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What happens when flow ends? How and why your creativity is limited after a flow experience

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Abstract

Flow is touted for the enjoyment it provides and for its relationship with concurrent task performance. But what happens when flow ends, and you move on to your next task? Our research demonstrates that there is a cost to being in flow in this regard. Specifically, the findings of three studies with 746 participants demonstrate that a person who just experienced flow carries forward a figurative tunnel vision which limits their creativity. This is important because flow can happen throughout daily life and can thus impair many creative tasks. In fact, our findings demonstrate that common activities can elicit a flow state that produces the effect on multiple subsequent tasks. Specifically, participants who experienced flow while playing video games in Study 1 were less creative in their subsequent two tasks compared to those who did not experience flow. This finding was replicated in Study 2 with a new flow inducing task. Study 2 also confirmed cognitive flexibility as an underlying mechanism wherein flow leads to a reduction in cognitive flexibility. Lastly, Study 3 shows that people can experience flow while shopping online, and if they do, their creativity is impaired in their next task. The negative carry-over effect was not equal for all forms of creativity, however; it consistently limited verbal creativity, but had limited influence on figural creativity. These findings make several theoretical contributions regarding the nature of flow and its consequences, while also providing practical insights for people structuring their day to increase creativity.

Keywords Flow · Creativity · Cognitive flexibility · Divergent thinking

Introduction

Flow is a state of full yet seemingly effortless engagement, in which one is so absorbed in what they are doing that everything else dissolves from consciousness, including their sense of time and self (Csikszentmihalyi, 1975). Flow happens in daily activities in short durations called micro-flow (Lavoie & Main, 2019a), whether it is at work (Debus et al., 2014; Gerpott et al., 2021) or in leisure (Csikszentmihalyi & Lefevre, 1989). While we know the enjoyable experiences that comprise flow (Lavoie et al., 2022) and its concurrent performance benefits (Engeser & Rheinberg, 2008), we do not have as good of an understanding of what happens after flow ends, including its downstream effects on cognition.

Our research addresses this gap by showing that flow has a *negative* carry-over effect on creativity that persists across multiple subsequent tasks. We consider flow's downstream influence on creativity in particular because of its importance to daily life (Herd & Mehta, 2019; Mehta et al., 2017; Moreau & Dahl, 2005). The results of three studies show that while flow may have concurrent performance benefits (i.e., in the task it is experienced in), when flow *ends*, people are left with a figurative tunnel vision. The tunnel vision limits their cognitive flexibility, referring to the ability to switch one's focus of attention (Finke et al., 1992), which mediates decreased creativity. Study 1 demonstrates the negative carry-over effect by inducing flow via a video-game. Study 2 replicates the effect while providing support for the mediating role of cognitive flexibility within the context of listening to new music. The empirical package concludes with Study 3 which demonstrates, through an online shopping task, that the negative effect is moderated by the

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type of creativity, such that it is strongest on verbal creativity but having a minimal influence on figurative creativity.

These findings make several contributions. First, by extending the temporal consideration of flow's outcomes, the results broaden our understanding of flow's nomological network, including a negative consequence it can have. We argue that the downstream effect of flow is equally as important as its influence on the flow-inducing task, as our studies show that flow is strong enough to negatively impact cognition in multiple subsequent tasks. The mediation findings related to flow decreasing flexibility, in addition to the moderation findings related to its negative influence on verbal but not figural creativity, enhance our understanding of flow and the type of information processing it encourages, which further broadens our understanding of the potential outcomes that flow may have. Lastly, our results contribute to the task switching literature by explaining a new factor (flow) that determines how a person is influenced when moving to a new task. Relatedly, these findings have practical implications regarding the role that flow plays within the larger scope of a day, including what should (not) be done after a flow experience and how to structure daily tasks to foster both creativity and enjoyment.

Conceptual development

Flow Flow is a psychological state of full yet seemingly effortless attention (Harris, Vine & Wilson, 2017). Flow is comprised of two sets of experiences: fluency and absorption (Lavoie et al., 2022). Fluency-related experiences capture much of the enjoyable aspect of flow as they involve the ease of thought and action that come with making continuous forward progress (Lavoie & Main, 2019a). The fluency aspect of flow is characterized by feelings of effortlessness—that everything is happening naturally and on its own—and a high degree of automaticity and control (Engeser & Rheinberg, 2008). The absorption-related experiences involve losing track of time and self-awareness, resulting from devoting full attention to a limited set of information for an extended period (Dietrich, 2004).

While all flow states possess the aforementioned characteristics, they differ in subjective intensity based on the duration and complexity of the activity that elicits them (Nakamura & Csikszentmihalyi, 2002). Flow states can be classified on a continuum, with the less intense *microflow* states at one end, elicited from relatively simple, shorter tasks (Lavoie & Main, 2019). Despite flow being largely associated with significant achievements in seminal writings and in popular press, evidence of flow is more common in everyday life in *microflow* variants. For example, listening to music is an example of something that can elicit *microflow* (Privette, 1983; Lavoie & Main, 2022), while slightly more complex tasks, such as reading have also been conceptualized as giving rise to *microflow* (Magyaródi & Oláh, 2015).

On the opposite end is *deepflow*, which is what most people associate with flow. *Deepflow* states are subjectively more intense and are elicited from activities that are longer in duration and relatively more complex, requiring a high degree of skill. For example, cruising a boat across the ocean (MacBeth, 1988), whitewater river surfing (Mackenzie et al., 2011) and sex (Privette, 1983) could all give rise to *deepflow*. Given the differing nature of the tasks that elicit *microflow* and *deepflow* with regards to complexity, there are differences in the potential consequences. For example, *deepflow* has greater potential to elicit a transformative experience given the challenge the activity provides over a longer period of time (Csikszentmihalyi, 1975).

