Costs and Benefits of Acting Extraverted: A Randomized Controlled Trial

Rowan Jacques-Hamilton, Jessie Sun, and Luke D. Smillie

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Rowan Jacques-Hamilton
University of Melbourne

Jessie Sun
University of California, Davis

Luke D. Smillie
University of Melbourne

Evidence suggests that extraverted (i.e., bold, agentic) behavior increases positive affect (PA), and could be targeted in wellbeing interventions. However, this evidence is either causally ambiguous or has questionable ecological validity, and the potential costs of sustained extraverted behavior have received minimal attention. To address these limitations, we conducted a randomized controlled trial examining the wellbeing benefits and costs of an extraverted behavior intervention conducted in everyday life. Participants ($n = 147$) were randomly assigned to an "act-extraverted" intervention or a "sham" (active control) intervention for 1 week in everyday life. Additional data for a contact control condition were obtained from a previous study ($n = 76$). Wellbeing outcomes included PA and negative affect (NA), feelings of authenticity, and tiredness—assessed both in the moment and retrospectively. There was a positive overall effect of the acting extraverted intervention on PA and authenticity. However, wellbeing outcomes also depended on dispositional extraversion: more introverted participants had weaker PA increases, experienced increased NA and tiredness, and decreased feelings of authenticity. Implications for wellbeing interventions and personality theory are discussed.

Keywords: extraversion, extraverted behavior, positive affect, wellbeing, randomized controlled trial

Decades of research have shown that personality traits are important predictors of wellbeing, with the Big Five trait domain of extraversion emerging as a particularly robust positive predictor of happiness and flourishing (see also Costa & McCrae, 1980; Keyes, Shmotkin, & Ryff, 2002; Lucas & Diener, 2009; Nave, Sherman, & Funder, 2008; Schmutte & Ryff, 1997; Smillie, De-Young, & Hall, 2015; Steel, Schmidt, & Shultz, 2008; Sun, Kaufman, & Smillie, 2017). In addition, experience sampling studies and laboratory experiments suggest that people feel happier in moments when they are acting more extraverted (e.g., Blackie, Roepke, Forgeard, Jayawickreme, & Fleeson, 2014; Fleeson, Malanos, & Achille, 2002; McNiel, Lowman, & Fleeson, 2010; Smillie, Wilt, Kabbani, Garratt, & Revelle, 2015; Sun, Stevenson, Kabbani, Richardson, & Smillie, 2017; Weninger & Holder, 2013; Wilt, Noftle, Fleeson, & Spain, 2012). This raises the intriguing possibility that people could reap the wellbeing benefits of *being* more extraverted simply by *acting* more extraverted (Blackie et al., 2014; Fleeson et al., 2002; McNiel et al., 2010; Weninger & Holder, 2013; Wilt et al., 2012). However, to date, no published research has investigated whether increasing one's levels of extraverted behavior throughout daily life could improve wellbeing. There has also been minimal attention given to the potential negative consequences of acting extraverted, which might be especially likely for people lower in trait extraversion (i.e., "introverts"; Cain, 2012; Little, 2008; Zelenski, Sobocko, & Whelan, 2014). Using the first randomized controlled trial on this topic,[1] we examined the positive and negative wellbeing consequences of increasing real-world extraverted behavior.

Extraverted Behavior and Positive Affect

The association between trait extraversion and wellbeing is most pronounced for one component of wellbeing in particular—positive

[1] Although our intervention study appears to be the first of its kind in this literature, we became aware of a manuscript reporting a similar study being prepared for publication while the present paper was under review (Margolis & Lyubomirsky, 2018).

affect (PA). Here, we defined PA in terms of positive valence positive valence and high arousal (e.g., "excited," "lively"), following Watson and Tellegen (1985). The relation between extraversion and PA has been known for decades (Costa & McCrae, 1980; Steel et al., 2008), is generalizable across cultures (Fulmer et al., 2010; Schimmack, Radhakrishnan, Oishi, Dzokoto, & Ahadi, 2002), and holds after ruling out potential confounding factors such as scale content overlap and common method variance (Lucas & Fujita, 2000; Smillie et al., 2015). In addition, studies using the experience sampling method (ESM; Conner & Lehman, 2012) consistently replicate this association at the level of momentary states: People report feeling more PA when they act more extraverted in their everyday lives (Fleeson et al., 2002; Heller, Komar, & Lee, 2007; Sun, Stevenson, et al., 2017; Wilt, Bleidorn, & Revelle, 2017; Wilt et al., 2012). Interestingly, none of this research has found evidence that these within-person associations are moderated by trait extraversion: introverts and extraverts report similarly high levels of PA following extraverted behavior.

Although it may seem counterintuitive that introverts enjoy acting extraverted as much as extraverts, this effect is predicted by Fleeson and colleagues' (2002) principle of state-trait isomorphism. This theory posits that states and traits share many properties and consequences and differ largely in terms of time course: States describe affects, behaviors, and cognitions over a short period of a time, whereas traits summarize those same affects, behaviors, and cognitions over a longer period of time (i.e., as the mean of a distribution of states). From this perspective, an extravert is simply someone who acts more extraverted more often compared to an introvert, but there is flexibility in behavior, so even introverts sometimes behave in an extraverted way (Fleeson, 2001). Indeed, trait levels of extraversion and other Big Five personality traits correspond well to average levels of their corresponding states assessed over 1–2 weeks (Fleeson & Gallagher, 2009). State-trait isomorphism therefore suggests that extraverts may experience higher trait PA than introverts simply because they more frequently behave in an extraverted way (Ching et al., 2014; Wilt et al., 2012). If so, it would follow that introverts could increase their experiences of PA by simply enacting extraverted behaviors more often (Fleeson et al., 2002; Wilt et al., 2012).

Several laboratory-based experimental studies offer causal evidence for the affective benefits of acting extraverted (Fleeson et al., 2002; Gallagher, Fleeson, & Hoyle, 2011; McNiel & Fleeson, 2006; McNiel et al., 2010; Smillie, Wilt, et al., 2015; Sun, Stevenson, et al., 2017; Zelenski, Santoro, & Whelan, 2012; Zelenski et al., 2013). Participants in such laboratory-based experiments complete short interactive tasks, during which they are instructed to act more extraverted (e.g., "act bold, talkative, and assertive"), more introverted (e.g., "act reserved and shy"), or do not receive any behavioral instructions. Consistent with the findings of correlational ESM studies, these laboratory-based experimental studies show that participants instructed to act extraverted report greater levels of PA, relative to participants instructed to act introverted. This effect holds for both self- and informant-ratings of states and has not been found to depend on trait levels of extraversion— introverts and extraverts reap similar affective benefits from acting extraverted (Fleeson et al., 2002; McNiel & Fleeson, 2006; McNiel et al., 2010; Zelenski et al., 2012).

A practical implication of this research is that acting more extraverted could be a simple tool for enhancing wellbeing. For example, some have suggested that acting extraverted could be implemented as a positive psychology intervention in healthy populations (Blackie et al., 2014; Wilt et al., 2012), or as a treatment intervention for anhedonia in clinical populations (i.e., similar to Behavioral activation therapy; Cuijpers, Van Straten, & Warmerdam, 2007; Zelenski et al., 2013). Proponents of this notion argue that acting more extraverted could be especially beneficial for introverts, who tend to act extraverted less often, and therefore experience the resulting hedonic benefits less frequently than extraverts (Blackie et al., 2014). However, conclusions about the potential therapeutic applications of extraverted behavior may be premature, because of two critical gaps in the evidence base. First, the possible costs of sustained extraverted behavior (especially for introverts) have received scant attention in previous research. Second, a randomized controlled trial (RCT) that includes both assignment to experimental and control conditions *and* the sampling of experiences throughout daily life has never been conducted. Addressing these two evidence gaps is essential to determine whether acting extraverted in everyday life could yield wellbeing benefits.

Potential Costs of Acting Extraverted

Little is known about the potential negative consequences of sustained increases in everyday extraverted behavior. Some have argued that pushing introverts to act more extraverted could be harmful (e.g., Cain, 2012; Little, 2008). This idea fits well with evolutionary perspectives on personality, which posit that extraverted behavior is not uniformly advantageous, but has different costs and benefits in different contexts (Lukaszewski & von Rueden, 2015; Nettle, 2005). Until we have a well-rounded understanding of both the positive and negative consequences of extraverted behavior, advocating any real-world applications of acting extraverted could be premature and potentially hazardous.

Several theoretical perspectives suggest that acting more extraverted would have negative impacts on introverts, especially in terms of perceived authenticity and feelings of tiredness. *Authenticity* is a subjective judgment that one's actions express one's true self (Fleeson & Wilt, 2010), whereas tiredness is a subjective feeling of lacking energy (Leikas & Ilmarinen, 2017). The trait-consistency hypothesis (Fleeson & Wilt, 2010) proposes that people feel most authentic when acting in line with their disposition (i.e., in a manner consistent with their personality), and that acting counterdispositionally can induce feelings of inauthenticity. The contra-trait effort hypothesis (Gallagher et al., 2011) proposes that counterdispositional behaviors are more strenuous than trait-concordant behaviors, which could result in feelings of tiredness (Zelenski et al., 2012). Similarly, free trait theory (Little, 2008) posits that when people behave against their dispositional tendencies they will subsequently need to "restore" or "recharge," otherwise they will suffer physical and emotional costs, including tiredness. Thus, it's possible that introverts who try to increase their levels of extraverted behavior might experience affective benefits at the cost of feeling inauthentic and tired.

Despite the apparent plausibility of these theoretical arguments, studies to date have yielded little empirical evidence for costs of acting extraverted. One series of ESM studies revealed, perhaps surprisingly, that both extraverts and introverts felt more authentic during moments in which they were acting more extraverted (Fleeson

& Wilt, 2010). These results contradict the trait-consistency hypothesis and suggest that acting extraverted could actually increase authenticity in introverts. In addition, two brief laboratory studies have investigated whether extraverted behavior can increase feelings of tiredness. Gallagher et al. (2011) found that introverts did not find it significantly more effortful to follow act-extraverted instructions, relative to act-introverted instructions. Similarly, Zelenski et al. (2012) found that acting extraverted did not impact introverts' performance on a cognitive task, used as a performance-based indicator of cognitive fatigue. They also found that acting extraverted did not impact on a further possible cost of extraverted behavior—increased negative affect (NA).

