Incubation & Divergent Solutions

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H_1: ***Participation in low cognitive load incubation activities enhances creative problem solving***

H_2: ***Music listening during incubation activities enhances positive mood which, in turn, enhances creative problem solving***

BACKGROUND

Have you ever woken up and known the answer to a problem you had been wrestling with the day before? When trying to solve problems, especially problems requiring creative solutions, doing something else—an *incubation activity*—can help (Sio & Ormerod, 2009). Furthermore, undemanding (low cognitive load) incubation activities, such as sleeping or listening to music, are particularly effective (Sio & Ormerod). Being in a positive mood also promotes creativity (Davis, 2009) and listening to music can also promote positive mood (Lingham & Theorell, 2009). Integrating these ideas, we examined the relationships between low load incubation, positive mood, and creativity. We invented one of our own measure of creativity, the *Divergent Solutions Task* (DST)and undertook the present study to test our hypotheses (see above).

METHODS

Participants: *n* = 81 (sex at birth: 68 female; 13 male) undergraduate students.

Measures and Materials

Divergent Solutions Task (DST). This verbal measure of creativity assesses (1) *Divergence* (divergent thinking) and (2) *Fluency* (number of responses), based on solutions to four Zen Koans (similar to the question: "What is the sound of one hand clapping?"). Divergence was rated on a scale from extremely unimaginative (1) to extremely creative (7) and Fluency was rated on the number of solutions.

Affect State. Measures of (1) Mood, and (2) Positive Affect, and (3) Negative Affect (from I-PANAS-sf) tested affective state at two points in time (T1, T2).

Incubation Activities. Incubation activities were provided between the presentation of the DST items and the subsequent prompts for solutions. For two groups (Low Load-Music & Low Load-Silence), we included low cognitive load incubation activities: A 72 second video clip of fractal images (Wolfe, 2010) accompanied either by (1) music (Swift, 1983), or (2) silence. Controls continued to respond to survey items, for their incubation period.

Procedures

First, participants simply read the four DST problems, then reported on their Affect states (T1). Two groups engaged in low load incubation activities, then, again, reported on their Affect states (T2). Next, all participants were asked for DST solutions. Based on the ratings of two judges, DST Divergence and Fluency scores were and calculated for responses to each of the 12 sets of prompts. Interrater reliabilities ranged from *r*=.97 to *r*=.501, and averaged *r*=.713. Consensus ratings were derived through discussion and analyses undertaken using these consensus ratings.

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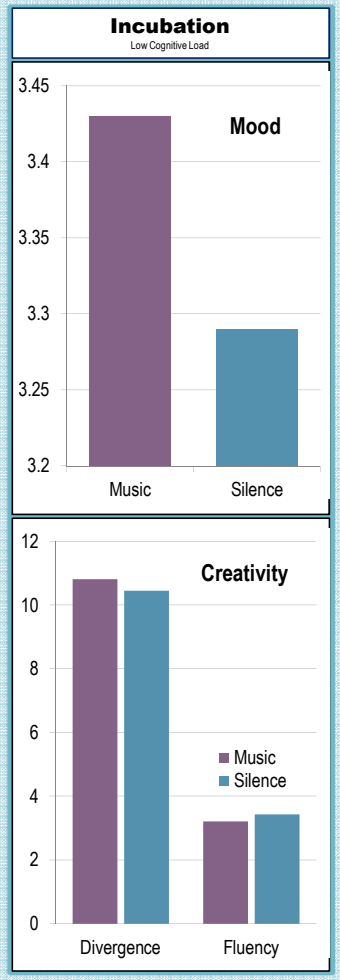

