; RMSEA = .069, CFI = .985) and the daily stress scale ($\chi^2(2) = 7.74$, $p < .05$; RMSEA = .048, CFI = .993). Finally, two models were tested that included a measurement model at the between-teacher level as well. In these models, factor loadings at the within-teacher level and the between-teacher level were constrained to be the same per item, so that the constructs could be interpreted similarly at both levels (Van Alphen et al., 2022). These models too, fitted well to the data for the DWBS ($\chi^2(7) = 41.47$, $p < .001$; RMSEA = .070, CFI = .945) and the daily stress scale ($\chi^2(7) = 31.33$, $p < .01$; RMSEA = .053, CFI = .970).

Following Van Alphen et al. (2022), the unstandardized parameter estimates of the last models were used to calculate two versions of McDonalds' ω reliability coefficient for both scales. These include ω_b, the reliability of the scales for measuring trait-like between-teacher differences in buoyancy and stress, and ω_w, the reliability of the scales for measuring state-like within-teacher variations in buoyancy and stress from day to day. The reliability of the scale for measuring between-teacher differences in buoyancy was $\omega_b = .88$. This shows that the between-teacher factor in the final factor model accounts for 88 % of the variance in observed teacher-level means of the scale scores. The reliability of the scale for measuring daily within-teacher differences in buoyancy was $\omega_w = .86$. This shows that the within-teacher factor in the final model accounts for 86 % of the variance in teachers' daily deviations from their mean scale scores. For the daily stress scale, reliabilities were $\omega_b = .88$ and $\omega_w = .90$, respectively.

To inspect the convergent validity of both scales, a factor model was evaluated in which the factors representing teachers' daily differences in stress and buoyancy beliefs were related to each other on the within-teacher level. On the between-teacher level, the factors representing differences in teachers' stable, trait-like stress and buoyancy were related to each other, and to a factor representing the original buoyancy construct of Martin and Marsh (2008). This model fitted well to the data ($\chi^2(76) = 213.69$, $p < .001$; RMSEA = .038; CFI = .953). Daily differences in teachers' buoyancy beliefs correlated negatively with daily differences in stress ($r = -.66$, $p < .001$). Stable differences between teachers in buoyancy, as measured with the DWBS were positively correlated to Martin and Marsh's (2008) original buoyancy construct ($r = .54$, $p < .001$) and negatively to stable differences in teachers' stress ($r = -.72$, $p < .001$). These results support the convergent validity of both scales.

Analyses Through the factor model that was used to inspect the validity of the DWBS and daily stress scale, the relative amount of variance in teachers' buoyancy beliefs and stress due to daily within-teacher differences and stable between teacher differences could be estimated. As such, these analyses also served to test this study's first hypothesis (see Results). To test this study's other substantive hypotheses about teachers' buoyancy beliefs and their relationship with teachers' stress experiences from day to day (and teacher to teacher), a random intercept cross-lagged panel model (RI-CLPM) was evaluated for the first week of data.[1] An advantage of this model over traditional cross-lagged panel models is that it accounts for stable, trait-like differences between persons when estimating relationships between variables over time. As such, the relationships that are reported solely reflect relationships of within-person fluctuations in variables over time. This results in less erroneous estimations regarding the presence, causal priority, and sign of Granger causal relationships (Hamaker et al., 2015).

The RI-CLPM was fitted to daily mean scale scores of buoyancy and stress, following the steps of building up a basic RI-CLPM outlined by Mulder and Hamaker (2021). This model estimates the (co)variance of stable trait-like, between teacher differences in buoyancy and stress. It also estimates 1) the respective autoregressive relationships of buoyancy and stress within teachers, from one day to the next (i.e., carryover), 2) the relationship between buoyancy and stress within occasions, and 3) the cross-lagged relationships between buoyancy and stress within teachers over time. The fit of this model was assessed using a non-significant χ^2, CFI that approaches.95, RMSEA that is close to.06, and SRMR that approaches.08 as thresholds for acceptable model fit (Hu and Bentler, 1999).

As suggested by Mulder and Hamaker (2021), it was further tested whether 1) (residual) (co–)variances in the within-part of the model, 2) grand means of buoyancy and stress, and 3) (cross-)lagged effects of buoyancy and stress could be constrained to be equal over time. Differences in model fit between the basic RI-CLPM and models with different combinations of constraints were tested through chi-square difference tests ($\Delta\chi^2$). All analyses were conducted in Mplus 8.4 (Muthén & Muthén, 2017), using the robust maximum likelihood (MLR) algorithm which also handled missing data.