All in all, there is as yet no evidence that acting extraverted causes introverts to feel inauthentic, tired, or more NA. However, previous studies did not examine the potential costs of sustained increases in extraverted behavior as part of daily life. For example, introverts normally engage in some extraverted behavior in their daily life (albeit less frequently than extraverts; Fleeson et al., 2002), so short bouts of extraverted behavior might not be experienced as inauthentic or tiring. In addition, Leikas and Ilmarinen (2017) found that both introverts and extraverts felt more tiredness 3 hours after extraverted moments occurring in daily life. The authors concluded that extraverted behavior has delayed, downstream effects on tiredness, and that positive effects of extraverted states (i.e., feelings of energy and enthusiasm) might obscure feelings of tiredness until after the extraverted states have dissipated. Because earlier studies (i.e., Gallagher et al., 2011; Zelenski et al., 2012) only measured tiredness concurrently or immediately after extraverted behavior, any delayed and cumulative effects on tiredness (and perhaps other wellbeing outcomes) could have gone unnoticed. Therefore, it is necessary to directly investigate how extended periods of experimentally manipulated extraverted behavior in daily life impact wellbeing outcomes.

The Value of a RCT

RCTs are the gold standard for evaluating intervention effectiveness (Schulz, Altman, & Moher & the CONSORT Group, 2010). Previous research using naturalistic ESM methods captures extraverted behavior over extended time periods in an ecologically valid context (i.e., everyday life), but only allows the correlational inference that people tend to feel happier when they spontaneously act more extraverted in daily life. On the other hand, laboratory manipulations of extraverted behavior allow better causal inferences but may not generalize to the wider range of situations that people encounter in everyday life. This is because such laboratory paradigms are brief (10–30 min) and somewhat artificial (e.g., deciding on the most useful objects if one were lost on the moon; Fleeson et al., 2002). Combining these naturalistic and experimental approaches can help us to understand the real-world, causal implications of acting extraverted.

An important consideration in the design of an RCT is identifying appropriate control groups. In previous experiments examining the effects of acting extraverted, an "act-extraverted" group is typically compared to an "act-introverted" group, or a group given no behavioral instructions at all. A concern with this design is that PA differences between the act-extraverted and act-introverted groups could be partly attributable to differences in socially desirable behavior. In Western cultures, where nearly all of this research has been conducted (cf. Ching et al., 2014), extraverted behaviors (e.g., "bold, sociable") are generally more socially desirable than introverted behaviors (e.g., "shy, reserved"; Hart, Ritchie, Hepper, & Gebauer, 2015; Steenkamp, De Jong, & Baumgartner, 2010). Acting in a socially desirable way may itself increase PA, confounding the effects of extraverted behavior per se on PA (Smillie, 2013). PA differences between an act-extraverted group and a no-instructions group could also be attributable to placebo-type effects or demand characteristics (Boot, Simons, Stothart, & Stutts, 2013). Here, we address this issue by comparing the effects of acting extraverted with both an active control group and a contact control group.

The Present Study

In this study, we randomly assigned participants to a 1-week act-extraverted intervention (i.e., instructions to engage in more extraverted behaviors) or active control (sham; i.e., instructions to engage in various nonextraverted behaviors) intervention, and compared both groups to participants from a previous daily life study who completed the same measurement protocol but received no behavioral instructions (contact-control group). This enabled us to address three primary aims: First, we investigated the consequences of a novel real-world acting extraverted intervention on a range of positive and negative wellbeing outcomes (PA, NA, authenticity, and tiredness), assessed in the moment, retrospectively at the end of the intervention period, and at follow-up 2-weeks postintervention. Second, we investigated whether the overall intervention effects were mediated by the hypothesized mechanism, extraverted behavior. Finally, we examined whether the overall intervention effects were moderated by trait extraversion.

We preregistered the following hypotheses and exploratory research questions at: https://osf.io/5xswa/. First, we hypothesized that participants in the act-extraverted condition would have higher levels of momentary and retrospective extraverted behavior and PA than participants in the sham and contact-control comparison conditions. We also predicted that the effect of intervention condition on PA would be statistically mediated by momentary extraverted behavior. Given that trait extraversion has not been found to moderate the effect of acting extraverted on PA in previous studies, we anticipated that the effect of our acting extraverted intervention on PA would be similar for introverts and extraverts. We also considered several exploratory research questions: does the act-extraverted intervention influence feelings of tiredness or subjective authenticity? Are any of the main effects of the intervention mediated by momentary extraverted behavior, or moderated by trait extraversion? Do any effects of the intervention persist to a 2-week follow-up? Finally, we addressed a research question that was not preregistered: Does the act-extraverted intervention influence feelings of NA?

Methods

This research received ethical approval from the Psychological Sciences Human Ethics Advisory Group, The University of Melbourne (Ethics ID 1646822). Data, analysis scripts and copies of materials uses are provided at https://osf.io/5xswa/.

As recommended by Simmons, Nelson, and Simonsohn (2012), we report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study.

Participants

Participants and design.   Participant flow through the study is shown in Figure 1, and described below. We recruited 147 participants, aged 18–55 (*M* = 24.12; 70% female), through flyers posted at the University of Melbourne and online advertisements. Participants were randomized to one of two experimental groups

(act-extraverted or sham; described below). To be eligible, participants needed to be 18 years or older, to be fluent English speakers, and to have access to a mobile device with Android 4.1 (or higher), or iOS 7.0 (or higher) installed. We aimed to recruit at least 60 participants per experimental group (after exclusions, described below), based on recommendations for statistical power and unbiased Level 2 standard errors in multilevel analyses (Maas & Hox, 2005; Scherbaum & Ferreter, 2009). Oversampling was required to replace unusable data (see exclusions below). Participants were compensated with $15 AUD cash (~$12 USD) after
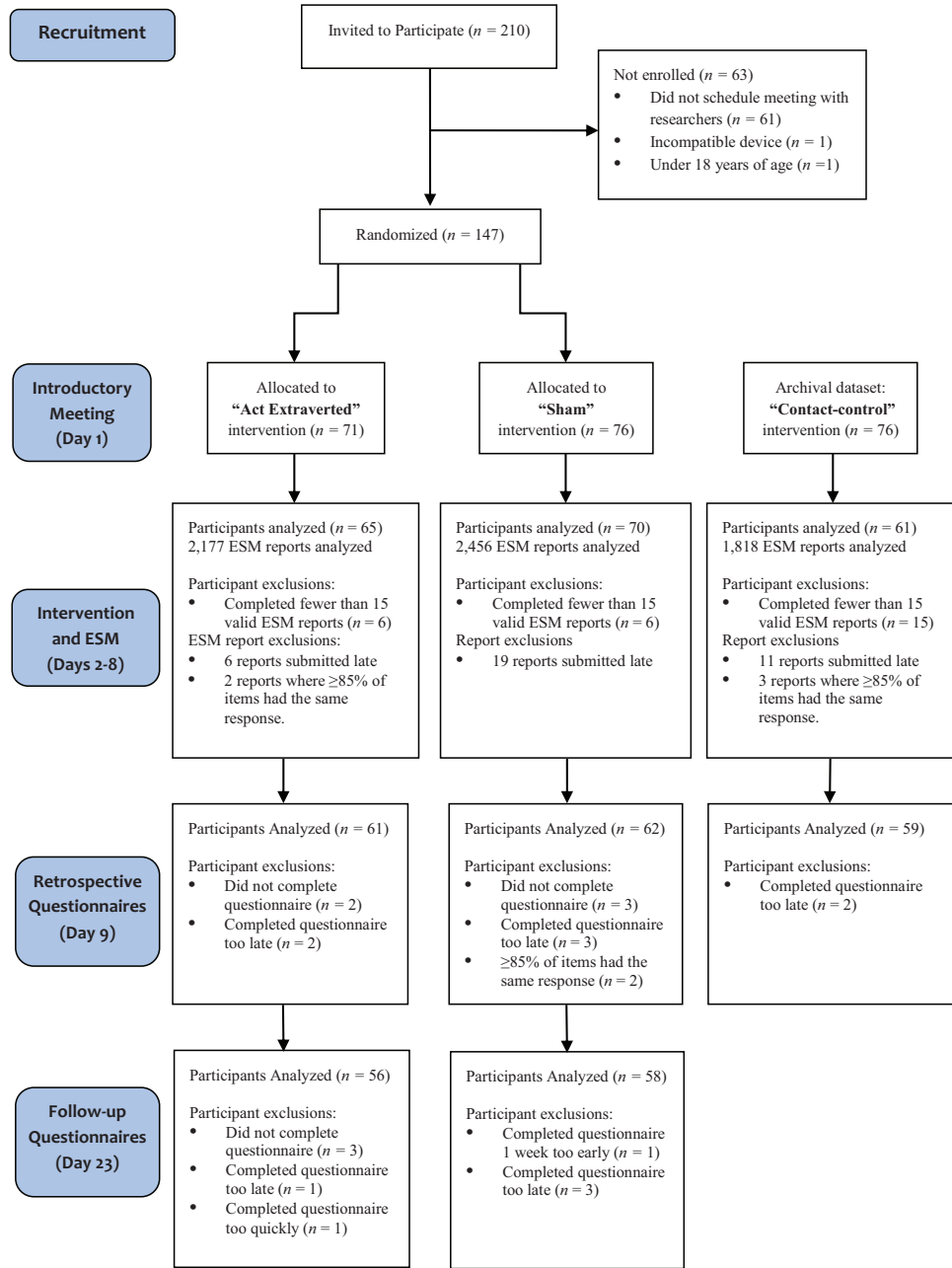

Figure 1.   Consolidated standards of reporting trials (CONSORT) flow diagram. See the online article for the color version of this figure.

completing baseline questionnaires (all measures are available in the online supplemental materials). If they completed at least 75% of the ESM surveys and the postintervention questionnaires, they received a further $20 AUD (cash or gift voucher), entry into a prize draw for $300 AUD cash, and feedback on their personality and wellbeing based on their baseline and ESM survey responses.

