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The Impact of Creativity, Flow and Interaction Quality on Collaborative Design Solutions in Social Groups

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Abstract
The purpose of this study is to investigate the impact of intragroup performance in relation to produced outcome during a collaborative and interdependent creative problem-solving task. The social dimensions of flow experiences and creativity influence group members' perception of social interaction have significant impact on the group's produced outcome. Twelve social groups of a total of sixty-two participants took part in an experiment consisting of two tasks generating qualitative data and two questionnaires measuring the experience of state flow and the perceived synchronization of social interactions. Group members autotelic experience predict the level of group interaction quality. It is important that facilitators encourage creative initiatives and enable conversations on task completion to increase the level of interaction quality, groups creativity capabilities and outcome functionality.

Keywords: creative capability; synchronized interactions; flow experience; intragroup performance; creative problem solving; interaction quality.

Introduction

In order to develop understanding of how group outcomes relate to group members experience of interaction among group members we adopt a two-blended perspective utilized in Zhang & Kwans (2019) research, social interaction quality and task achievement will be measured. There is a need to understand in what ways co-ordinational and motivational factors influence group members' interaction and exchange of ideas. The rationale is that the degree of interaction quality has a mediating effect on the relationship between the task's demands for interdependent initiatives and the group's produced design solution (Zenk et al, 2021).

The characteristics of produced outcome, a design solutions functionality and originality, is related to group members perception of interaction quality in order to understand in what ways group members creative productivity influence the intragroup performance as well as the groups' produced outcome.
The study has the following two research question:

1. In what way and to what extent is group members experience of state flow

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and perceived quality of interactions associated to the groups' produced outcome on a collaborative creative problem-solving task?
2. What is the association between group members' divergent thinking capabilities, their perception of the groups' synchronized social interactions and the collaboratively produced creative problem solving?

This introduction section comprises three related theory areas each establish the fundament for three hypotheses respectively. The next section develops Hypothesis 1 by introducing a social perspective on flow building on state flow theory.

Coordinating initiatives: Flow under interdependent CPS

An implication of interaction and exchange in social groups is the extent to which it enables the group members to experience flow (Magyaródi and Oláh 2015). The psychological experience called flow can occur during the performance of challenging activities in which the difficulty of the task is matched to the skill level of the person (Csikszentmihalyi and Csikszentmihalyi, 1988). Characteristics of the flow experience include high but subjectively effortless attention, a sense of control, loss of self-awareness, and altered experience of time and enjoyment (Csikszentmihalyi & Nakamura, 2010). Flow has been studied in widely different activities ranging from e.g., sports (Jackson *et al*., 1992) to computer gaming (Keller *et al*., 2011; Harmat *et al*., 2015), music and arts performances (de Manzano *et al*., 2010, Harmat *et al*. 2021). However, flow experiences have predominantly been investigated in individual performers, there is a growing research interest in the quality of flow in social contexts. i.e., group flow experiences (Sawyer, 2007; 2015 and Pels *et al*. 2018). Sawyer (2007) defines group flow as "an optimal collective experience that occurs when members develop a feeling of mutual trust and empathy, in which individual intentions harmonize with those of the group". Van den Hout and colleagues (2016) suggested that group flow creates a group-level state in which all participating team members are completely involved in their common activity and are working together intuitively and synergistically towards the common purpose and enhance team's effectiveness, productivity and performance. Pels *et al* (2018) have recently reviewed research on group flow and defined it as a "shared state of balance within a group as represented by (a) fluent, positive interactions within the group, (b) a high collective competence of the group and (c) a collective state of mind of the group by means of positive relationships between group members may facilitate optimal collective performance and creativity, and making group flow a positive collective experience".

According to Magyaródi and Oláh (2017) emergence of flow can be more intense in a shared cooperative activity than in solitary situations. Interpersonal synchrony may be an indicator of prosocial behavior in which the group

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members become likely to trust in and cooperate with one another. According to the Flow Synchronization Theory (Magyaródi & Oláh, 2015, 2017), flow synchronization is a psychological mechanism stimulating the group members to interact with each other, and to work for common goals in cooperation during an optimally challenging situation. Thus, social interaction includes experience of cooperating together as well as iterative exchange of initiatives, ideas and views. Group members who experience this know the purpose of the task and share a common strategy to achieve agreed goals. The group members help each other, integrate with consistency, motivate themselves, and learn from each other. In addition, reflecting on the experience of collaborating they realize how much they have developed during the activity and how they affected each other's performance. This may support emergent motivation for the collaboration (Csikszentmihalyi & Nakamura 2005). Flow synchronization denote a certain level of interaction quality, a complex composite constructed by the group members' estimation of their experience when interacting with the other group members during a specified task (Magyaródi & Oláh, 2015, 2017). Based on the summarized current research on flow in social context the first hypothesis focuses on the level of association between group members experience of flow state and perceived flow synchronization**.**