2.2. Results

The estimates of the confirmatory factor model that served to evaluate the validity of the DWBS and the daily stress scale showed that, of the total variance in buoyancy, 54.13 % is due to daily variation in teacher's scores on the DWBS items, whereas 45.87 % is due to stable differences between teachers. Freely estimating the within-teacher daily variance showed that it was significant ($\sigma^2_w = 1.18$ (s.e. = .27), $p < .001$). For stress, 57.14 % of the total variance is due to daily differences within teachers and 42.86 % can be attributed to stable differences between teachers. For this scale too, the variance on the within-teacher level is significant ($\sigma^2_w = 1.33$ (s.e. = .21), $p < .001$). This shows that buoyancy and stress vary significantly from day to day, supporting hypothesis one.

The basic RI-CLPM that served to evaluate hypotheses 2 through 5 fitted well to the data. The fit of this model, as well as models in which increasingly more constraints are applied, are reported in Table 2. These results show that the concurrent within-teacher covariances between buoyancy and stress and the grand means of the item scores could be constrained to be equal across days. The equality of grand means shows that teachers' buoyancy and stress are stable constructs at the population level, for the duration of this study and the part of the population that the sample represents. Constraining the (cross-)lagged relationships to be equal from day to day led to a significantly worse fitting model.

[1] This is because, for this first study, measurements were not taken from teachers during weekends and RI-CLPMs require time-intervals between measurements to be the same (Mulder & Hamaker, 2021). Moreover, for weeks two and three of the study, cases with missing data on all variables were $N = 43$ and $N = 97$, respectively, which lead to convergence problems. For this reason, a second study was performed and reported on in this papers' sections on Study 2.

Table 2
Fit of Increasingly More Constrained Random Intercept Cross-lagged Panel Models of the Relationship Between Teachers' Buoyancy and Stress Experiences from Day to Day.

Model tested	$\chi^2(df),p$	$\Delta\chi^2(df),p$	RMSEA	CFI	SRMR	Pass?
1. Basic RI-CLPM	30.86 (21), $p = .08$		.056	.979	.069	Yes
2. Constrained covariances	33.91 (25), $p = .11$	3.05(4), $p = .55$	.049	.981	.086	Yes
3. Constrained variances and covariances	63.46 (33), $p < .01$	25.82(4), $p < .001$	.079	.934	.111	No
4. Constrained grand means	43.52 (29), $p = .04$	12.66(8), $p = .12$	.058	.969	.082	Yes
5. Model 2 + 4	45.74 (33), $p = .06$	14.88 (12), $p = .25$	.051	.972	.091	Yes
6. Model 5 + constrained (cross-)lagged effects	71.18 (45), $p < .01$	40.32 (24), $p = .02$	.063	.943	.082	No

Unstandardized parameter estimates of the final model are presented in Fig. 1. In line with hypothesis 2, these estimates show that teachers' concurrent buoyancy and stress covary negatively on each day of this study. Buoyancy and stress, however, do not significantly predict each other from day to day in the current data. As such, hypotheses 3 and 4 were not supported. In line with hypothesis 5, trait-like between-teacher differences in buoyancy and stress were strongly negatively related (r_b = -.74). Finally, regarding the carryover effect of buoyancy beliefs, the results show that, for four of the five days, these effects were significant and positive. This means that teachers who scored above their expected (i.e., average) buoyancy score on the day before, also scored above their expected score on the next. This carryover is not the same for each day, however, since the autoregressive effects could not be constrained to be the same without loss of model fit. From the fourth day to the fifth, no buoyancy is carried over at all. On days 2 through 4 the explained variance in buoyancy is 11.30 %, 11.10 %, and 16.60 %, respectively. Stress only significantly carried over from day 1 to day 2.

2.3. Brief discussion

The results of Study 1 showed that teachers' buoyancy beliefs and stress experiences vary significantly from day to day, as hypothesized. Notably, both constructs vary more from day to day than from teacher to teacher. In addition, results show only a small amount of stability in teachers' buoyancy from one day to the next (around 11 to 16 % of teachers' buoyancy is carried over). This stability also fluctuated, since the autoregressive effects could not be constrained to be the same without loss of model fit. The results thus show that more buoyancy is carried over on some days than on others. Teachers' stress experiences do not seem to carry over from day to day in the week that this study describes.