Additional comparison group. We used data from a previous study (Sun, Stevenson, et al., 2017) to form a third comparison group, the contact-control condition. Participants in this study were drawn from a similar population and had completed an ESM protocol similar to that used in the present study (i.e., filling out reports six times per day for 7 days), but the design was naturalistic in that participants did not receive any behavioral instructions. This can help to detect any placebo effects of the two main experimental protocols resulting from mere participation in an ESM study. It is important to emphasize, however, that this dataset was included post hoc in the present study and differs in a number of respects from our primary data. Specifically, only a subset of the outcome variables of interest for the present study was measured by Sun and colleagues (described below), and there were several other minor differences in study design and procedure that may limit the degree to which this sample is directly comparable to those randomized to the other two groups (e.g., a different experimenter, remuneration scheme, and app). A more detailed comparison of the present study and Sun, Stevenson, et al. (2017) is given in the online supplemental materials.

Procedure

The following procedures only apply to participants in the newly recruited experimental groups. Procedural details for the additional comparison group can be found in the original paper (Sun, Stevenson, et al., 2017; Study 3).

Introductory meeting. Participants in the experimental groups first attended an introductory session (Day 1), with up to three participants attending each meeting. During this session, they provided consent to participate, downloaded an ESM mobile app (MetricWire Inc., 2016) onto their smartphone and completed a baseline questionnaire implemented through Qualtrics™ survey software. They were then given the intervention instructions (see below), and guidance for completing the ESM questionnaires via the mobile app. To reduce differences in expectation for improvement (i.e., placebo effects) between the two groups (Boot et al., 2013), all participants were told that the study aimed to investigate how behavior influences mood and wellbeing in everyday life. They were otherwise kept naïve to the purpose of the study and were unaware that there were two experimental conditions.

Randomization. We used a cluster randomization design, with introductory meetings as the unit of randomization, such that all participants in any given meeting were provided with the same intervention instructions. To have approximately equal sample sizes in each condition, meetings were randomized in blocks: for every block of 10 meetings, five meetings were randomly assigned to each condition. Rowan Jacques-Hamilton generated the random allocation sequence, allocated meetings to experimental conditions, enrolled participants, and conducted the introductory meeting.

Treatment interventions. Participants were randomly assigned to one of two 7-day intervention conditions (Days 2–8).

Participants in the act-extraverted condition were instructed, "In your interactions with other people across the next week, act in a bold, talkative, outgoing, active, and assertive way, as much as possible." These terms were drawn from trait descriptors that mark the high pole of extraversion (e.g., Goldberg, 1992). Participants in the sham condition were instructed, "In your interactions with other people across the next week, act in an unassuming, sensitive, calm, modest, and quiet way, as much as possible". These terms were markers of both the low pole of extraversion (e.g., "quiet") and the high pole of other Big Five traits (e.g., "sensitive," "modest") and were selected to comprise a set of behaviors that seemed coherent and relatively socially desirable. The sham condition was designed as an active control group against which to assess any effects of the act-extraverted intervention on wellbeing outcomes, over and above nonspecific effects of participating in an intervention study. In both conditions, participants were told to ignore the instructions if they judged the behaviors to be inappropriate for particular situations (e.g., being "talkative" in the quiet area of a library or being "quiet" during a job interview). For reference, participants were emailed a document summarizing their intervention instructions, and with definitions of the terms contained in the instructions (see the online supplemental materials). Participants were shown a reminder of the instructions on their mobile device upon completing each ESM survey ("Remember to continue acting in [an unassuming, sensitive, calm, modest, and quiet/a bold, talkative, outgoing, active, and assertive] way in your interactions with other people:)").

ESM protocol. During the intervention week (Days 2–8), participants received six ESM surveys on their mobile phone every day, for a total of 42 surveys. Each survey was delivered through the MetricWire application, which would create a phone notification upon delivery. Surveys were delivered at random times between 9:00 a.m. and 10:00 p.m., with the restriction that a survey could not be delivered within 90 min of the previous survey. If participants did not complete a new survey within 15 min of delivery, a reminder notification was triggered. If the survey was not opened within 30 min, it expired and could no longer be accessed. On the third and fifth day of the intervention, the experimenter contacted each participant to let them know whether they were meeting the 75% completion rate requirement, and to provide encouragement. At these times, if participants were unlikely or unable to reach the 75% survey response requirement, they were reminded that they had the opportunity to withdraw if they wished (i.e., due to being ineligible for further payment).

Retrospective and follow-up questionnaires. At the end of the intervention week (Day 9), participants were sent the "retrospective questionnaire" via e-mail. This questionnaire could be completed using a web browser (median completion time = 9.38 min), and participants were requested to complete it on the same day. An additional follow-up questionnaire was completed 2 weeks after the conclusion of the study (Day 23). After completing the follow-up questionnaire, participants were presented with a debrief statement describing the full aims and design of the study and received final payment collected as cash or delivered as a gift voucher via e-mail.

Exclusion criteria. Three preregistered exclusion criteria were used. First, survey responses were excluded from analyses if they had a large number of identical responses, indicating inattentive responding. Baseline surveys were excluded if participants

responded to 22 or more of the 25 (i.e., >85%) items in the largest
question block with the same value. Individual ESM reports were
excluded if 17 or more of the 20 questions (i.e., ≥85%) measured
on an 11-point scale (see below) were responded to with the same
value. Similarly, retrospective and follow-up reports were ex-
cluded if 17 or more of the 20 items in the largest survey question
block had identical responses. Second, we excluded baseline,
retrospective and follow-up surveys that were deemed to be sub-
mitted too quickly. Cutoff times were based on how long was
required for Rowan Jacques-Hamilton to finish to the question-
naire as quickly as possible without reading any of the questions.
Because of a lack of survey timing information, we could not
implement this exclusion in the archival Contact-control dataset.
Third, participants were excluded if they responded to fewer than
15 valid ESM reports (after the above exclusions), indicating a
lack of engagement with the study. We included a fourth exclusion
criterion that was not preregistered, because we decided that this
would reduce potential biases in the results: reports were excluded
if they were not submitted in a timely fashion. ESM reports were
excluded if they were submitted more than 35 min after the survey
was triggered, retrospective reports were excluded if they were
submitted after Day 10 (i.e., more than one day late), and
follow-up reports if they were submitted after Day 26 (i.e., more
than three days late). Final sample sizes for participants included
in the analyses are shown in Figure 1.

Materials

All questionnaires relating to the present hypotheses are re-
ported below. Extraneous questionnaires are shown in the prereg-
istration document and the online supplemental materials. For
every scale, responses were averaged to produce a score for that
scale.

Baseline questionnaires. We measured trait extraversion us-
ing the 20-item extraversion scale from the Big Five Aspects
Scales (BFAS; DeYoung, Quilty, & Peterson, 2007). This scale
presents self-descriptions (e.g., "I see myself as a good leader," "I
rarely get caught up in excitement" [R]) for which respondents
indicate their agreement using a 5-point scale ranging from 1
(*strongly disagree*) to 5 (*strongly agree*).

To measure trait PA and trait NA, participants completed the
Positive and Negative Affect Schedule (PANAS; Watson, Clark,
& Tellegen, 1988), in which they rated how accurately adjectives
(e.g., "excited", "irritable") describe their feelings in general.
Responses were made on a five-point scale ranging from 1 (*very
slightly*) to 5 (*extremely*).

Trait authenticity was measured with a scale adapted from
Fleeson and Wilt (2010), in which participants rated their agree-
ment with five statements concerning general feelings of authen-
ticity (e.g., "I act like my true self," "People would have an
accurate impression of me from the way I act") on a 7-point scale
ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

Given the absence of a widely accepted tiredness scale in the
literature, trait tiredness was measured using an 11-item scale
constructed for this study. In this scale participants were asked
how accurately each item, either an adjective or statement, de-
scribed their feelings in general. Eight of these items (tired; alert
[R]; fatigued; lethargic; energized [R]; lively [R]; impulsive; "I
nearly always feel alert and awake" [R]) were adapted from

previous scales (Matthews, Jones, & Chamberlain, 1990; Ryan &
Frederick, 1997; Thayer, 1986) and three additional items ("At
times I feel too tired to complete everyday activities [e.g. house-
work, chores, study]"; "I need to spend time restoring & recharg-
ing"; "I do not have energy to do some of the things I would like
to do") were created for this study. Answers were made on a
5-point scale ranging from 1 (*very slightly or not at all*) to 5
(*extremely*). We excluded one item (impulsive) that did not load
well onto the scale according to a confirmatory factor analysis (see
the online supplemental materials), resulting in a 10-item scale.
Omission of this item did not change the interpretation of the
results.

ESM questionnaire. The purpose of the ESM questionnaire
was to measure momentary behaviors and affective experiences
during the intervention week. Momentary extraverted behavior
was measured with five items ("In the past hour, how [bold; quiet
(R); gregarious; assertive; reserved (R)] were you?"; Goldberg,
1992). However, we excluded one item (gregarious) that did not
overlap with the items used in the archival dataset to ensure that
the extraverted behavior composites were based on the same items
for all conditions. This omission did not substantively influence
the obtained results. Momentary PA was measured with three
items drawn from the PANAS-X ("How [excited; lively; enthusi-
astic] do you feel right now?"; Watson & Clark, 1999). Momen-
tary NA was initially measured using two items ("How [irritable;
distressed] do you feel right now?") derived from the PANAS
(Watson et al., 1988). A third NA adjective (nervous) was added
after 12 participants had already commenced the study to improve
the measurement of this construct. Aggregate NA scores computed
with three items ($M = 2.04$, $SD = 1.44$) and scores computed with
only two items ($M = 2.04$, $SD = 1.46$) were highly correlated, $r =
.98$, so we computed NA scores from the mean of all available
items. Momentary authenticity was measured with three items ("In
the past hour, [how much were you acting like your true self; how
much were you putting on an act (R)]"; "How accurate an impres-
sion would someone have of you from the way you were acting?]";
Fleeson & Wilt, 2010). Momentary tiredness was measured with
two items formulated for this study ("How [tired do you feel; much
do you feel the need to recharge] right now?"). ESM items were
answered on an 11-point integer sliding scale. The extraverted
behavior items had anchors 0 (*not at all*) and 10 (*very*). PA, NA,
and tiredness items had anchors 0 (*not at all*) and 10 (*extremely*),
and authenticity items had anchors 0 (*not at all*) and 10 (*very
much*).

Participants were also asked, "In the past hour, how much time
have you spent focused on socially-oriented activities?". This
question was answered using a sliding scale with 5-min incre-
ments. Participants were instructed to only include interactions
focused on social connection (e.g., casual conversation), and to
exclude business-type interactions (e.g., meetings and business
phone calls).