In this paper we focus on *microflow*, and we use the term interchangeably with flow for the remainder of the paper. Flow can be experienced in a wide variety of daily activities, including work tasks (Lahti & Kalakoski, 2023; Olčar et al., 2019; Xie, 2022; Mao et al., 2023) and leisure activities (Havitz & Mannell, 2005). Contexts involving interactive technology appear to be highly conducive to flow, with growing evidence of technology-induced flow experiences, including contexts like playing video games (Zhang et al., 2022), smartphone use (Lavoie & Zheng, 2023), online search (Hoffman & Novak, 1996; Mathwick & Rigdon, 2004; Novak et al., 2003) and online gambling (Lavoie & Main, 2019b).

Flow is considered by many to be an optimal experience (e.g. Csikszentmihalyi & Lefevre, 1989; Pelet et al., 2017) and has been demonstrated to have several positive consequences, including increased wellbeing (Lavoie & Zheng, 2023), resilience (Mao et al., 2023) and performance in goal-based tasks (Bakker & Woerkom, 2017; Demerouti, 2006; Quinn, 2005). It is associated with a myriad of positive affective outcomes, including enhanced levels of enjoyment, intrinsic motivation (Bakker, 2008), happiness (Collins et al., 2009) and subjective meaningfulness (Silverman et al., 2016). Flow also bolsters attitudes towards and further engagement with whatever created it (Korzaan, 2003; Hsu et al., 2012).

Our research extends these findings by considering what can happen when flow ends, while recognizing that there can be negative consequences. While the duration of flow varies across a range from microflow to deepflow, it must necessarily end when someone's attention shifts away from the focal task, and they are thus no longer absorbed in the task (Csikszentmihayli, 1975). That is, while attention is full and narrowed to the task in flow, when it shifts to other things including awareness of the self, or different points in time, whether it be the future or the past, one is said to not

be in flow (Lavoie et al., 2024). While the attentional shift that pulls one out of flow can be caused by a multitude of factors, we consider the example of it happening from the task ending (completion), which all but ensures that attention is no longer fully dedicated to the task, as one is not engaging with it.

Creativity Creativity is defined as the generation of ideas that are both novel and potentially useful (Guilford, 1959). Thus, to be creative one must be able to think both divergently, to generate an original idea, and convergently, to ensure that the idea is practical (Amabile, 1983). In this research we focus on the ability to generate original (novel) ideas; thus, the ability to think divergently. We use the terms, "creativity," and "novelty," interchangeably for the remainder of the paper.

People require creativity for several reasons, whether it be to accomplish work tasks (Amabile et al., 2005), or to solve daily problems (Hirschman, 1980). For example, creativity aids decisions related to personal life changes and to purchases, such as designing a living room or whether / how to do a home renovation (Burroughs et al., 2008). It helps people explore the range of products that may work and ultimately choose the right one(s) (Burroughs & Mick, 2004). Modern consumption also gives people the opportunity to create products and marketing materials through co-creation with their favorite brands, the value of which will be a function of their creativity (Moreau & Herd, 2010; Atakan et al., 2014; Ramaswamy & Ozcan, 2016; Wang et al., 2008). Creativity also helps people find alternative ways to use a product, maximizing their utility and enjoyment of it and potentially saving money and time (Mehta & Zhu, 2015; Ram & Jung, 1994).

Beyond its functional value, creativity is similar to flow in that is fuels a myriad of positive affective experiences and is a crux of positive psychology (Csikszenthimalyi, 1996). For example, being creative can lead to feelings of accomplishment, pride, and confidence (Burroughs & Mick, 2004), while failures to be creative are associated with negative affect (Hildebrand et al., 2013). Creativity is suggested to have intrinsically rewarding properties, reinforcing people to engage in a task without the need for external rewards (Csikszentmihalyi, 1996; Ryan & Deci, 2000). As a result, being creative is associated with enjoyment and psychological well-being (Hampton-Sosa, 2017; Rasulzada & Dackert, 2009).

Creativity is partly a function of cognitive flexibility (De Dreu et al., 2008), which refers to the ability to switch the focus of attention (Finke et al., 1992; Geurts et al., 2009). Flexibility facilitates the production of novel ideas by allowing one to compare different perspectives, consider new information and thus reflect on multiple ways to approach a problem (e.g., Smith & Blankenship, 1991; Johnco et al., 2014). That is, by allowing one to pay attention to information outside of their immediate sphere of awareness, cognitive flexibility broadens the amount of information that is accessible and helps people generate ideas beyond what first comes to mind (Cañas et al., 2003; Martin & Rubin, 1995; Mehta & Zhu, 2015). Several variables have been demonstrated to promote cognitive flexibility, including counterfactual thinking (Markman et al., 2007) and distrust mindsets (Schul et al., 2008). Construal level is also related, such that a low-level of construal is associated with being fixated on limited stimuli and thus low flexibility, while the opposite is the case for a high level of construal (Alter & Oppenheimer, 2008).

Hypothesis development

Flow and creativity Since its inception, flow has been associated with creative tasks and has been suggested to bolster creativity (Csikszentmihalyi, 1975, 1996). Evidence exists of flow happening while being creative in activities such as drawing (Cseh et al., 2016) or playing the piano (De Manzano et al., 2010). Their positive relationship has been supported by preliminary empirical evidence (Schutte & Malouff, 2020), including the finding that experiencing flow while composing music has a positive relationship with the perceived creativity of the song (MacDonald et al., 2006) and that flow experienced in web communities of workers can enhance their creativity (Yan et al., 2013).

It is important to note that one key characteristic of prior research is that it explores the relationship between flow and creativity within the *same* (concurrent) task. We ask a different question- what happens to your creativity when flow ends, and you transition to the next task? For example, if you experience flow while listening to music or shopping online and then engage in a new task (e.g., work), how is your creativity influenced? We believe that task switching will alter the nature of the relationship to be a negative one for several reasons explained below.

The extant flow literature offers competing hypotheses for how flow will carry over to influence creativity in subsequent tasks. The energizing aspect of flow, along with its relationship with positive affect (Rogatko, 2009) would suggest that it may facilitate creativity in subsequent tasks, if affect can be sustained (Mehta et al., 2017). However, we believe that since one is moving away from the flow-inducing task, which is what resulted in positive feelings, that the potential for such positive effects will be limited. While the affective mechanisms may be dampened, we theorize that the style of cognitive processing *will* transfer to the

subsequent task, as it often does (Gollwitzer, 1990; Moreau & Engeset, 2016). Moreover, we believe that it will do so in a manner that limits flexibility and ultimately creativity, since flexibility is a source of creativity (De Dreu et al., 2008; Herd & Mehta, 2019).