Regarding the relationship between teachers' buoyancy and stress experiences, this study, in line with previous research (Collie, 2021; Martin & Marsh, 2008a), indicates that teachers who belief to be more buoyant in general also feel less stressed (or the reverse). A new result is that teachers who feel more buoyant on particular days, concurrently feel less stressed, and that this relationship does not change over the course of one week. Finally, this study suggests that teachers whose buoyancy beliefs on a particular day are higher do not feel any more or less stressed on the next, nor do teachers who feel more stressed on a particular day feel any more less buoyant on the next.

A limitation of Study 1 is that it only took a small longitudinal snapshot of the daily dynamics between teachers buoyancy beliefs and stress experiences. To be more certain that effects reported in this study are not an artefact of only having studied teachers for one particular week, the next study reports on daily relationships between teachers' buoyancy and stress for eight weeks.

3. Study 2

3.1. Method

Sample The sample for this second study was acquired through convenience, meaning that secondary school teachers from the authors' networks were asked to participate. Any questions regarding their participation were answered through individual phone conversations and subsequent e-mails. Similar to Study 1, participating teachers were told that the study included installing a smartphone application which would ask them to fill out short daily questionnaires (see Study 1). Additionally, the teachers were informed that they would be asked to complete these questionnaires for eight consecutive weeks, each day, including weekends. Finally, they were assured that their participation was confidential, voluntary, and that they could discontinue their participation at any time.

The sample included $N = 10$ teachers, who completed at least one daily questionnaire. The return rate of daily questionnaires ranged from

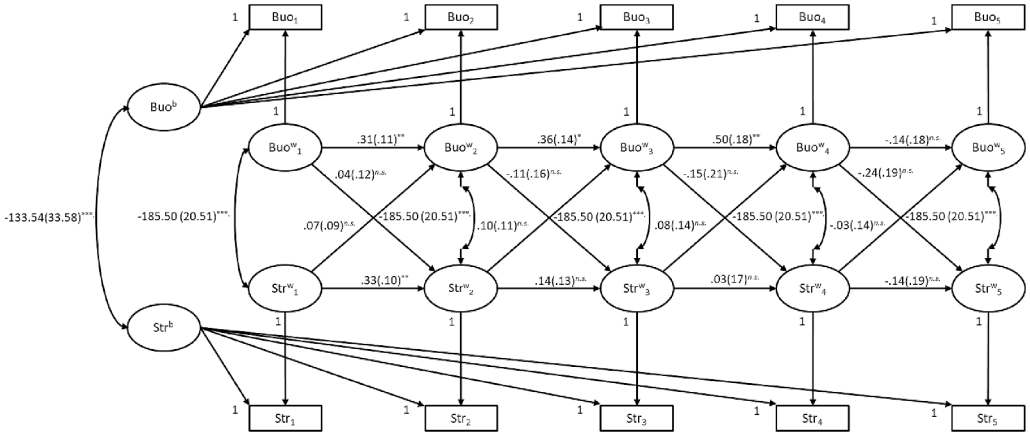

Fig. 1. Unstandardized parameter estimates of a RI-CLPM in which covariances between buoyancy and stress and the grand means of the item scores were constrained to be equal across days. For clarity of the figure, and because the level of buoyancy was not of substantive interest for this study, grand means were not included. Standard errors are presented in parentheses. Buo = buoyancy, Str = Stress. Superscripts 'b' and 'w' indicate between- and within-teacher components of the model, or trait-like and state-like buoyancy/stress, respectively. * = p < .05, ** = p < .01, *** = p < .001, n.s. = p > .05.

1 to 61 ($M = 30.84$, $SD = 17.69$), where the total number of completed daily questionnaires was $N = 569$. Given the maximum number of days it was possible to participate, the expected number of daily questionnaires was $N = 610$. This means that the daily response rate was 93.28 %. The average age of participating teachers was 33.44 years ($SD = 8.24$) and their average teaching experience was 9.44 years ($SD = 7.04$). Three females were included in the sample.

Measures, procedure, and instruments The daily questionnaire for Study 2 was administered through the same smartphone application as in Study 1, which asked participants to complete a questionnaire via a push notification at 5p.m., with a reminder at 9p.m. Both the invitation and the reminder were also sent to participants via e-mail. To ensure that each measurement occasion corresponded to the intended day, the participants were prevented from completing questionnaires of any of the previous days. Daily stress and daily buoyancy were measured through the same instruments as in Study 1.