Retrospective and follow-up questionnaire. Participants re-
ported retrospective extraverted behavior by rating how accurately
nine adjectives (bold; quiet [R]; gregarious; assertive; reserved;
talkative; withdrawn [R]; extraverted; shy [R]), drawn from Gold-
berg (1992), described their behavior during the previous week.
Two of these items (gregarious; shy) were not measured in the
archival dataset, so were excluded to ensure that the extraverted
behavior composites were based on the same items for all condi-

tions. Responses were made on a 9-point scale ranging from 1 (*extremely inaccurate*) to 9 (*extremely accurate*), and three items were reverse scored.

Retrospective positive affect, negative affect, authenticity, and tiredness were measured using the same questionnaires as at baseline; however, these were reworded to be in the past tense (e.g., "I acted like my true self" rather than "I act like my true self"), and rated with respect to the previous week, rather than "in general" or "on average." In addition, one item was added to the retrospective tiredness questionnaire ("It made me feel tired or fatigued to behave according to the experimenter's instructions").

The items included in the follow-up questionnaire were identical to those in the retrospective questionnaire, except that except that one item was excluded ("It made me feel tired or fatigued to behave according to the experimenter's instructions").

Archival group measures. The contact-control condition only included a subset of the above measures, including baseline, momentary, and retrospective measures of extraverted behavior and PA, and baseline and retrospective measures of NA. Measures of authenticity, tiredness, and momentary NA were not collected.

Data Analysis

The criterion for statistical significance in all models was set at $\alpha = .05$, and all interval estimates were 95% confidence intervals (CIs). Any departures from the analyses stated in the preregistration are described in the online supplemental materials.

Descriptive statistics. Descriptive statistics were calculated for all variables using the dplyr package (Version 0.5.0; Wickham & Francois, 2016) in R (Version 3.4.0; R Development Core Team, 2017). Omega (ω) reliability coefficients (Dunn, Baguley, & Brunsden, 2014) were computed for retrospective variables using the MBESS package in R (Version 4.2.0; Kelley, 2007). For momentary variables, within-person ω coefficients were computed using Mplus (Version 7; Geldhof, Preacher, & Zyphur, 2014; Muthén & Muthén, 2017).

Intervention effects. The effects of intervention condition on each outcome were tested using multilevel models (for momentary variables) and general linear models (for retrospective variables). Multilevel models were computed using the nlme package (Version 3.1–131; Pinheiro, Bates, DebRoy, Sarkar, & R Development Core Team, 2017), and general linear models were computed using the base functions in R. A separate model was used for every outcome, with intervention condition modeled as a predictor. For momentary outcomes, time since first ESM report was modeled as a Level 1 covariate with random slopes, following the recommendation of Bolger and Laurenceau (2013), but no other covariates were included in any model. This is analogous to testing how levels of momentary outcomes, averaged across the week, differ between groups, but offers more precision than testing for a difference between aggregated scores. For outcomes that were measured in all three conditions, pairwise contrasts were conducted. All statistical inferences were drawn from unstandardized models.

Standardized effect sizes for retrospective measures were expressed in terms of Hedge's *g*, a less biased estimator than Cohen's *d* (Lakens, 2013). In the case of momentary measures, there is currently no consensus in the literature on methods for producing standardized mean difference effect sizes in multilevel models. We

therefore computed standardized regression coefficients for multilevel models by standardizing all continuous predictor and dependent variables across all observations. We bootstrapped 95% CIs for standardized regression coefficients using the lme4 package in R (Bates, Mächler, Bolker, & Walker, 2015). R^2 for multilevel models was computed following LaHuis, Hartman, Hakoyama, and Clark (2014).

Mediation analyses. We examined whether extraverted behavior was a plausible mediator of any effects of the act-extraverted intervention on momentary wellbeing outcomes (2–1–1 mediation models) and retrospective wellbeing outcomes (2–1–2 mediation models). Only the act-extraverted versus sham and the act-extraverted versus contact-control contrasts were considered for mediation due to our interest in the effects of acting extraverted, and mediation analyses were only conducted where the main effect of the intervention contrast on the outcome was significant. All mediation analyses were conducted in Mplus, using syntax adapted from Preacher, Zyphur, and Zhang (2010), and the MplusAutomation package in R (Hallquist & Wiley, 2016).

We also considered the possibility that enacted extraverted behavior may have different within-person effects on momentary wellbeing outcomes, compared to naturally expressed extraverted behavior. To test this possibility, we examined whether the within-person associations between extraverted behavior and the wellbeing outcomes differed across conditions using random-slope multilevel models. Momentary extraverted behavior was person-mean-centered and used to predict momentary outcome variables. Each outcome was used as a DV in a separate model. These within-person analyses were conducted across the whole sample, and also separately within each condition.

Moderation analyses. Finally, to investigate whether the effects of the intervention were moderated by trait extraversion, we conducted further analyses that added the main effect of trait extraversion, and the Condition $\times$ Trait Extraversion interaction terms to the above "main intervention effects" models. Significant interaction effects were probed by computing regions of significance analyses using the Johnson-Neyman procedure, following Preacher, Curran, and Bauer (2006).

Results

Descriptive Statistics and Missing Data

Descriptive statistics for continuous variables by condition are shown in Table 1. Descriptive statistics for categorical demographic variables, and correlations among continuous variables, are shown in the online supplemental materials (Supplemental Tables S4 and S5, respectively). There were no significant differences between treatment conditions on any trait measure ($ps > .167$). Mean age was significantly lower in the contact-control condition ($M = 21.64$, $SD = 3.66$) relative to both the act-extraverted condition ($M = 24.51$, $SD = 7.39$), $t(217) = 2.95$, $p = .004$, and the sham condition ($M = 23.77$, $SD = 6.01$), $t(217) = 2.24$, $p = .026$, but did not differ between the latter two conditions, $t(217) = 0.75$, $p = .452$. Including age as a covariate did not substantively alter the results of any of our main analyses and was therefore excluded from the final reported models for parsimony.

Table 1
Descriptive Statistics by Condition

		Act-extraverted condition				Sham condition				Contact-control condition			
Variable	ω	M	SD_{BP}	SD_{WP}	ICC(1)	M	SD_{BP}	SD_{WP}	ICC(1)	M	SD_{BP}	SD_{WP}	ICC(1)
Trait measures													
Extraverted behavior	.85	3.50	.55			3.45	.53			3.37	.46		
Positive affect	.83	3.48	.63			3.51	.61			3.55	.49		
Negative affect	.87	1.95	.62			2.14	.76			2.11	.61		
Authenticity	.89	5.14	1.18			5.10	1.16			—	—		
Tiredness	.86	2.65	.68			2.72	.68			—	—		
ESM measures													
Extraverted behavior	.74	5.69	1.26	1.65	.32	3.97	1.13	1.22	.42	4.37	.94	1.88	.16
Positive affect	.81	5.18	1.64	1.53	.49	4.40	1.75	1.60	.52	5.01	1.24	1.52	.36
Negative affect	.63	2.13	1.55	1.24	.56	1.99	1.29	1.28	.48	—	—	—	—
Authenticity	.66	7.18	1.77	1.40	.57	6.49	1.47	1.43	.48	—	—	—	—
Tiredness	.62	3.87	1.83	1.93	.44	4.03	1.34	1.94	.30	—	—	—	—
Minutes in social interactions		21.02	9.48	17.23	.20	20.29	9.12	16.60	.20	—	—	—	—
Retrospective measures													
Extraverted behavior	.81	6.40	1.13			4.74	1.12			5.15	1.03		
Positive affect	.89	3.61	.63			3.33	.68			3.23	.60		
Negative affect	.85	1.83	.59			1.89	.58			2.03	.61		
Authenticity	.84	5.43	1.03			4.87	.88			—	—		
Tiredness	.83	2.37	.68			2.52	.55			—	—		

Note. ω = omega reliability coefficient; within-person omegas and aggregated means are reported for experience sampling method (ESM) measures; SD_{BP} = between-person standard deviation; SD_{WP} = average within-person standard deviation; ICC(1) = intraclass correlation coefficient, which represents the proportion of total variation due to variation between-persons. Blank cells indicate nonapplicable measures, whereas dashes indicate that data were not available.

Across the two treatment conditions and the contact-control group, participants completed a total of 6,593 ESM reports out of a possible 8,736 (75.5% completion rate). After exclusions (see Figure 1), this resulted in valid completion rates of 2,177 out of 2,730 (79.7%) in the in the act-extraverted condition ($M_{reports}$ = 33.49, SD = 5.91), 2,456 out of 2,940 (83.5%) in the sham condition ($M_{reports}$ = 35.09, SD = 5.15), and 1,818 out of 2,562 (71.0%) in the contact-control condition ($M_{reports}$ = 29.80, SD = 5.95). A general linear model showed that completion rates were significantly higher in females, and negatively predicted by trait tiredness, but were unrelated to all other baseline trait variables reported in this study (see the online supplemental materials). Similarly, a logistic regression showed that the probability of returning to complete the retrospective survey could be predicted by baseline tiredness, but not by other baseline trait variables, gender, or age (see the online supplemental materials).

Manipulation Check

Participants in the act-extraverted condition reported significantly higher levels of extraverted behavior, compared to those in both the sham and the contact-control conditions (which did not differ from each other; see Table 2). This held for both momentary and retrospective reports, indicating that the intervention successfully increased levels of extraverted behavior. However, further analyses revealed boundaries to the effectiveness of our manipulation: trait extraversion significantly moderated the effect of the act-extraverted intervention on momentary extraverted behavior (see Table 3). As depicted in Figure 2, our attempt to increase momentary extraverted behavior throughout daily life was more successful for participants higher on trait extraversion, and wholly unsuccessful for extreme introverts. Specifically, regions of sig-

nificance analyses revealed that differences in momentary extraverted behavior between the act-extraverted condition and the sham condition were statistically nonsignificant for values of trait extraversion below 2.43 (which is 1.95 SD below the mean level of trait extraversion in this study). Similarly, differences between the act-extraverted condition and the contact-control condition were statistically nonsignificant for values of trait extraversion below 2.80 (1.24 SD below the mean). No such moderation effects were evident in the retrospective measures (see Table 2).

Effects of the Acting Extraverted Intervention on Wellbeing Outcomes

PA. Results for all main intervention effects are shown in Table 2. Levels of momentary and retrospective PA were significantly higher in the act-extraverted condition than the sham condition. Participants in the act-extraverted condition also reported higher levels of PA than those in the contact-control condition, but this difference was only statistically significant for retrospective PA. Finally, participants in the sham condition reported significantly lower momentary PA than the contact-control condition, but retrospective PA did not significantly differ between these groups. Thus, retrospective reports suggest that the act-extraverted intervention boosted levels of PA relative to both control conditions, whereas momentary reports suggest that this was true only relative to the sham condition.