Two experiences consistently used to describe flow are: (1) that is comprised of *fluent* thought and action such that it feels effortless, and (2) it involves full *narrowed* attention (Lavoie et al., 2022). We suggest that these characteristic experiences provide insight into the cognition that underlies flow and thus how it will negatively influence subsequent creativity. The full *narrowed* attention on whatever elicited flow should limit the degree to which people can fully engage in a broad set of new information (i.e. flexibility) in the next task. This is consistent with findings in the task-switching literature regarding the general difficulty that people have re-engaging in a new task (Leroy, 2009). We believe the negative influence would be even more profound in our case given the level of engagement in flow.

The seemingly effortless (fluent) experience in flow suggests that the person is *not* processing information analytically, as that would be disfluent. In fact, findings related to processing fluency suggest that frequently using executive functions like cognitive flexibility would feel disfluent (Song & Schwarz, 2008, 2009). This is consistent with neurocognitive theorizing, which suggests that several executive functions are quieted during flow, sometimes referred to as transient hypofrontality (Dietrich, 2004; Wolf et al., 2015). If carried to the next task, this type of processing will also limit the breadth of information that people consider (i.e., flexibility), but for a different reason - to maintain a degree of effortlessness, referred to as path of least-resistance processing (Ward, 1994).

In summary, we believe that experiencing flow and then exiting it will have a negative influence on creativity in the next task. Specifically, it will limit cognitive flexibility, which will mediate decreased creativity. This is depicted in Fig. 1 and the following hypotheses:

Hypothesis 1: Experiencing flow will lead to decreased creativity in a subsequent task.

Hypothesis 2: Cognitive flexibility will mediate the negative relationship between flow and creativity in a subsequent task.

Not all forms of creativity equally rely on cognitive flexibility, however. Verbal creativity is related to processing and responding with words, while figural creativity is related to processing and responding with pictures and shapes (Torrance, 1974; Kim et al., 2006). For instance, playing Scrabble would involve verbal creativity while playing Pictionary would be more related to figural creativity (e.g., Saggar et al., 2015). Verbal creativity is largely driven by executive functions like flexibility and right-hemispheric processes (Torrance, 1974; McGee, 1979), evidenced by activation in the pre-frontal cortex and its ability to integrate other functions of the brain (Beaty et al., 2018). However, flexibility is not as critical to figural (visual-spatial) creativity (Torrance et al., 1966; Kim, 2006a). In fact, figural creativity is largely derived from abstractness, and is associated with decreased engagement of certain executive functions related to flexibility (Finke, 1996; Saggar et al., 2017). The two aspects of creativity are distinct and not always related, at times showing a lack of convergent validity (e.g. Clapham, 2004). The distinction between verbal and figural creativity is noteworthy to our research because the need for cognitive flexibility differs across the two. Thus, our theorizing suggests that figural creativity should be less impacted by flow, with the type of creativity acting as a moderator of the relationship. Stated formally:

Hypothesis 3: Figural creativity will be less negatively affected than verbal creativity by having experienced flow in the prior activity.

Study 1

The primary goal of Study 1 is to provide preliminary support for Hypothesis 1, that experiencing flow will decrease creativity in a subsequent task. A secondary goal is to rule out the potential alternative explanation that those who do not experience flow could be more motivated to do better, whether it is to redeem themselves in the next task or to improve their mood, which would account for increased creativity. We followed an established paradigm for manipulating and measuring flow (i.e., Keller & Bless, 2008) in which participants were randomly assigned to play Tetris at one of three different levels of difficulty (easy, medium,

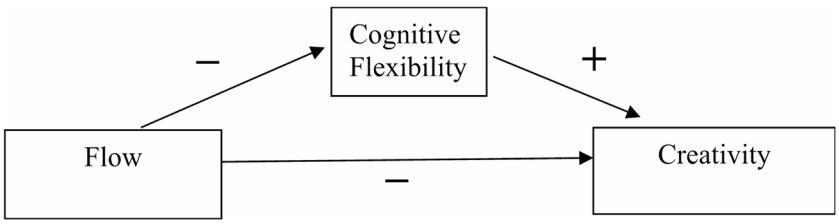

Fig. 1 Mediation model

or difficult). Participants (N = 189 undergraduate students, 56.1% male, M_{age} = 20.17) were compensated with course credit. They were first given instructions related to how to play Tetris and given a chance to practice before playing. Then, when they were ready, the lab coordinator started the game for them and told the participants that they would stop them when their time was up. Participants were not told how long they would be playing for, but the lab coordinator was instructed to stop them at 8 min, which was a reasonable amount of time for them to have been able to experience flow based on prior research (e.g., Lavoie et al., 2022).

The difficulty level of Tetris is adaptive, increasing in difficulty as one makes progress. In the easy condition, we thwarted the ability for participants to move their puzzle pieces faster, making the game too easy. That is, in the easy condition the objects continued to fall at a slow pace despite making progress. We maintained the adaptive properties of Tetris in the medium condition so that participants would continue to have challenges equal to their skill level as they progressed, with the pieces falling slightly faster as the participant showed mastery over the task. In the difficult condition, the objects started falling significantly faster and would continue to fall faster, without participants having time to make decisions. Based on the manipulated skills-demand compatibility, we expected participants playing in the medium difficulty condition (skills = demands) to report higher scores on indicators of flow than those in the easy (skills > demands) or difficult (skills < demands) conditions (Keller & Bless, 2008).