Analyses In Study 2, the hypotheses regarding the daily relationship between teachers' stress and buoyancy were tested through an instance of Dynamic Structural Equation Modelling (DSEM) (Hamaker et al., 2018). Like the RI-CLPM, the general DSEM framework allows for evaluating the (co)variance of stable trait-like, between teacher differences in variables, as well as the respective autoregressive relationships (i.e., carryover), the concurrent relationships within occasions, and the cross-lagged relationships between variables over time, respectively. However, unlike the RI-CLPM, DSEM allows the inclusion of a large number of time-points (Asparouhov et al., 2018). It does so by organizing data in long format, clustering observations under individuals as would be done in regular multilevel analysis, rather than in wide format as is the case for analysing a RI-CLPM. As a consequence, longitudinal data is decomposed into a time-varying 'within-person' and a time-invariant 'between-person' component. This decomposition results in a within-person level model and a between-person level model. In the within-person level model, lagged and cross-lagged relationships appear as single estimates in DSEM (whereas a RI-CLPM uniquely estimates these parameters for each occasion to the next). Given the dataset of $T = 61$ days, estimates for all these relationships represent the overall effects for all days combined. In DSEM, normally, these single estimates have variances (i.e., random effects) which are included and can be modelled on the between-person level (Hamaker et al., 2018). As in normal multilevel modelling, including this between-person level also accounts for dependency in the data that results from measuring the same persons on multiple occasions.

However, given this study's small sample size ($N = 10$) on the between-level (i.e., individual teachers), accounting for this dependency could not be done using a standard multilevel analysis approach. This is because there was not enough data for an accurate estimation of variance components on this level. Based on the article by McNeish & Stapleton (2016) we decided to use a fixed effect model (within the DSEM framework). In this model we added ten dummy variables, one for each participant in our sample, to account for between-person differences in the dependent variables. As such, these dummies enable the partitioning of within- and between-person variance and the 'pure' modeling of within-person variance, just like random intercepts do in multilevel models. This comes at the price of not being able to include the main effect of individual-level predictors (McNeish & Stapleton, 2016). However, since there is no power for testing individual-level effect with an N of 10 to begin with, and since fixed-effect models provide even better protection against confounding on the individual level than multilevel models (McNeish & Stapleton, 2016), we decided this was an appropriate way to model our data for Study 2.

Before running our final model, we determined that there was no significant mean trend in buoyancy and stress over time that needed to be accounted for in our model. This was done through two linear regression analyses with time as the predictor and buoyancy and stress as the respective outcome variables (McNeish & Hamaker, 2020). These tests showed close to zero and non-significant effects for stress (β = -.046, p = .268) and buoyancy beliefs (β = -.070, p = .130), which suggests the absence of a linear trend over time.

In the final model, buoyancy beliefs and stress were included as scale means of their respective questionnaire items. Currently, for DSEM, a Bayesian estimation approach is required (McNeish & Hamaker, 2019). Therefore, model convergence was assessed using the potential scale reduction (PSR) criterion of each model parameter. Parameter conversion is sought after and indicated by the PSR being close to one, and < 1.05 (Gelman & Rubin, 1992). Additionally, non-convergence was checked by inspecting the trace plots of each parameter (Hamaker et al., 2018). These parameter trace plots should look like 'fat caterpillars', indicating stable convergence (Heathcote et al., 2019). We used 10,000 Markov Chain Monte Carlo iterations with two Markov chains. The first half of each chain was discarded as the burn-in period (Hamaker et al., 2018).

3.2. Results

The fixed effects model fitted the data well. This was indicated by the PSR converging close to one for each parameter (all < 1.05). In addition, for each parameter, the trace plots were inspected. These likewise indicated stable estimations for each parameter of interest. The unstandardized parameter estimates of the fixed effect model are shown in Fig. 2.