Authenticity, NA, and tiredness. As shown in Table 2, participants in the act-extraverted condition reported significantly higher levels of authenticity than in the sham condition, and there were no significant differences between the two conditions on NA or feelings of tiredness. There was also no evidence that partici-

Table 2
Intervention Effects on Wellbeing Outcomes

Dependent variable	Act-extraverted vs. sham		Act-extraverted vs. contact-control		Sham vs. contact-control		R^2
	b (SE)	ES [95% CI]	b (SE)	ES [95% CI]	b (SE)	ES [95% CI]	
Momentary							
Extraverted behavior	1.70*** (.19)	.80 [.61, .98]	1.32*** (.20)	.62 [.42, .82]	−.38 (.20)	−.18 [−.38, .03]	.12
Positive affect	.76** (.27)	.33 [.08, .55]	.20 (.28)	.09 [−.15, .34]	−.56* (.27)	−.25 [−.47, −.01]	.02
Negative affect	.11 (.24)	.06 [−.18, .32]	—	—	—	—	.00
Authenticity	.77** (.28)	.35 [.11, .60]	—	—	—	—	.03
Tiredness	−.19 (.27)	−.07 [−.31, .15]	—	—	—	—	.00
Retrospective							
Extraverted behavior	1.66*** (.20)	1.52 [1.16, 1.87]	1.26*** (.20)	1.15 [.79, 1.51]	−.41* (.20)	−.37 [−.73, −.01]	.30
Positive affect	.28* (.11)	.43 [.08, .79]	.38** (.12)	.60 [.24, .96]	0.10 (.12)	.16 [−.19, .52]	.06
Negative affect	−.06 (.11)	−.09 [−.45, .26]	−.20 (.11)	−.33 [−.69, .03]	−.14 (.11)	−.24 [−.60, .12]	.02
Authenticity	.57** (.17)	.59 [.23, .95]	—	—	—	—	.08
Tiredness	−.15 (.11)	−.24 [−.59, .12]	—	—	—	—	.01

Note. b = the effect of intervention condition (unstandardized regression coefficient); CI = confidence interval; ES = standardized effect size (Hedges *g* for retrospective measures, and standardized regression coefficients for momentary measures); 95% confidence around the effect size is shown in brackets; the effects of covariates are not shown (full model output is presented in the online supplemental materials); R^2 for multilevel models was computed following LaHuis, Hartman, Hakoyama, and Clark (2014). Dashes indicate that data were not available.
* $p < .05$.   ** $p < .01$.   *** $p < .001$.

pants in the act-extraverted intervention experienced wellbeing costs in terms of increased NA or tiredness.

Follow-up effects. Participants in the act-extraverted condition reported higher levels of weekly extraverted behavior than participants in the sham condition at 2 weeks postintervention. However, there were no significant between-groups differences in any other wellbeing outcome at follow-up (see the online supplemental materials). This suggests that there was a return-to-baseline effect after withdrawal of the intervention.

Mechanisms Underlying Effects of the Intervention

Next, we examined three potential mechanisms that could explain the effect of the act-extraverted intervention on PA and authenticity.

The mediating role of extraverted behavior. The most obvious explanation for the observed effect of intervention condition on wellbeing outcomes is differences in extraverted behavior. In fact, it would be puzzling if the increased wellbeing observed in the Act-

Extraverted condition was unrelated to increases in extraverted behavior. We conducted multilevel mediation analyses to investigate this. As shown in Table 3, average extraverted behavior was a statistically significant mediator of the effect of intervention condition on average momentary PA, retrospective PA, and retrospective authenticity. However, there was no significant indirect effect via average momentary extraverted behavior for average momentary authenticity. In the act-extraverted versus sham comparison, the indirect effect via momentary extraverted behavior accounted for 67% of the total intervention effect on momentary PA, 66% of the total effect on retrospective PA, and 54% of the total effect on retrospective authenticity. In the act-extraverted versus contact-control comparison, the indirect effect via momentary extraverted behavior accounted for 70% of the total effect on retrospective PA.

Moderation of momentary associations by intervention condition. Another plausible mechanism is that the intervention condition changed the momentary association between extraverted behavior and the wellbeing outcomes. For example, successful

Table 3
Mediation of Intervention Effects on Wellbeing Outcomes by Extraverted Behavior

Dependent variable	Act-extraverted vs. sham					Act-extraverted vs. contact-control				
	IV → M (a path)	M → DV (b path)	Direct effect (c' path)	Indirect effect ($a \times b$ path)	95% CI of indirect effect	IV → M (a path)	M → DV (b path)	Direct effect (c' path)	Indirect effect ($a \times b$ path)	95% CI of indirect effect
Momentary (2–1–1)										
PA	1.67***	.98***	−.8	**1.64**	[.98, 2.29]					
Authenticity	1.67***	−.19	1.01	−.32	[−1.03, .39]	—	—	—	—	—
Retrospective (2−1−2)										
PA	1.67***	.33***	−.28*	**.55**	[.38, .73]	1.32***	.22***	.07	**.28**	[.15, .42]
Authenticity	1.67***	.18**	.26	**.30**	[.07, .53]	—	—	—	—	—

Note. Indirect effects in bold denote that the 95% confidence interval (CI) does not capture zero. Blank spaces indicate that mediation analyses were not conducted, whereas dashes indicate that data were not available.
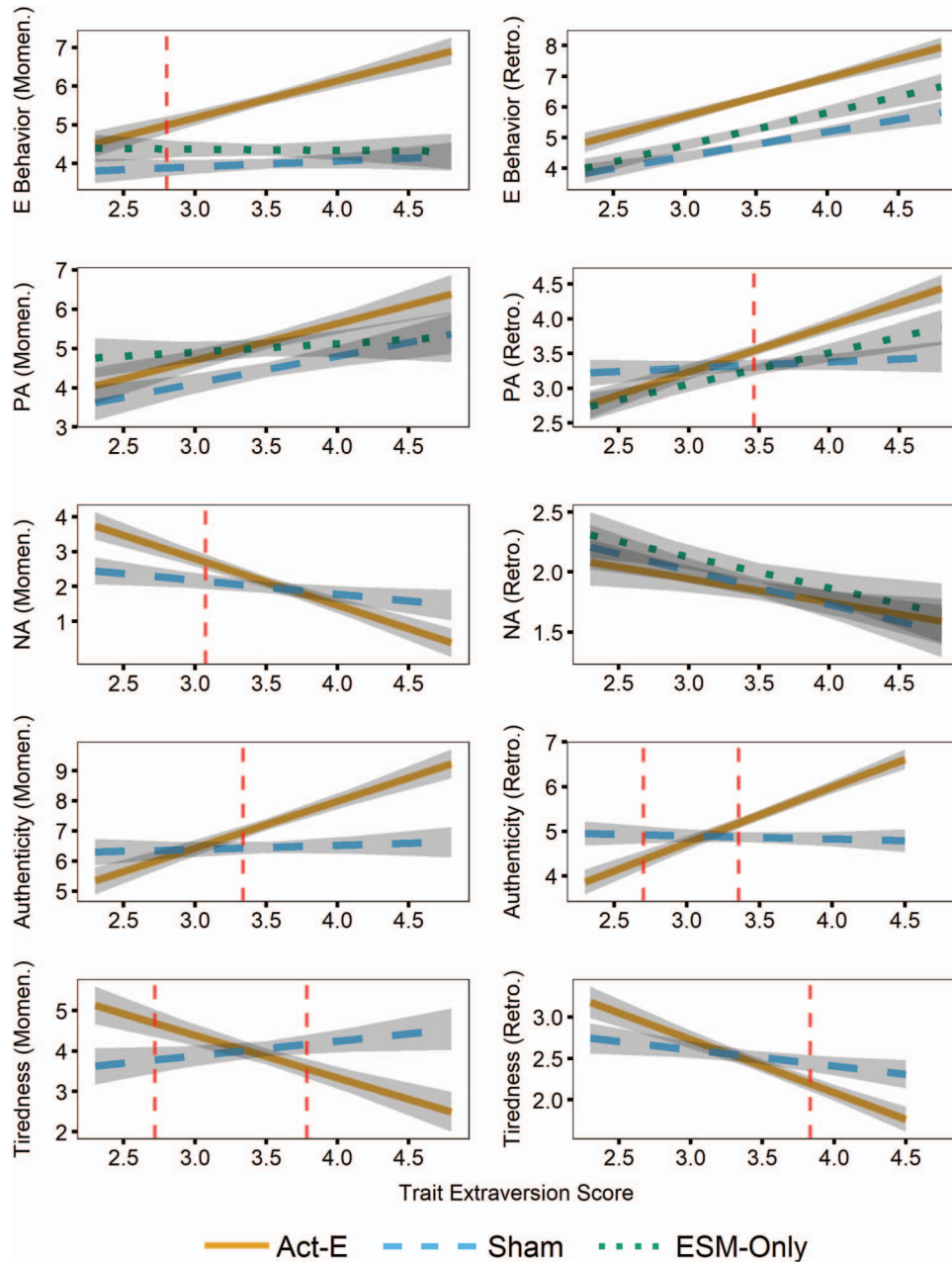* $p < .05$.   ** $p < .01$.   *** $p < .001$.