After playing Tetris, participants were asked to note and report their score on the screen. We assessed creativity in two different tasks immediately after that, and then participants completed a questionnaire assessing flow (see Fig. 2 for illustration). Thus, there would have been a limited amount of time between tasks (< 30 s for most participants). To assess creativity, participants were first asked to generate ideas for a new product and then the second creativity measure was administered- the Alternate Uses Test (AUT). Flow was assessed after the creativity tasks to prevent any demand effects of asking flow prior to creativity. Other measures were included for exploratory purposes in each study. We determined sample size using G*Power software. Given the effect size of the mean difference demonstrated in pretesting (d = 0.4), G*Power suggested a sample size of 156 to detect a mean difference across the conditions with a power of 0.8. We included slightly more participants than recommended.

Measures

Manipulation check (flow) We assessed the validity of our flow manipulation by assessing several of flow's defining characteristics (Keller & Bless, 2008): (a) perceived fit of skills with task demands, (b) control, and (c) enjoyment. Perceived fit of skills and task demands was assessed by asking participants "To what degree did the demands of the game match your ability?", where 1 = did not match my skill, 4 = matched my skill, and 7 = exceeded my skill. We assessed perceived control using four items (α = .905) scored from 1 (not at all) to 7 (very much so): "I think that I had everything under control" I think that I had the necessary skill to play the game successfully," "I knew exactly what I had to do," and "I think I performed well in the game". We measured enjoyment using 2 items (r = .806) anchored at 1 (not at all) and 7 (very much so): "Playing the game felt rewarding" and "I'd love to play the game again".

Creativity Creativity was assessed in two different tasks as we sought to show a sustained negative effect in both. First, we asked the participants to generate an idea for a new mattress which was later evaluated by three people from the same population (one male, two female undergraduate students) on a 7-point scale from 1(not at all original) to 7 (very original, Moreau & Dahl, 2005). We took the average of their three ratings as our measure of creativity (α = 0.831). Creativity was also assessed using the AUT (Guilford, 1959, 1967) wherein participants were asked to generate as many alternate uses for a paperclip as they could in one minute. After compiling each participants' list of alternate uses, two separate coders were asked to choose the most creative idea and rate it on a scale of 1(not at all creative) to 7 (very creative). We took the average of their ratings as our measure of creativity *(r(160)* = 0.735, p < .001).

Alternative explanation - motivation It is possible that those who did not experience flow were more motivated in the next task to bolster their self-efficacy. We included a measure of motivation to rule out that possibility, expecting that there would be no differences across the groups. Specifically, we counted the *amount* of alternative uses in the

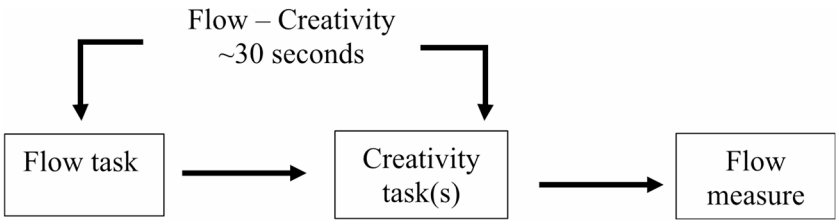

Fig. 2 Study 1 procedure

AUT as a measure of motivation, as persistence on a task is an indicator of motivation (Graham & Weiner, 1996).

Results

Manipulation check (flow) One-way ANOVAs on each aspect of flow were statistically significant (see Table 1 for the statistics of each analysis in Study 1 including mean values). Further pairwise comparisons revealed that those in the difficult condition perceived that the challenge exceeded their skills to a greater degree than those in the flow ($p = .037$, $d = 0.36$) and easy ($p = .001$, $d = 0.57$) conditions. The same analysis on control revealed that the expected pattern such that those in the flow condition experienced a greater sense of control than those in the difficult condition ($p = .034$, $d = 0.39$), and marginally less control than those in the easy condition ($p = .078$, $d = 0.3$). Pairwise comparisons revealed that those in the flow condition enjoyed the game more than those in the easy condition ($p = .014$, $d = 0.41$) and marginally more than those in the difficult condition ($p = .088$, $d = 0.32$). Together these findings support a successful manipulation.

Creativity A one-way ANOVA on the creativity of the mattress ideas revealed a statistically significant difference. Pairwise comparisons revealed that as expected, those in the flow condition were less creative than those in the difficult ($p < .001$, $d = 0.80$) and easy conditions ($p = .001$, $d = 0.67$). The same analysis was used to assess creativity based on the alternate uses for a paperclip which revealed the same results, as those in the flow condition produced the least original alternate uses compared to those in the difficult ($p < .001$, $d = 0.69$) and easy conditions ($p = .001$, $d = 0.60$).

Alternative explanation (motivation) A one-way ANOVA on motivation revealed no differences across the conditions ($p = .4$), thus suggesting that it is unlikely that those who did not experience flow were more motivated to perform better, thereby positively influencing creativity.

Discussion

Study 1 provides preliminary support for Hypothesis 1, that there is a direct negative effect of flow, as elicited by playing a video game, on creativity in a subsequent unrelated task. Moreover, the negative effect is strong enough to hold across *two* subsequent creative tasks. The results also provide support against motivation as an alternative explanation for the pattern of results. We thought it was possible that those who did not experience flow could be more motivated in the creative task afterwards. Specifically, those in the difficult condition could have been more motivated to get redemption based on relatively worse performance in the more challenging task. Alternatively, those in the easy condition could be more motivated based on excelling in the first task. However, the results of Study 1 demonstrate that participants did not differ in their motivation, so it does not account for the pattern of results.

In addition to motivation, there are several other potential alternative explanations that the design of Study 1 rules out. One of those being related to cognition, as flow is a state of high absorption and full engagement, participants could have been more fatigued in flow, leading to its negative influence. However, having easy, medium (flow) and difficult conditions in Study 1, the results are incompatible with this explanation, as the participants in the difficult condition should be more cognitively fatigued than those in the flow condition. The experimental design also provides support against the potential for individual differences in cognitive ability accounting for the results due to random assignment to conditions. That is, those high (or low) in cognitive ability should have been distributed equally across groups. Lastly, we also wondered if affect could have explained the results. However, an affect account is also not consistent with the pattern of results since flow is known to enhance positive affect, which is supposed to increase creativity (Isen et al., 1987).