These results show that, in line with hypothesis 2 and the findings of Study 1, buoyancy and perceived stress are significantly and negatively related on the same day. However, no significant relationship was found for the cross-lagged effect of buoyancy on stress, nor the cross-lagged effect of stress on buoyancy. As such, like in Study 1, no support for hypotheses 3 and 4 was found within this sample. Finally, the mean autoregressive effects of both buoyancy and stress were found to be significant. This means that, on average, teachers who reported higher levels of buoyancy and/or stress on a given day are likely to carry over these values of buoyancy and/or stressed with them to the following day. The model explained 34.30 % of the variance in buoyancy and 33,60 % of the variance in perceived stress.

3.3. Brief discussion

The results of Study 2 support the hypothesis that teachers' buoyancy negatively coincides with stress of the same day (hypothesis 2). However, no significant effect was found for either buoyancy predicting stress of the following day or for stress predicting buoyancy of the following day (hypotheses 3 and 4). As such, the majority of the results from Study 1 are corroborated by the data in Study 2 that describe a longer period of time. One difference between the results of Study 1 and Study 2 is that Study 2 provides stronger support for carryover effects of buoyancy and stress from one day to the next. This is because the number of time-points in Study 2 is much larger than in Study 1. As in Study 1, however, these carryover effects are relatively small.

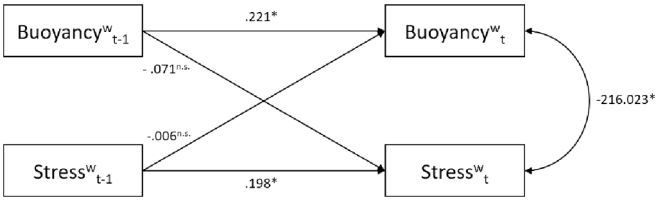

Fig. 2. Unstandardized parameter estimates of the DSEM focusing on the within-teacher relationships of buoyancy and perceived stress. For clarity, and because no hypotheses are tested at this level, the dummy variables are not included. Superscript 'w' indicate within-teacher components of the model (i.e., state-like buoyancy/stress). * = credibility interval (95 %) does not include 0, n.s. = credibility interval (95 %) does include 0.

4. General discussion

This paper described two studies on the daily dynamics between teachers' buoyancy beliefs and their perceived stress. The reason for investigating these daily dynamics was that, to date, buoyancy had not been studied in close proximity to everyday experiences, despite its pertinence to everyday work. Moreover, longitudinal research on teachers' stress, buoyancy and their relationship was lacking. It was hypothesized that teachers' stress and buoyancy would (1) vary from day to day, (2) relate negatively on the same day, (3) buoyancy would negatively predict stress on the next day, controlling for previous day stress, (4) stress would negatively predict buoyancy on the next day, controlling for previous day buoyancy, and (5) stress and buoyancy would relate negatively from teacher to teacher. Finally, this study explored to what extent previous day stress and buoyancy carry over to the next day.

In line with Schmidt et al. (2017), hypothesis 1 was supported by the data. The same is true for hypotheses 2 and 5, which is in line with previous research as well (Collie, 2021; Martin & Marsh, 2008a). As such, teachers' stress and buoyancy varied from day to day and on days that teachers feel buoyant they feel less stressed (and the reverse). Moreover, teachers who feel more buoyant overall feel less stressed overall (and the reverse).

Regarding the carryover of stress and buoyancy beliefs from one day to the next, this research suggests that effects are small. Carryover effects of both buoyancy beliefs and stress in Study 2 were around .2. This suggests that after a day, of a peak or dip in stress or buoyancy beliefs, only one fifth remains. After two days, this would be .2*.2 = 4 %. As such, the current study suggests that after a peak in stress, teachers take approximately two days, on average, to return to their baseline stress levels (i.e., recover from stress). However, this is assuming that peaks in stress occur according to a random process and that no other peaks in stress occur during these two days. For future research, it would be interesting to estimate differences between teachers in the rate at which they return – or bounce back – to their baseline levels of stress and predict these differences from between-teacher differences in buoyancy beliefs. This would provide further insight into the extent to which buoyancy beliefs offer proactive stress-resistance (Putwain et al., 2023; Montpetit et al., 2010).