Figure 2. Predicted values for study outcomes at different scores on trait extraversion, by experimental condition. Standard error (± 1) is shaded. Boundaries of the regions of significance are shown by vertical dashed red lines. E Behavior = extraverted behavior. For clarity, only one region of significance line is shown for momentary extraverted behavior, representing the act-extraverted versus contact-control comparison; the act-extraverted versus sham comparison is excluded. Plots were generated using the ggplot2 package in R (Wickham, 2009). See the online article for the color version of this figure.

compliance with instructions to act more extraverted could increase PA due to a sense of accomplishment, or as a result of study demand characteristics. This could result in a stronger association between momentary extraverted behavior and PA in the act-extraverted group, contributing to between-condition differences in average momentary PA. We therefore examined the momentary associations between extraverted behavior and the four wellbeing

outcomes across the full sample and in each subgroup (see Table 4). For concision, we will only describe the momentary associations for PA and authenticity (given that there were no between-condition differences in NA and tiredness). As reported in previous studies, participants tended to report more PA and authenticity during moments in which they had recently been acting more extraverted. The strength of the association between extraverted

Table 4
Associations Between Momentary Extraverted Behavior and Momentary Wellbeing Outcomes by Condition

Dependent variable	Full sample b (SE)	Act-extraverted b (SE)	Sham b (SE)	Contact-control b (SE)
Positive affect	.40*** (.02)	.39*** (.03)	.34*** (.04)	.45*** (.03)
Negative affect	−.01 (.02)	−.04* (.02)	.03 (.03)	—
Authenticity	.09** (.03)	.10* (.04)	.09* (.05)	—
Tiredness	−.20*** (.03)	−.24*** (.04)	−.13* (.05)	—

Note. b = the fixed effect of extraverted behavior (unstandardized regression coefficient). Dashes indicate that data were not available.
* p < .05. ** p < .01. *** p < .001.

behavior and PA was weaker in the sham condition than the contact-control condition (see Table 5). However, there was no evidence that the strength of the association between extraverted behavior and PA or authenticity was different between the act-extraverted and sham condition, or between the act-extraverted and contact-control condition. Thus, it seems more likely that the effects of the act-extraverted intervention on momentary wellbeing outcomes were due to increased levels of extraverted behavior, rather than by strengthening the relation between extraverted behavior and wellbeing outcome.

The mediating role of social activity. Finally, it is possible that the act-extraverted intervention could have influenced wellbeing by increasing the amount of time participants spent in social situations (see Lucas, Le, & Dyrenforth, 2008). However, participants in the act-extraverted and sham conditions did not report spending different amounts of time in social situations throughout the intervention study, β = 0.04 [CI −0.12, 0.21], t(133) = 0.51, p = .614. This suggests that the intervention changed how people acted in social situations (i.e., how much extraversion they enacted), rather than the quantity of time that people spent in social situations.

Were the Intervention Effects Conditional on Trait Extraversion?

So far, we have shown that the act-extraverted intervention increased PA and authenticity and had no effects on NA and tiredness for the average participant. However, it is possible that the act-extraverted intervention could have different effects for

Table 5
Moderation of Momentary Associations Between Extraverted Behavior and Wellbeing Outcomes by Intervention Condition

Dependent variable	Act-E vs. sham b (SE)	Act-E vs. contact b (SE)	Sham vs. contact b (SE)
Positive affect	.05 (.05)	−.07 (.05)	−.12* (.05)
Negative affect	−.06 (.04)	—	—
Authenticity	.01 (.06)	—	—
Tiredness	−.12 (.06)	—	—

Note. Act-E = Act-Extraverted; b = the cross-level interaction effect of Extraverted Behavior × Intervention condition (unstandardized regression coefficient). The effects of covariates are not shown (full model output is presented in the online supplemental material). Dashes indicate that data were not available.
* p < .05.

more extraverted people relative to more introverted people. In our final set of analyses, we examined trait extraversion as a moderator of the intervention effects reported above. Where trait extraversion was a significant moderator of an intervention effect, we used the Johnson-Neyman procedure to compute regions of significance. Regions of significance indicate the range of values on trait extraversion for which intervention effects were significant. Results are depicted in Table 6 and Figure 2.

PA. Contrary to all previous laboratory experiments and naturalistic ESM studies in this literature, we found that trait extraversion significantly moderated the effect of the Act-Extraverted intervention on retrospective (but not momentary) PA, relative to the Sham condition. Regions of significance analyses showed that only participants with trait extraversion scores exceeding 3.46 (0.05 SD above the mean) reported higher levels of retrospective PA in the Act-Extraverted condition than the Sham condition.

NA. Trait extraversion also moderated the effects of the act-extraverted intervention on momentary (but not retrospective) NA, relative to the sham condition. Regions of significance analyses showed that participants with trait extraversion levels below 3.07 (0.71 SD below the mean) reported higher levels of momentary NA in the act-extraverted condition relative to the sham condition.

Authenticity. Trait extraversion moderated the effects of the intervention on both momentary and retrospective measures of authenticity. Regions of significance analyses showed that participants who scored above 3.34 (0.19 SD below the mean) on trait extraversion reported higher momentary authenticity in the act-extraverted condition than in the sham condition. In addition, we found a cross-over interaction effect for retrospective authenticity. Those who scored above 3.36 (0.16 SD below the mean) on trait extraversion reported higher levels of retrospective authenticity in the act-extraverted condition, but those who scored below 2.70 (1.43 SD below the mean) on trait extraversion reported lower levels of retrospective authenticity in the act-extraverted condition (relative to the sham condition).

Tiredness. Although there were no main effects of the act-extraverted intervention on tiredness, we found that trait extraversion moderated the effects of the intervention on both momentary and retrospective feelings of tiredness. Regions of significance analyses indicated that there was a cross-over interaction effect for momentary tiredness: those who scored above 3.79 (0.68 SD above the mean) on trait extraversion reported lower levels of momentary tiredness in the act-extraverted condition, whereas those who scored below 2.72 (1.39 SD below the mean) on trait extraversion

Table 6
Moderation of Main Intervention Effects by Trait Extraversion

Dependent variable	Act-extraverted vs. sham		Act-extraverted vs. contact-control		Sham vs. contact-control		R^2
	$b_{Condition}$ (SE)	$b_{Condition \times Trait\ E}$ (SE)	$b_{Condition}$ (SE)	$b_{Condition \times Trait\ E}$ (SE)	$b_{Condition}$ (SE)	$b_{Condition \times Trait\ E}$ (SE)	
Momentary							
Extraverted behavior	−1.16 (1.24)	.81* (.35)	−2.16 (1.37)	.99* (.39)	−1.00 (1.36)	.18 (.40)	.14
Positive affect	−.11 (1.74)	.24 (.50)	−2.37 (1.92)	.72 (.55)	−2.26 (1.91)	.49 (.56)	.05
Negative affect	3.47* (1.50)	−.95* (.43)	—	—	—	—	.07
Authenticity	−4.23* (1.71)	1.42** (.48)	—	—	—	—	.10
Tiredness	4.78** (1.77)	−1.42** (.50)	—	—	—	—	.03
Retrospective							
Extraverted behavior	−.00 (1.21)	.44 (.34)	.44 (1.26)	.17 (.36)	.45 (1.26)	−.27 (.37)	.46
Positive affect	−1.78* (.74)	.58** (.21)	−.45 (.77)	.21 (.22)	1.33 (.78)	−.37 (.23)	.19
Negative affect	−.32 (.73)	.08 (.21)	−.37 (.76)	.06 (.22)	−.05 (.76)	−.02 (.22)	.06
Authenticity	−4.14*** (1.05)	1.33*** (.30)	—	—	—	—	.30
Tiredness	1.46* (.72)	−.44* (.20)	—	—	—	—	.17

Note. $b_{condition}$ = the main effect of intervention condition (unstandardized regression coefficient). $b_{Condition \times Trait\ E}$ = the intervention Condition × Trait extraversion interaction effect. SE = standard error. Effects of trait extraversion and covariates are not shown (full model output is presented in the Supplemental Materials). R^2 for multilevel models, based on multivariance partitioning (MVP) was calculated following LaHuis et al. (2014, Equation 14). Dashes indicate that no data were available.
* $p < .05$.   ** $p < .01$.   *** $p < .001$.

reported higher levels of momentary tiredness in the act-extraverted condition (relative to the sham condition). In addition, those who scored above 3.83 (0.77 *SD* above the mean) on trait extraversion reported lower levels of retrospective tiredness in the act-extraverted condition than the sham condition.

Summary

Table 7 summarizes the findings from this study. Overall, we found that participants in the act-extraverted intervention, relative to comparison conditions, had higher levels of extraverted behav-

Table 7
Summary of Key Results

Outcome variable	Main intervention effect	Main intervention effect mediated by extraverted behavior?	Main intervention effect moderated by trait E?
Extraverted behavior			
Momentary	Act-E > Sham		Act-E = Sham for extreme introverts ($Z_{Trait\ E}$ less than −1.95)
	Act-E > Contact		Act-E = Sham for introverts ($Z_{Trait\ E}$ less than −1.24)
	Contact = Sham		No
Retrospective	Act-E > Sham		No
	Act-E > Contact		No
	Contact > Sham		No
PA			
Momentary	Act-E > Sham	Yes	No
	Act-E = Contact		No
	Contact > Sham		No
Retrospective	Act-E > Sham	Yes	Act-E = Sham for those below average on Trait E ($Z_{Trait\ E}$ less than .05)
	Act-E > Contact	Yes	No
	Contact = Sham		No
Authenticity			
Momentary	Act-E > Sham	No	Act-E = Sham for those below average on Trait E ($Z_{Trait\ E}$ less than −.19)
			Act-E = Sham for those below average on Trait E ($Z_{Trait\ E}$ less than −.16)
Retrospective	Act-E > Sham	Yes	Sham > Act-E in introverts ($Z_{Trait\ E}$ less than −1.43)
Tiredness			
Momentary	Act-E = Sham		Act-E < Sham for those above average on Trait E ($Z_{Trait\ E}$ greater than .68)
			Act-E > Sham for introverts ($Z_{Trait\ E}$ less than −1.39)
Retrospective	Act-E = Sham		Act-E < Sham for those above average on Trait E ($Z_{Trait\ E}$ greater than .77)
NA			
Momentary	Act-E = Sham		Act-E > Sham for those below-average on Trait E ($Z_{Trait\ E}$ less than −.71)
Retrospective	Act-E = Sham	None	
	Act-E = Contact	None	
	Contact = Sham	None	

Note. Act-E = Act-Extraverted. > indicates significantly greater, < indicates significantly less, = indicates ns difference. Z indicates the number of standard deviations from the mean of trait E. Blank cells indicate that mediation analyses were not conducted.

ior, PA, and authenticity. Mediation analyses suggested that ex-traverted behavior was a plausible mediator of the overall act-extraverted intervention effect on PA, whereas the evidence that extraverted behavior mediated effects on authenticity was mixed. Finally, moderation analyses revealed that the effects of the act-extraverted intervention varied as a function of trait extraversion: although more extraverted participants showed all of the above effects, plus lower levels of tiredness, more introverted partici-pants reported smaller increases in extraverted behavior and PA, increased NA, reduced authenticity, and increased tiredness.