Table 1 Study 1 results

Measure	M, $SD_{(easy)}$	M, $SD_{(flow)}$	M, $SD_{(difficult)}$	F value	ANOVA *P* value
Flow - enjoyment	3.84, (2.04)	4.62, (1.69)	4.07, (1.64)	$F(2, 188) = 3.23$	0.042
Flow – control	4.79, (1.81)	4.25, (1.77)	3.61, (1.51)	$F(2, 188) = 7.36$	< 0.001
Flow – fit of skills and task demands	3.37, (1.52)	3.70, (1.55)	4.29, (1.69)	$(F(2, 190) = 5.42$	0.005
Creativity (Mattress)	4.48, (1.44)	3.47, (1.57)	4.66, (1.41)	$F(2, 154) = 10.44$	< 0.001
Creativity (AUT)	4.50, (1.55)	3.42, (2.03)	4.62, (1.42)	$F(2, 169) = 8.93$	< 0.001
Alternative explanation (motivation)	3.09, (1.19)	3.45, (2.38)	3.54, (2.04)	$F(2, 166) = 0.808$	*> 0.4*

Study 2

Study 2 seeks to provide additional support for Hypothesis 1, that experiencing flow will lead to decreased creativity in a subsequent task, and to provide preliminary support for Hypothesis 2; that cognitive flexibility mediates the negative effect of flow on creativity. To increase the generalizability of our findings, instead of manipulating flow while playing Tetris, we had participants engage in a different common everyday experience- listening to music, as the flow-inducing activity. Listening to music is not only common in everyday life but is often used around times when people need to be creative. The cover story suggested that the study was concerned with how people listen to and experience sounds. Participants were instructed to listen to 1 of 4 clips of music and to reflect on their experience. In actuality, all participants listened to the same clip. Specifically, participants were asked to listen to a 3-minute clip of the electronic song, "Indigo," by Fehrplay.

We chose the song "Indigo" because it provides a particularly smooth yet engaging stimulus, which together can support the two primary dimensions of flow, fluency and absorption. We believe that it can do so because it has a repetitive rhythm and *progressively* adds layers of new sound which can foster the fluency dimension, but along with the new layers of sound, it also increases pace which together should increase arousal to a moderate level and maintain attention long enough to reach absorption (Csikszentmihalyi, 1975; Keller et al., 2011). This is consistent with prior research showing that music can create a level of engagement strong enough to elicit flow (Lavoie et al., 2022).

This study followed a 2 cell quasi-experimental design, with people falling into a flow or no-flow condition based on their subjective reporting. After listening to the song, participants were given a flow measure. Then, they were asked to complete a measure of cognitive flexibility, followed by a creativity assessment, and demographic questions related to age and gender (see Fig. 3 for an illustration of the procedure). Similar to Study 1, there would have been a limited amount of time in between the flow-inducing task and the creative task, but slightly longer (approximately 1–2 min). An online sample of participants was recruited via the crowdsourcing site, Crowdflower, in exchange for nominal compensation ($N = 99$, 51.3% male, $M_{age} = 38.49$). Sample size was determined using G*power, which recommended a sample size of 88 to achieve a power of 0.8 in detecting the relationships proposed through the fixed linear regression mediation model that we were testing. This is consistent with Fritz and Mackinnon's (2007) recommendation for a sample size of 78 to detect mediation consisting of the combination of two medium effect sizes using the percentile bootstrap method. We included slightly more participants than recommended.

Measures

Flow Since we sought a dichotomous measure for flow-whether they had experienced flow ($N = 48$, 48.5%) or not ($N = 51$, 51.5%), it was assessed using the flow questionnaire (Csikszentmihalyi & Csikszentmihalyi, 1988). The flow questionnaire provides participants with quotes which describe the characteristic feelings of flow and asks if they experienced each of the quotes or not (Csikszentmihalyi & Csikszentmihalyi, 1988; Moneta, 2012). If the participant did not experience at least one of the feelings, they are instructed to answer 'no' as that would not constitute a flow state. We used this new measure of flow for several reasons, in part because it provides a dichotomous variable of whether people experienced flow or not, and to increase the robustness of our findings. Please see the Appendix for the full measure.

Creativity Creativity was measured using the Remote Associates Test (RAT) (Mednick, 1962). The RAT is comprised of several three-word combinations and asks participants to find a common word that links the three words (e.g., "shelf"/"read"/"end," are linked by the word, "book"). We used nine sets of three-word combinations, with each set having one correct answer. Each participant's creativity score was the sum of their correct answers to the nine combinations (see the Appendix for word combinations and correct answers).

Mediator (cognitive flexibility) We followed established procedures to measure cognitive flexibility by asking people to think of as many different uses for a brick as they could (Zmigrod et al., 2019). Then, we had three independent coders create categories that represented the different types of uses given in their ideas (e.g. building, weapon,

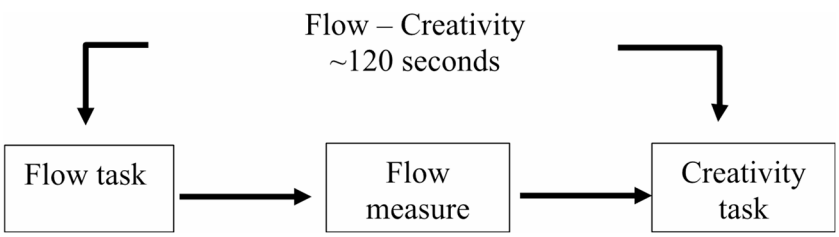

Fig. 3 Study 2 procedure

and art). Then, the three coders went through each person's set of ideas and counted how many different categories of uses were represented by their answers. Thus, the measure comprised the total number of categories captured by each participant's responses as tabulated by three independent coders (1 male, 2 females), with the average of the reviewer scores ($a = 0.92$) being used for the analysis. The more categories a participant's uses could be placed into, the higher their cognitive flexibility (Guilford, 1967). For example, suggesting that a brick can be used to build a house and to hit someone represent two categories of uses (to build things and as a weapon).