No support was found for negative effects of buoyancy on stress from one day to the next or negative effects of stress on buoyancy from one day to the next (hypotheses 3 and 4). One possible explanation for not finding these daily cross-lagged effects between buoyancy beliefs and stress, respectively, is suggested by other results from Studies 1 and 2. That is, in line with hypothesis 1, teachers' stress and buoyancy varied substantially over time. However, as mentioned above, only little stress and buoyancy appeared to carry over from day to day. This suggests that teachers' buoyancy beliefs and stress are more momentary than daily experiences. Since effects of variables on themselves and other variables decay exponentially with time (events that happen further in the past have less impact on current events; Kuiper & Ryan, 2018; Lai & Lu, 2017), it is possible that the dynamics between teachers' buoyancy and stress happen on a time-scale that is smaller than daily. Therefore, a recommendation for future research would be to study the dynamics between teachers' buoyancy beliefs and stress on a smaller time-scale (e.g., from lesson to lesson).

Another explanation for the absence of cross-lagged relationships between teachers' stress and buoyancy beliefs over time possibly lies in how these constructs were operationalized in the current studies. That is, substantial overlap exists between these constructs, both concurrently from day to day and from teacher to teacher. Possibly, this overlap is due to similarities between items that measured daily buoyancy and anxiety, respectively. For example, the DWBS contains the item "Today, I was good at withstanding work stress", while the daily measure of stress in this study included the item "Today, I felt stressed because of work". The former item aims at capturing the capacity of dealing with daily stressors as a *process* (i.e., focus on *withstanding*). The latter item is intended to measure the *outcome* of that process (i.e., focus on *felt*). However, teachers might have interpreted the buoyancy item with their current stress (i.e., the outcome) in mind and concluded that, if their stress was high, they were not good at withstanding work stress. This suggestion is partly supported by a post-hoc analysis of the model that was used to inspect the convergent validity of the scales in Study 1. This analysis showed that the fit of this model improved when a residual correlation was included between the stress and buoyancy items that mention 'stress' in their wording. As such, the scales that were used to measure teachers' buoyancy beliefs and stress experiences might partly be subject to a jangle fallacy, in the sense that these dissimilarly labelled scales measure similar constructs (cf. Marsh et al., 2019). Such a jangle fallacy can result low cross-lagged predictive power once the concurrent correlations are partialled out.

Therefore, future research is recommended to operationalize teachers' buoyancy more in line with its conceptualization as the capacity to successfully *overcome* (i.e., a process of dealing with) setbacks and challenges that are typical of the ordinary course of everyday work. If teachers' beliefs in this capacity are of interest, this can be done through questionnaire items that ask teachers to rate how long they typically take to recover from peaks in stress from particular everyday hassles or how confident they are about successfully dealing with stressful situations at the next measurement occasion. Such items would prompt teachers' beliefs about their capacities for overcoming everyday stress, rather than their recollections of having been stressed. If it is not teachers' beliefs, but their actual capacity of overcoming everyday stress that researchers are interested in, questionnaire items are not suitable. In that case, more objective physiological data (e.g., heart rate or skin conductivity) can be used to identify peaks in stress and the rates at which teachers 'bounce back' to their normal levels of functioning. Both these approaches would be in line with research that investigates day-to-day resilience (i.e., buoyancy) as a process (Montpetit et al., 2010) and earlier calls for objective and multidimensional indicants of buoyancy in addition to existing measures of buoyancy (Putwain et al., 2023; Martin & Marsh, 2008a; 2009), that have not yet been answered in research.

4.1. Limitations

Before discussing the implications of this study's results for theory and practice, some limitations need to be addressed. First of all, despite the relatively large sample of teachers (Study 1) and a large sample of time-points (Study 2), the fact that this study concerned work related stress may have resulted in the non-participation of teachers with the most extreme high and low stress experiences. Teachers who experienced little or no stress may have been less inclined to participate in this research because, for them, the personal relevance to contribute was low. On the other hand, teachers who experienced the most severe amounts of stress may not have been inclined to spend their remaining valuable time and energy on completing questionnaires. Therefore, it seems plausible that a part of the population under investigation was underrepresented. Future research should therefore carefully consider additional methods to attain a representative sample of the population under investigation.

Second, a larger sample that combines many teachers and many occasions would have allowed the modelling of stress and buoyancy as latent factors in the longitudinal analyses, instead of using mean scores. This can be an improvement, because using sum scores unrealistically assumes the absence of measurement error. Mulder and Hamaker (2021) discuss RI-CLPMs that include latent factors, thereby accounting for measurement error in the model. Importantly, the authors emphasize the need to test for measurement invariance over time, making sure that the latent factors for each occasion are comparable. For DSEM too, extending the model to include latent factors instead of single indicators is proposed as a good method to address the presence of measurement error (Asparouhov et al., 2018). However, given the high reliability

coefficients found for both the DWBS and the stress scale used in this study, we think that using scale scores was warranted for the purposes of our study.