RESULTS

Affect State

As a precaution, we tested the three groups' Affect State-T1 at the start of the study. Unexpectedly, a Group (3) by Affect-T1(3) MANOVA revealed significant and near significant group differences: *Omnibus* $F(9,234)=14.17$, $p<.001$; $\eta^2=.353$. (Pillai's Trace criterion was used for all MANOVAs & MANCOVAs.) Post hoc comparisons revealed that, compared to the Low Load-Music group, the Low Load-Silence group started the study in a more positive mood (Table 1). We conceded the null hypothesis for the Control group and focused, on comparisons of the two Low Load groups. We wanted to know whether music listening would influence affect (and, in turn, creativity), so we statistically controlled Affect State-T1, by using them as covariates in a Group (2) by Affect State-T2 (3) Multivariate Analysis of Covariance (MANCOVA). The results were significant: *Omnibus* $F(6,92)=3.59$, $p=.003$; $\eta^2=.177$. The resultant ANOVAs revealed that the difference was driven by Mood-T2, exclusively: $F(2,47)=3.90$, $p=.001$; $\eta^2=.256$. Compared to listening to silence, listening to music was associated with higher Mood T2.

Table 1. Incubation Groups' Affect States at Time 1

Affect State	Group (*n*)	*M (SD)*	Contrast	*p* (2-tail) =	*sig.*
Mood T1					
	Music (28)	3.29 (.16)	Music: Silence	.017	*
	Silence (24)	3.80 (.17)	Silence: Control	.388	*ns*
	Control (29)	3.55 (.15)	Music: Control	.299	*ns*
Positive Affect T1					
	Music	2.76(.13)	Music: Silence	.190	*(ns)*
	Silence	3.03(.15)	Silence: Control	.428	*ns*
	Control	2.87 (.13)	Music: Control	.579	*ns*
Negative Affect T1					
	Music	1.78(.15)	Music: Silence	.052	*trend*
	Silence	1.35(.16)	Silence: Control	.076	*trend*
	Control	1.74 (.15)	Music: Control	.845	*ns*

Incubation and Creativity

We tested for and found group differences in creativity using a Group (3) by Creativity (2) MANOVA: *Omnibus* $F(6,156)=24.63$, $p<.001$; $\eta^2=.487$. Unexpectedly, planned comparisons of the three groups did not reveal significant differences. We decided undertake a couple of exploratory analyses to help us understand these results. First, excluding the control group, and statistically controlling for Mood T1, we compared the two Low Load groups with Mood-T1 as a covariate. The MANCOVA was again, significant. This time, however, ANOVA revealed significant group differences: Music listeners' responses were higher for Divergence, as predicted; but counter to prediction, they were lower for Fluency. We combined the two Low Load groups and compared their DST responses to the Control group's. The Group (2) by Creativity (2) MANOVA revealed significant group differences: *Omnibus* $F(4,158)=36.56$, $p<.001$; $\eta^2=.481$. The ANOVAs revealed robust group differences, because the Low Load group significantly outperformed controls for both Divergence and Fluency (Table 2).

Table 2: Divergence, Fluency, and Incubation

DST Creativity	Group (*n*)	*M (SD)*	*F* (2,79)	*MSE*	*p* (1-tail)	η^2
Divergence						
	Low Load (52)	10.64 (5.38)	141.98	38.31	<.001	.782
	Control (29)	9.94 (5.86)				
Fluency						
	Low Load	3.31(.69)	810.32	.608	<.001	.954
	Control	3.20 (.80)				

DISCUSSION

H_1: We hypothesized that listening to music would enhance mood; however our first assessment of mood revealed pre-existing differences between the groups. Controlling for prior mood, we found music-listeners' mood after incubation was more positive than silence-listeners' mood, supporting our hypothesis. The former outcome was inconsistent with our hypothesis; whereas the latter finding was consistent with our hypothesis that music would enhance listeners' moods.

H_2: We also hypothesized that low cognitive load incubation activities would enhance creativity (divergence and fluency). Although we expected music-listeners to outperform the other groups, this was not the case. However, music-listeners' responses were higher in divergence, but lower in fluency, compared to silence-listeners. Thus our hypothesis was only partially supported. Nevertheless, the combined low cognitive load groups did evidence more creativity than did the control group.

Conclusions: Consistent with the literature and partially consistent with our hypotheses, we found both (a) positive mood and (b) low cognitive load incubation periods enhance creative problem solving on the Divergent Solutions Task. This suggests that suitable incubation activities, especially those that enhance mood, could benefit those seeking creative solutions. In addition, although additional research is needed, our results suggest that the DST may be a viable measure of creativity.

REFERENCES (*See Handout*)