Results

We ran independent samples t-tests between those who experienced flow and those who did not on both cognitive flexibility and creativity. The results showed that those who experienced flow were less flexible in their thinking (M_{Flow}= 2.54, SD = 1.64) compared to those who did not experience flow (M_{NoFlow} = 3.41, SD = 1.46, t(83) = -2.62, p = .01, d = 0.56) and that they were also less creative (M_{Flow}= 2.63, SD = 2.39) than those who did not experience flow (M_{NoFlow} = 3.63, SD = 2.21, t(97) = -2.17, p = .032, d = 0.44), providing additional support for Hypothesis 1.

We then tested for mediation using Model 4 of the PROCESS macro in SPSS and 10,000 bootstrap samples (Hayes, 2017). The results indicated that cognitive flexibility mediated the decrease in creativity [*effect* $t = -0.2741$, S.E. = 0.1797, CI: −0.7973, −0.0288]. Specifically, flow decreased cognitive flexibility [$B = -0.5337$, S.E. = 0.2446, CI: -1.0199, −0.0474], which decreased creativity, given that cognitive flexibility had a positive relationship with creativity [$B = 0.5136$, S.E. = 0.2129, CI: 0.0903, 0.9370]. When cognitive flexibility was included in the model, the direct effect of flow on creativity was non-significant [$B = -0.5384$, S.E. = 0.4933, CI: -1.5193, 0.4425].

Discussion

In summary, Study 2 provides additional support for Hypothesis 1 and preliminary support for Hypothesis 2, demonstrating that flow decreased creativity as mediated by cognitive flexibility. By exploring the relationship in the context of listening to music, Study 2 increases the generalizability of the findings of Study 1. To this point we have demonstrated that flow decreases creativity, but the creative tasks have focused on verbal creativity. This is important because verbal creativity relies heavily on cognitive flexibility, but not all forms of creativity require flexibility to the same extent. In Study 3 we seek to turn off the negative relationship between flow and downstream creativity by assessing a form of creativity that is less reliant on cognitive flexibility- figural creativity.

Study 3

Study 3 seeks to provide preliminary support Hypothesis 3, that the relationship between flow and creativity is moderated by the type of creativity, such that figural creativity will be less negatively affected. To further increase generalizability, we explore the relationship in a new flow-inducing activity- online shopping. Shopping, especially for household items, is another common experience in which people rely on their creativity to obtain the best result by considering a variety of options and ultimately choosing the best one (Burroughs et al., 2008).

An online sample of participants from the crowdsourcing panel Turkprime were recruited to participate for nominal compensation (N = 458, 39.1% male, M_{age}= 41.22). Participants were instructed to shop on Amazon.com as if they were moving into a new house and needed to find household items. Participants were told to shop for approximately ten minutes and were asked to report the items that they would buy, the quantity and the price, creating a 'cart' for us to see in an open-ended response format. Following the shopping experience, participants were immediately moved to the creativity task (a matter of seconds in between), in which they were randomly assigned to complete either a verbal or figural (visual) creativity task. With regards to the flow conditions, flow was assessed in the same way as Study 2 through self-report using the flow questionnaire, with people indicating whether they experienced flow (N = 271, 58.3%) or not (N = 194, 41.7%) while shopping. Unlike Study 2, the report was done after the creative task (see Fig. 4 for an illustration of the procedure). This study thus followed a 2(flow vs. no flow) x 2(creative task: figural vs. verbal) between-participants quasi-experimental design.

Measures

Flow In the same way as Study 2, flow was assessed using the flow questionnaire (Csikszentmihalyi & Csikszentmihalyi, 1988).

Creativity In the same way as in Study 2, verbal creativity was measured using the RAT (see Appendix for the items). We measured figural creativity by having participants imagine the completion of a picture (Torrance et al., 1966; 1984; Kim, 2006b). We gave them two lines and asked them to imagine a larger picture that those two lines could be a

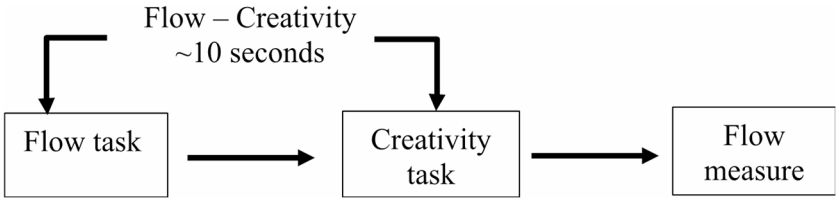

Fig. 4 Study 3 procedure

part of and then to describe what it would look like in writing (see the Appendix for the picture). We asked them to describe what they imagined in writing instead of drawing the actual picture to control for participants' drawing ability. Five independent coders (3 male, 2 female) rated the imagined picture ideas based on creativity ($\alpha = 0.894$) and novelty ($\alpha = 0.904$), each from 1(not at all creative/novel) to 7 (very creative/novel). The first author worked through 5% of ideas with the coders for training purposes. The ratings of creativity and novelty ($r = .977$, $p < .001$) were combined as the measure of figural creativity.

Results

We ran a 2(flow: yes vs. no) x 2(task: verbal vs. figural) ANOVA on creativity, which revealed a significant interaction ($F(1, 458) = 6.47$, $p = .01$). As expected, flow had a negative influence on verbal creativity, with those who experienced flow being significantly less creative ($M = 4.66$, SD = 3.21) than those who did not experience flow ($M = 5.67$; SD = 2.89, $t(204) = 2.29$, $p = .01$, $d = 0.33$). However, flow did not impair figural creativity, as those who experienced flow were equally as creative in their imagination of the completed picture ($M = 3.59$, SD = 1.43) than those who were not in flow ($M = 3.48$, SD = 1.35; $t(254) = 0.63$, $p = .53$, $d = 0.08$).