Discussion

A maturing literature shows that people feel happier when they act more extraverted, even if they are dispositional introverts (Fleeson et al., 2002; Sun, Stevenson, et al., 2017). However, no published study has yet investigated whether people can improve their wellbeing by deliberately acting more extraverted during their everyday lives. To address this critical gap in the evidence, we conducted a randomized controlled trial of the potential well-being benefits and costs of acting extraverted across a week of daily life. On average, our act-extraverted intervention increased participants' reports of PA and authenticity, and these effects could be explained by increases in average levels of extraverted behavior reported across the intervention period. These wellbeing benefits did not appear to be offset by any costs in terms of increased NA or tiredness, or reduced feelings of authenticity. However, in sharp contrast to virtually every previous study in this literature, we found that these effects depended on one's level of trait extraver-sion. Specifically, the intervention was successful for participants who had at least average levels of trait extraversion, but extreme introverts experienced wellbeing costs in terms of increased NA, tiredness, and reduced feelings of authenticity. These are novel findings, supported by what is arguably the most stringent test yet conducted of the impact of acting extraverted on wellbeing.

Was the Act-Extraverted Intervention Beneficial and Why?

We found that acting extraverted over one week in everyday life increased levels of PA in the average participant. This finding is consistent with the growing body of correlational ESM research (e.g., Fleeson et al., 2002; Sun, Stevenson, et al., 2017; Wilt et al., 2017) and experimental laboratory research (e.g., McNiel et al., 2010; Smillie, Wilt, et al., 2015; Zelenski et al., 2012) showing links between extraverted behavior and PA. However, there was one complicating finding: When compared to the sham condition, the act-extraverted intervention appeared unequivocally successful for increasing both momentary and retrospective reports of PA. In contrast, compared to the contact-control group, the act-extraverted intervention only increased levels of retrospective, but not momentary, PA. This lack of difference in momentary PA is similar to the results of previous laboratory studies, most of which have shown that participants instructed to act extraverted during a group discussion task do not significantly differ in PA compared to a comparison group given no behavioral instructions (McNiel & Fleeson, 2006; Sun, Stevenson, et al., 2017; Zelenski et al., 2012, Study 2; Zelenski et al., 2013, Studies 2 & 5; cf. Zelenski et al., 2012, Study 1; Zelenski et al., 2013, Study 3). However, it should

be noted that the momentary effect was in the same direction as the retrospective effect, albeit of smaller magnitude. Therefore, it is possible that we lacked statistical power to detect this small effect. Nevertheless, the evidence overall suggests that following instruc-tions to act more extraverted might be beneficial for PA relative to following sham instructions, but less decisively so in comparison to how one would naturally behave in the absence of any instruc-tions.

We also examined potential costs of acting extraverted on perceptions of authenticity, NA, and tiredness. On average, people did not feel less authentic by following instructions to act extra-verted: To the contrary, instructions to act extraverted *increased* feelings of authenticity for most participants. This result is con-sistent with the finding that naturalistic extraverted behavior is associated with higher levels of perceived authenticity (Fleeson & Wilt, 2010) and shows for the first time that this effect extends to experimentally manipulated extraverted behavior. From an inter-vention acceptability standpoint, this suggests that most partici-pants find it natural to act more extraverted and do not feel like they are "putting on an act." We also found no overall cost of the act-extraverted intervention in terms of feelings of tiredness or NA. This was despite recent correlational evidence indicating that extraverted behavior is associated with increased levels of tired-ness three hours later (Leikas & Ilmarinen, 2017).[2] Thus, the main effects of the intervention were wholly positive, and no costs of extraverted behavior were detected for the average participant.

What might explain the effects of the act-extraverted interven-tion on PA and authenticity? We hypothesized that the act-extraverted intervention should have effects on wellbeing out-comes via increased extraverted behavior across the week. Although this seems like it would be a foregone conclusion, it was important to put it to the test, as it would be concerning (suggesting demand characteristics or placebo effects) if extraverted behavior was not found to mediate the effects of the act-extraverted intervention on wellbeing outcomes. Supporting this mechanism, we found that extraverted behavior accounted for a large proportion of the over-all effect of the intervention on PA. On the other hand, the evidence that the effect of the intervention on authenticity was mediated by extraverted behavior was more mixed: retrospective authenticity was mediated by extraverted behavior, but average momentary authenticity was not. Nevertheless, and although we acknowledge the limitations of statistical mediation (Bullock, Green, & Ha, 2010), these analyses suggest that extraverted be-havior offers a plausible explanation for at least some of the intervention effects.

The extraverted behavior mechanism also appears to be more plausible than two alternative explanations. First, it seemed pos-sible that the intervention instructions could influence the conse-quences of extraverted behavior. For example, successful compli-ance with instructions to act more extraverted could lead to increased PA, due either to a sense of accomplishment or, more trivially, to demand characteristics. Such an effect could contribute to the observed differences between conditions in PA. However,

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[2] We attempted to conceptually replicate Leikas and Ilmarinen's (2017) finding of an association between extraverted behavior and later feelings of tiredness, but no such lagged effects emerged as significant in our data (see Supplemental Materials).

we found that extraverted behavior had similar associations with momentary positive affect and authenticity in both of the experimental conditions. This implies that the act-extraverted intervention affected wellbeing outcomes by increasing levels of extraverted behavior, rather than by changing the consequences of that extraverted behavior. Second, although some studies have found that the association between trait extraversion and PA can be partially explained in terms of social activity (Srivastava, Angelo, & Vallereux, 2008; cf. Lucas et al., 2008), we found no evidence that the Act-Extraverted intervention affected how much time people spent in social interactions. This indicates that the intervention effects are likely to be attributable to processes beyond the quantity of social interactions they experience; rather, changes in qualitative aspects of social experiences resulting from increased extraverted behavior may be more relevant (see Smillie, Wilt, et al., 2015; Sun, Stevenson, et al., 2017). However, we acknowledge that other unmeasured processes could also explain the intervention effects (e.g., demand characteristics).

If changes in extraverted behavior are the most likely explanation for the effects of the intervention, a final consideration is whether differences in wellbeing outcomes between the act-extraverted and sham groups were due to the act-extraverted instructions increasing extraverted behavior, or due to the sham instructions decreasing extraverted behavior. Comparing levels of extraverted behavior in the act-extraverted and sham groups to the uninstructed contact-control group indicates that both of these processes may have occurred. The act-extraverted group reported higher levels of extraverted behavior relative to the contact-control group, whereas the sham group reported somewhat lower levels of retrospective (but not momentary) extraverted behavior relative to the contact-control group. Differences in PA between the three groups showed a similar pattern: The act-extraverted group reported higher levels of PA relative to the contact-control group, whereas the sham group reported lower levels of momentary (but not retrospective) PA relative to the contact-control group. Overall, these findings suggest that relative to the contact-control group, the act-extraverted intervention increased levels of extraverted behavior, whereas the sham intervention decreased levels of extraverted behavior, and that differences in levels of extraverted behavior between these groups can potentially explain the observed differences in wellbeing outcomes.

For Whom Did the Intervention Work Best?

We found positive effects and no costs of an act-extraverted intervention on average, but an understanding of the effectiveness of an intervention is incomplete without considering the moderating role of individual differences. Models of person-activity fit (Lyubomirsky & Layous, 2013) suggest that different activities are more successful at increasing happiness for different people. In the context of acting extraverted, some have suggested that introverts may find it draining and inauthentic to act more extraverted (e.g., Cain, 2012; Little, 2008). Although previous research has generally not supported for these claims, we found that the consequences of extraverted behavior did indeed depend on dispositional extraversion. Specifically, although the act-extraverted intervention had multiple benefits and no costs for people who had at least average levels of extraversion, more introverted people experienced fewer benefits and more costs of acting extraverted.

To begin with, the effect of the act-extraverted intervention on PA was weaker for more introverted people. Although the act-extraverted intervention appeared to increase *momentary* PA, regardless of dispositional extraversion, no benefit in *retrospective* PA was detected in relatively introverted participants. This dependence on trait extraversion may not have emerged in previous daily life studies because such studies have not attempted to constrain individuals' naturally occurring behavior. On the other hand, lab experiments in which participants have been instructed to act counterdispositionally have typically involved a short (~20min), structured interactive task involving one or two strangers. Unlike in previous studies, introverted participants assigned to our act-extraverted intervention were instructed to sustain increased levels of extraverted behavior for multiple days across repeated interactions in daily life. Given the lack of previous support for the moderating role of dispositional extraversion, and the inconsistencies between state and retrospective reports, this finding should be interpreted cautiously until replicated. It should also be noted that this study was powered to detect our hypotheses regarding main effects but was not highly powered to detect moderation effects. However, if our results prove to be robust, they suggest that acting extraverted can increase experiences of PA in most individuals, but that these benefits could be more limited for relatively introverted people, at least as recalled in retrospective reports.

Next, although higher levels of authenticity were reported by participants in the act-extraverted intervention, this effect was moderated by trait extraversion: participants of average extraversion and above who were instructed to act more extraverted reported increased feelings of momentary and retrospective authenticity, but more introverted participants did not. These findings conceptually diverge from previous ESM research on this topic (Fleeson & Wilt, 2010), which showed that extraverted moments were associated with greater feelings of authenticity for introverts and extraverts alike.[3] It is again possible that the extended experimental nature of the present study can account for this difference in findings: more introverted people may feel authentic in naturally expressed extraverted moments, but less authentic when intentionally attempting to increase and sustain extraverted behavior. If robust, these findings support previous cautions that acting extraverted may make introverts feel less authentic.

Finally, the act-extraverted intervention also increased retrospective tiredness and retrospective NA among more introverted people. This finding lends support to the contra-trait effort hypothesis (Gallagher et al., 2011), and notions that introverts may need to "restore" after behaving in an extraverted way, or else suffer affective costs (Little, 2008). Again, it is possible that previous laboratory-based experiments (Gallagher et al., 2011; Zelenski et al., 2012) have not detected this effect due to their short duration, and that acting extraverted for short durations of time is insufficient to induce subjective feelings of tiredness and NA. However, as the tiredness measures developed for this study require further validation, and the corresponding effects on momentary tiredness and NA were nonsignificant, these conclusions are tentative.

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[3] We instead found that the association between momentary extraverted behavior and authenticity was only positive in more extraverted people, see the online supplemental materials.