Finally, samples that include many teachers and time-points would also allow for testing the effects of third variables on carryover effects, that had to be omitted in the current study. For example, anxiety is higher among beginning teachers than in their more experienced colleagues. This is because beginning teachers are less certain about how they perform and how to deal with demands of – and changes in – their work (Keller et al., 2014). As a consequence, more experienced teachers could also be more stable in their stress, anxiety, and buoyancy (i.e., show higher carryover) than beginning teachers. To evaluate such differences larger samples in terms of teachers are required in future research.

4.2. Implications and conclusion

Despite the limitations discussed above, this paper shows that, in the current samples, both teachers' stress experiences and their buoyancy vary considerably from day to day, but carry over to subsequent days only minimally. This suggests that both teachers' buoyancy beliefs and stress are – to a considerable extent – state-like constructs, in addition to being trait-like. Theoretically, these findings may call into question the extent to which buoyancy beliefs refer to a frontline capacity that enables teachers to play a proactive role in their adaptation, rather than simply reacting to adversity in their environments (Martin & Marsh, 2009). High daily variation, and low carryover from day to day, suggest that teachers' buoyancy is reactively subject to changes in situational circumstances to a higher extent than can be expected from a proactive capacity for dealing with stress. This is also in line with previous findings that show higher negative effects of anxiety on buoyancy over time than those of buoyancy on anxiety (Martin et al., 2010; Putwain et al., 2015). Based on our findings, the relationship between stress and buoyancy seems more dynamic than research has shown so far. However, as mentioned earlier, to draw conclusions about the extent to which buoyancy and stress actually influence each other, studies that include a more representative sample of teachers and employ designs with a higher time intensity of measures, which, at the same time, rule out a possible jangle fallacy between stress and buoyancy are needed.

For practice, the results suggest that teachers' stress and buoyancy are relatively malleable and can therefore be targeted by interventions. The low carryover effects that were found in this study, however, suggest that teachers can feel uncapable of dealing with high levels of stress on one day, while on the next day they only experience little stress and feel highly capable of dealing with it. As shown by Schmidt et al. (2017), this likely has to do with particular hassles that teachers have to deal with on particular days and about which they feel strongly negatively. If so, this means that interventions should focus on overcoming these particular hassles to change teachers' stress and buoyancy experiences, instead of trying to increase buoyancy as a general capacity or reduce stress in general. Depending on whether buoyancy or stress is targeted, this could be done through, for example, taking away particular stressors (e.g., reducing the grading load for a particular class) or creating mastery experiences for dealing with hassles through direct coaching (e.g., through earpieces worn during instruction [Crasborn et al., 2018]). Both such interventions can be facilitated by school administrators.

The fact that (how teachers deal with) stress differs on a daily basis can also be considered by school administrators and policy makers in other ways. For example, administrators could take daily effects of stress among their staff into account when scheduling plenary activities (e.g., professional development or team meetings). Moreover, they can consider discussing the sources of stress that individual teachers experience from day to day and distribute these over teachers' work weeks through their influence on the division of tasks and teaching schedules. To create more room for school administrators to do so, policy makers should consider reducing teaching hours of teachers in general. This is easier said than done, when many countries struggle to deal with teacher shortages. However, internationally, having to teach too many lessons is among the most important perceived sources of stress reported by teachers and is negatively related to teachers' satisfaction and desire to continue in the profession in many countries (OECD, 2023).

Finally, the finding that teachers' buoyancy and stress were highly state-like and relatively unrelated over days in the current studies could somewhat ameliorate the generally held view of teaching as an altogether stressful profession. This is not to say that teaching is not stressful at all, or that it cannot be stressful at times. However, this study suggests that, at least, for some teachers, some days are more stressful than others and that teachers can change in how well they handle stressful days.

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CRediT authorship contribution statement

Joost Jansen in de Wal: Writing – review & editing, Writing – original draft, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Thijmen van Alphen:** Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jaap Schuitema:** Writing – review & editing, Project administration, Funding acquisition, Conceptualization. **Lucija Andre:** Writing – review & editing, Funding acquisition. **Joran Jongerling:** Writing – original draft, Formal analysis. **Thea Peetsma:** Writing – review & editing, Supervision, Resources, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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