Discussion

Study 3 thus provides support for Hypothesis 3 that figural creativity is less negatively affected by experiencing flow in the prior task than verbal creativity, which has been the focus of the paper to this point. Thus, flow does not appear to negatively influence all forms of creativity equally, so the relationship depends in part on the creative task. The experimental design of Study 3 also provides further support against the potential for individual differences in cognitive ability accounting for the results due to random assignment to conditions. That is, participants were randomly assigned to engage in different types of creativity, which should limit the influence of any particular skillset related to creativity as they should be evenly distributed across the two groups.

General discussion

Three studies demonstrate that if flow is experienced in common daily activities such as listening to music, playing games and shopping online, it can make you less creative in subsequent tasks. Given the prevalence of the activities that can give rise to flow throughout daily life, flow is likely to happen before tasks which benefit from creativity. The results demonstrate that reduced cognitive flexibility mediates the effect and that the relationship is stronger for verbal creativity than it is for figural creativity. These findings make several theoretical and practical contributions, which we discuss below.

Theoretical and practical implications

The primary contribution of this research is to the flow literature. In contrast to prior research which has focused on the implications of flow in the task that gives rise to it, we expand the temporal focus, considering its downstream influence. By doing so, this research develops our understanding of flow and its nomological network, including the negative consequences it can have. While flow is often considered an optimal state (Csikszentmihalyi & LeFevre, 1989), our results suggest that it can come at the cost of your ability to creatively perform in what you do next. These findings continue a nascent stream of work which demonstrates that flow can have negative consequences depending on the context in which it happens (Dixon et al., 2018; Lavoie, Main, King & King, 2021). For example, consumers who experience flow when gambling spend more time and money compared to those who do not experience flow (Lavoie & Main, 2019b). We advance these findings by revealing a downstream cognitive impairment that is not context-dependent (i.e., limited cognitive flexibility). Overall, our research advances the original flow theory (Csikszentmihalyi, 1975) by shifting our understanding of flow to not be an optimal state per se, as there are fundamental shortcomings to the cognitive nature of it.

Our findings also contribute to the creativity literature, in part by advancing our understanding of the nuance in the relationship between creativity and flow. While flow is typically associated with enhanced creativity within the task it is experienced (Csikszentmihalyi, 1975; MacDonald et al., 2006; Schutte & Malouff, 2020), some evidence suggests

that flow's influence on creativity is only within the mind of the creator and not to others (Cseh et al., 2015, 2016). Our research extends these findings by showing that if there are indeed positive effects on creativity in the concurrent task, they do not transfer to subsequent tasks. Despite eliciting positive affect, which often increases creativity (Isen et al., 1987; Mehta et al., 2017), the cognitive elements of flow limited any positive transfer of creativity in our studies.

Our findings also contribute to the creativity literature by suggesting that flow's relationship with creativity may depend on the stage of the creative process. Reconciling our findings with those of the seminal writings on flow, we note that flow can be experienced at various stages of the creative process, which ranges from idea generation to the physical act of bringing the idea to life (Mednick, 1962). For example, an artist will generate ideas for a painting, and then paint it at another point in time. Previous research, which shows some evidence of a positive relationship between flow and creativity, considered people in flow in the latter stages of creativity- as they were bringing an idea to life, such as a painting, or playing music (e.g., Csikszentmihalyi, 1996; De Manzano et al., 2010). It is important to note that at this stage the idea has likely been largely developed, but it is being realized through physical action. Flexible (divergent) thinking is less important at this stage, as one is following a guide of the already formed idea. This process is different from the early stages of idea generation, which is what our work is concerned with, where flexible thought is vital to generating the creative idea.

Our findings also contribute to the task switching literature, which has demonstrated that task switching can influence cognition in both positive (Kapadia & Melwani, 2021) and negative ways (Leroy, 2009). For example, Lu et al. (2017) suggest that task switching can increase creativity by decreasing cognitive fixation. Task switching can also increase creativity via increased affective arousal (Newton et al., 2020). Our results show that these results may depend on the way you engage with the prior task, such that full engagement with the prior task can thwart creativity. These findings also have practical implications for how to structure your day as they hint at the risk of going straight into another task. This is consistent with research showing the cognitive and affective importance of taking breaks after being absorbed in something for an extended duration (Kim et al., 2018). Understanding these limitations is especially important given how common microflow is becoming in daily life, especially with technology use (Lavoie & Zheng, 2022).

Lastly, our findings contribute to a deeper understanding of flow, in particular its cognitive underpinnings. To date, our understanding of flow has been largely based on descriptions of its phenomenology (Csikszentmihalyi, 1975) and as a result, we know a lot about how it feels and looks, but not as much about the specific cognitive and affective processes that underlie these experiences.[1] This is important, since the underlying cognitive and affective processes are critical to understanding flow's antecedents and consequences. Our mediation findings, which show that flow limits cognitive flexibility and our moderation findings, which show that flow promotes limited verbal creativity provide tangential support for the efficient nature of information processing that may underlie flow.

The possibility that flow is driven by efficient processing is consistent not only with its phenomenology, but with theorizing and evidence that it is more common amongst experts who have the skills to master the demands of the task and its related to implicit processes (Csikszentmihalyi, 1975; Nakamur & Csikszentmihalyi, 2002; Engeser & Rheinberg, 2008; Gold & Ciorciari, 2021). It is also in line with nascent research concerning perfectionism and flow, which reveal that additional contemplative thought related to concerns limits one's ability to experience flow (Arslan & Altan-Atalay, 2022). These findings open the door for a myriad of future research, which we discuss next.

Limitations and avenues for future research

Perhaps the most interesting avenue for future research to explore is other negative consequences of flow. While we demonstrate one negative consequence, there is likely many more. Since our results suggest that flow may influence people to process efficiently, this could influence decisions that people make throughout the day, including their susceptibility to persuasive information like advertisements by focusing on heuristic cues or the lack of information they consider when making inferences of other people (Kahneman & Frederick, 2002). As an enjoyable state in which stimuli not relevant to a goal are dissolved from awareness (Csikszentmihalyi, 1975), flow may also decrease peoples' desire to engage with others to protect their flow state or to achieve it again.