Recalled Versus Experienced Wellbeing

There were several differences between momentary reports and retrospective reports in our results. These differences could merely be due to measurement error, or could reflect more substantive differences, in line with the idea that retrospective and momentary reports measure different types of conscious "selves" (Conner & Barrett, 2012). Retrospective reports are more distant from actual experiences and, because of imperfections of memory, are more prone to distortion by recent events, semantic knowledge, and beliefs (Robinson & Clore, 2002). Therefore, our retrospective results may have been influenced by beliefs about extraverted and counterdispositional behavior. For example, introverts tend to underestimate how much PA and overestimate how much NA they will experience after acting extraverted (Zelenski et al., 2013). In addition, people tend to believe that they feel most authentic when they act in line with their Big Five traits, and that introverts will feel less authentic when acting in an extraverted way (Fleeson & Wilt, 2010). The influence of such lay beliefs could explain why retrospective reports seemed less favorable than momentary reports in our study.

However, these biases do not necessarily make retrospective reports inferior to momentary reports. Another process that could cause retrospective and momentary reports to differ is that retrospective reports often manifest larger degrees of change relative to momentary reports (e.g., Luong, Wrzus, Wagner, & Riediger, 2016), possibly due to momentary effects accumulating over time into larger effects within global retrospective reports. In addition, in some circumstances retrospective reports can be better predictors of future behavior and other criteria than momentary experiences (Conner & Barrett, 2012; Redelmeier, Katz, & Kahneman, 2003). For example, Wirtz, Kruger, Scollon, and Diener (2003) found that students' recollections of feelings during a spring vacation, relative to momentary reports of those feelings, were better predictors of whether those students intended to repeat the trip in the future. Therefore, it is not obvious whether we should evaluate the success of the act-extraverted intervention on the basis of effects on retrospective or momentary reports. When the two differ, we must balance the evidence from both momentary and retrospective measures and consider the possible implications of differences between the two. For example, if participants consistently reported feeling more momentary PA during the act-extraverted intervention, but do not remember feeling any happier when retrospecting at the end of the intervention week, feedback could be provided reminding participants that the intervention actually did make them feel happier in the moment, potentially correcting their beliefs over the long term.

Limitations and Future Directions

Our RCT provides a critical, direct test of the claim that acting more extraverted in everyday life might be an effective strategy for increasing wellbeing, and is one of the most comprehensive examinations of both the benefits and costs of extraverted behavior. However, there are many ways that future studies could build off this initial effort.

Comparison group. Here, the effects of the act-extraverted intervention were compared to a sham intervention that included behavioral instructions drawn from across the Big Five domains. The sham instructions were intended to control for placebo-type effects associated with participation in an intervention, while accounting for potential social desirability confounds. However, the sham instructions may have produced their own specific intervention effects that confounded the effects of the act-extraverted intervention, as discussed previously. For example, it is possible that instructions to act "sensitive" and "calm" may lead to wellbeing benefits specifically for introverts.[4] Therefore, future research could explore alternative active comparison groups to better understand the specific effects of an act-extraverted intervention. For example, comparison groups adopting other sets of instructions (e.g., "Act in a polite and respectful way") could be used.

Effectiveness of the manipulation for introverts. According to momentary reports, the present intervention was less effective at increasing levels of extraverted behavior among more introverted people and was wholly ineffective at increasing extraverted behavior in extreme introverts. This could be because increasing extraverted behavior for extended periods of time is unsustainable for introverts (e.g., due to the negative consequences that are incurred), which would establish the boundary conditions of earlier conclusions that introverts and extraverted are equally capable of engaging in extraverted behavior (e.g., Fleeson et al., 2002). However, another possibility is that the present intervention was too difficult and/or insufficiently engaging for introverts. Importantly, the reduced effectiveness of the manipulation for more introverted participants may help explain why such individuals did not benefit as much as their extraverted counterparts in terms of wellbeing outcomes. Acting more extraverted may yet be shown to be beneficial for introverts if an alternative implementation of an act-extraverted intervention could more successfully increase extraverted behavior for such individuals.

There are numerous modifications that could be made to the present intervention to attempt to increase its potency for introverts. In particular, reducing the perceived intensity of the intervention could be beneficial. Instead of being instructed to act extraverted "as much as possible," participants could be asked to act extraverted in a small number of social interactions per day. Brief field experiments showing that even minimal social interactions (e.g., talking to strangers during a commute, Epley & Schroeder, 2014; having a genuine interaction with a cashier, Sandstrom & Dunn, 2014) can influence wellbeing. This suggests that a less intensive intervention than the one evaluated here might still be effective. A less intensive intervention might also be less intimidating for introverts, who tend to predict that acting extraverted will result in negative affective consequences (Zelenski et al., 2013). By allowing more freedom to return to an introverted "restorative niche" (Little, 2008), a less intensive intervention might also result in fewer costs to NA, authenticity, and tiredness. It might also prove more effective for participants to establish specific implementation intentions (a series of "if-then" statements; e.g., "If I encounter situation X, I will do Y"), which has previously been shown to help people achieve personality change goals (Hudson & Fraley, 2015). Finally, the intensity of the intervention could even be tailored to an individual's level of trait extraversion and motivation to participate in the intervention.

Long-term effects. Another critical area to be investigated is how to sustain the positive wellbeing outcomes of an act-

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[4] We are grateful to an anonymous reviewer for this suggestion.

extraverted intervention over the longer term. We found that there were no consequences of acting extraverted on wellbeing outcomes at 2-week follow-up. This was true even though participants in the act-extraverted intervention still reported somewhat higher levels of extraverted behavior at 2-week follow-up. This suggests that once the intervention is withdrawn, its positive consequences also cease. Nevertheless, it would obviously be desirable if the benefits of an intervention could be sustained beyond the intervention period.

Longer-term effects of the intervention might have been achieved if participants were encouraged and felt motivated to continue acting in an extraverted way after the conclusion of the intervention. This might be achieved if participants were informed that the intervention was thought to benefit wellbeing. This is seen in positive psychology interventions which often have an overt focus on improving wellbeing, and often show effects on wellbeing that persist for at least three to six months, potentially because participants continued engaging in these positive activities after the intervention period (Bolier et al., 2013). Alternatively, personality-change intervention approaches (Hudson & Fraley, 2015; Roberts et al., 2017) could facilitate longer-term change in extraverted behavior and wellbeing (Hudson & Fraley, 2016). Such longer-term interventions may also help make extraverted behavior more habitual, which could reduce the negative consequences of the intervention (as implied by the contra-trait effort hypothesis; Gallagher et al., 2011) while retaining its positive effects.

Generalizability. This article investigated several outcome measures to obtain a broad view of the effects of acting extraverted on wellbeing. However, there are many other aspects of wellbeing that we did not consider here (e.g., meaning, engagement, positive relationships; Ryff, 1989; Seligman, 2011). Previous laboratory-based experiments have shown that acting extraverted impacts on multiple positive affective states and measures of wellbeing (Mc-Niel & Fleeson, 2006; Smillie et al., 2015), and that trait extraversion is linked with multiple dimensions of wellbeing (Sun et al., 2017). Nevertheless, future work that examines the effects of an acting extraverted intervention on other aspects of wellbeing would be helpful to determine the breadth and boundaries of the effects reported here.

Final Thoughts and Conclusion

Given the robust links that extraverted behavior has with wellbeing, many have asked the naturally occurring question: Should more introverted people act extraverted more often? Our goal is not to deliver any prescriptive recommendations about whether to act more extraverted. Instead, we have provided evidence that acting extraverted has merit as a potential self-regulatory tool, which could be strategically deployed to yield affective benefits. However, we also found that those who were more introverted, relative to those who were more extraverted, experienced fewer benefits of sustained increases in extraverted behavior. Introverts might "feel good" after naturally expressing extraverted behaviors, or when enacting extraversion for short bouts, but attempts to enact extraverted behavior for longer durations of time seem to have less pronounced benefits, and possible costs. Thus, rather than attempting to act more extraverted, introverts may benefit more from pursuing other wellbeing pathways (e.g., mindfulness and other positive psychology interventions; Bolier et al., 2013). We also

note that there are individual differences in ideal levels of affect (Tsai, Knutson, & Fung, 2006; Tamir, 2009), and that introverts may not desire the experience of PA as strongly as extraverts. Therefore, the assumption that experiencing increased levels of PA is "beneficial" and desirable may be misguided (e.g., Ford, Mauss, & Gruber, 2015; Gruber, 2011; Gruber, Mauss, & Tamir, 2011).

In conclusion, the present study aimed to provide new insights into the debate around whether acting more extraverted is beneficial for wellbeing, even for introverts. In the first randomized controlled trial to be published on this topic, we found that an act-extraverted intervention increased PA and feelings of authenticity in those who were at or above average on trait extraversion. The effect of the intervention on PA was statistically mediated by extraverted behavior. However, potential benefits of the act-extraverted intervention in terms of PA were less apparent for dispositional introverts, and these participants did not increase in feelings of authenticity. Highly introverted participants may even suffer costs in terms of increased NA and tiredness, and reduced feelings of authenticity. Because these findings may hinge on specific features of our RCT, such as our choice of control groups, future research should explore alternative implementations of an act-extraverted intervention, especially those that may be more accessible and beneficial for introverts.

Context of the Research

The present research was inspired by fundamental questions about what personality is, how it impacts on our lives, and whether we can intervene in these processes to promote human flourishing. Cantor (1990) observed that we often think about personality in terms of what people "are" or "have", but we could also think about personality in terms of what people "do". A more recent, growing literature on counterdispositional behavior, which has primarily focused on manipulations of extraverted behavior, seems to reinforce this perspective. Specifically, several studies suggest that the wellbeing benefits enjoyed by extraverted people can be reaped by all people when they behave in a more extraverted way. This has profound theoretical implications for understanding why extraverts have higher wellbeing, as well as potential practical implications for promoting wellbeing. We planned our RCT of the wellbeing effects of extraverted behavior specifically to inform these practical implications, given that previous studies had comprised either laboratory-based experiments (which have limited ecological validity) or correlational daily life studies (the results of which are causally ambiguous). Our results provide both encouragement and caution to the idea that people can boost their wellbeing by engaging in extraverted behavior. Perhaps our most significant finding was the observation that dispositional introverts may reap fewer wellbeing benefits, and perhaps even incur some wellbeing costs, from acting more extraverted. Our future research priorities in this area include confirming the present findings and identifying wellbeing pathways that are more effective for introverted people.

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