Our research is also limited in that we only explore flow's influence on creativity resulting from relatively short (5–10 min) microflow experiences, which may not be painting the full picture of its negative influence. Perhaps the negative influence could sustain for hours if it was a *deep-flow* state. After deeper forms of flow, it is suggested that some of the affective components are stronger and linger, referred to as the afterglow (Lavoie et al., 2024). The same

[1] The physiology literature represents an exception to this as it explores specific underlying factors and is revealing markers of flow, including reduced heart rate variability and cortisol (e.g., Keller et al., 2011). For a recent summary of the neurocognitive correlates of flow see Gold and Ciorciari (2021).

research also suggests that thoughts about the experience can also linger after deepflow, with people wanting to reflect on and continue to think about the flow experience, which we expect would increase the strength of the negative effect demonstrated in this research. Thus, we expect the duration of the flow experience to moderate the relationship. This interesting line of inquiry would lend itself to an experimental methodology, by manipulating the amount of time that people engage in a flow-inducing activity to reveal its influence on creativity, or cognition in general.

Beyond their duration, flow states can also differ in how much they rely on cognition and physical action. For example, flow can be experienced in exercise or sport, which is more physical than the activities in our studies, which were more cognitive. We expect this to also moderate the negative effect of flow on creativity, such that we expect more physical forms of flow to have less of a negative impact on cognitive flexibility than purely cognitive tasks, given the decreased reliance on cognition. This would be an interesting avenue for future research to explore, especially given the prominence of flow in physical tasks, and physical activity being used as a means of respite in between creative tasks. This could be studied following a similar experimental methodology to our Study 1, but with employees engaging in different forms of (flow-inducing) activities for their break.

Relatedly, we also expect the amount of time in between tasks to moderate the relationship. Our research was limited to looking at the influence of flow on a creative task that happened very shortly or immediately after a flow experience. Future research can explore the amount of time needed to limit the negative influence of flow. We believe that this will in part be moderated by individual differences in ability to regulate attention. Those who are more proficient at regulating their attention should be relatively unaffected by the prior flow-inducing task, as they should be able to switch the focus of their attention to the next task relatively quickly and perform at a higher level (Randall et al., 2014).

This possibility highlights the need for future research to also explore the potential benefits of recovery periods after flow before engaging in a subsequent task to maintain one's creativity. As a part of this directive, future research could explore interventions that can limit the negative effect of flow. For example, mindfulness techniques and microbreaks can enable employees to disengage and then fully re-engage in new activities (Chong et al., 2020; Kim et al., 2018), which could help to detach from the prior task and thwart the negative effects we demonstrate. If this is the case, people could potentially experience the benefits of flow while not thwarting creativity in subsequent tasks. This is important from a practical perspective, as our research suggests that the structure of the day matters, since tasks influence each other. This is noteworthy, as many people use the tasks that we study (e.g., shopping, music) as breaks and to potentially enhance creativity. Despite flow being marketed as an optimal state, it may not be appropriate to encourage flow in every task. This is important because seminal theorizing related to the optimal nature of flow may be interpreted to suggest that people should try to be in flow as often as they can.

Our research also examined how participants performed in creative tasks after exiting a flow state, but these tasks were all unrelated. It is possible that flow may have a positive influence on subsequent creativity when tasks are related semantically, which should be explored in future research. For example, if someone experienced flow while listening to a song or searching for music, would they be more creative in generating ideas for a song or names for a song? Perhaps they would still be processing efficiently but they would persist on the task and reach novelty by creating more ideas (De Dreu et al., 2008). Beyond semantic relation, tasks could be matched in processing style, such as the degree to which they are rational vs. experiential (Novak & Hoffman, 2009); similar to our manipulation of verbal and figural creativity, which may moderate the relationship.

Future research can also build from our findings by exploring the specific cognitive and affective constructs that underlie flow as a way to understand the consequences it will have. To this point, researchers have focused on individual differences and enabling task conditions, which have helped a great deal in revealing the nature of flow (e.g., Bakker & van Woerkem, 2017; Briki & Dagot, 2022; Olčar et al., 2019; Grotewiel et al., 2022; Lahti & Kalakoski, 2023; Schiepe-Tiska et al., 2021; Seger & Potts, 2012; Xie, 2022; Zhang et al., 2022). However, it remains that despite these individual differences and the presence of enabling conditions, flow does not always arise. So, what are the necessary cognitive and / or affective processes? It may be valuable to take a step back and pinpoint the processes that underlie flow with established constructs. For example, working memory may be able to partly explain flow based on its relevance to both the amount and subjective ease of attention (Baddeley, 1992; Baddeley & Hitch, 1974). Other established constructs like construal level (Trope & Liberman, 2010) could also be used to explain the type of processing in flow and in doing so, the outcomes it will have.

Lastly, the notion from our findings that flow promotes efficient processing and may itself be comprised of it, is an interesting avenue for future research to explore. While it seems reasonable from prior theorizing that expertise can provide the seemingly effortless experience of mental order that is flow (Csikszentmihalyi, 1975), is it the balance of skills with task demands alone that leads to this or can the same experience come from other things? For example,

could flow be manipulated through processing fluency (Song & Schwarz, 2008), or by narrowing the breadth of attention? Relatedly, could it be produced by providing a stream of positive affective stimuli, which are known to orient attention effortlessly (Theeuwes, 1994)? Revealing the necessary conditions from a psychological process perspective would be fruitful not only for the sake of understanding flow, but also to help people achieve it.

In summary, our results help illuminate the nature of the relationship between flow and creativity, and open the door to future research opportunities. While we considered various flow-inducing tasks (i.e., video games, music, shopping online) in our studies, it is important to note that our results may not generalize across flow states, as we expect differences, especially amongst more physical flow experiences. Moreover, most of our creativity measures require proficiency in the English language, so it would be important to understand if there are any cultural differences in the relationship with other creative tasks.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s12144-024-06591-4.

Data availability The datasets generated during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the corresponding institutional research committee.

Consent to participate Informed consent was obtained from all individual participants included in the study.

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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