Hypothesis 1: *Group members' experience of state flow positively associate with their perception of synchronized social interactions*.
Relating the work tasks' characteristics and challenges to group members skill level is central in the theory of flow. During group members' intentional social interaction, a shared understanding of the problem constituents is developed. Making this understanding explicit is considered a prerequisite for interdependent exchange of initiatives that contributes to a solution that is considered creative by external assessors. The next section develops Hypothesis 2 regarding the relationship between creative capabilities on individual and group levels and collaboratively produced design solutions originality and/or functionality.

Creativity capabilities; divergent thinking and idea fluency
Creativity is defined by two factors: originality and usefulness. The originality-factor is described in terms of novelty, originality, or unexpectedness, and the usefulness-factor is commonly referred to as appropriate, value, and of high quality (e.g., Runco & Jaeger, 2012; Sternberg, *et al*., 2005; Stein, 1953; Barron, 1955). Creativity is thus expressed in initiatives which are both original and useful in relation to the task constrains (Sternberg & Lubart, 1999, Amabile, Conti, Coon, Lazenby, & Herron, 1996), or in a groups integrative activities combining member diversity, as well as in a produced outcome, such as physical solutions to a given problem (e.g., Rhodes, 1961; Beersma & De Dreu, 2005)). Specifically, creativity ignite in the combination of differences rarely or never interconnected (Sternberg & Kaufman, 2018) and is generally assessed based on

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the amount of such combinations, the number of ideas that these combinations generate (Hocevar, 1979; Weisberg, 2006; Kaufman *et al*., 2013). The ability to begin idea generation immediately, an aspect of executive function, is considered the strongest determining factor for the number of ideas proposed over a given period of time (Guilford, 1956; Benedek *et al*., 2010). This fluency capacity is used as a measure of divergent thinking, a concept that also includes flexibility. A measure of flexibility is how wide apart (divergent) the different ideas or thought fragments combined, the variety indicate subject's flexibility (Runco & Acar, 2012, 2018). The fluency and flexibility in ideational activities is thus a result of *divergent thinking* processes (Rothenberg & Hausman, 1976; Runco, 2007; Torrance, 1981). The blending of several deviant initiatives constitutes the originality-dimension, that should meet the task constraints to also be assessed as appropriate and functional (Shamay-Tsoory, 2011; Guilford, 1956; MacKinnon, 1965). The originality of such combinations, usually assessed by independent experts in the particular field (Amabile, 1982), it has been shown to be the strongest predictor of creativity (e.g., Acar, Burnett, & Cabra, 2017).

In group based creative problem solving (CPS) the establishment of original combinations (divergence) and the negotiation of their appropriateness in relation to the task (convergence) are central activities (e.g., Prince, 1972). *Group creativity* is defined as the ongoing combination of differences through social exchange between a minimum of three individuals with the purpose of creating something original and valuable (e.g., Paulus & Nijstad, 2003; Sawyer, 2007; Kaufman & Sternberg, 2010). The central notion of group creativity is that ideas from each group member spark ideas in other members which results in a cumulative synthesis into a group idea (e.g., Kohn, Paulus, & Choi, 2011; Köping Olsson & Florin, 2011; Steiner, 1972). Chrysikou (2019) maintain that the generative process of originality is characterized by spontaneous, unregulated bottom-up processes, whereas convergent processes is a controlled, top-down process focused on task goals. Other scholars suggest a relationship between divergent thinking (idea generation) and integrative behavior in social interaction (Wronska *et al*., 2018; Colzato *et al*., 2013). Even so, Mukherjee *et al*. (2018) suggests that divergent thinking and a broadening attentional scope is reciprocally linked to social behavior and consider this a thinking style (c.f executive function) as underlying generic cognitive processes for social interaction and decision making (Nussionson *et al*., 2013; Andersson *et al*., 2002). Social groups performing high level of interdependent tasks requires members to interact fluently and depend on one another to a larger extent than low level task interdependence (e.g., Leung & Wang, 2015; Campion *et al*., 1993). The outcome of *collaborative* CPS is considered to be the production of several equivalent functional solutions. In a CPS processes emotions, social situations and facts are considered, and group members are encouraged to be aware of unexpected experiences and indulge in leap-wise and synthesizing thinking (Isaksen & Tidd, 2006; Rawlinson, 1981; Stein, 1974 and 1975). A high-

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performing work group enable the activation of these resources and are capable to combine divergent initiatives and proposals into functional and original solutions (Katzenbach & Smith, 1993; Paulus & Nijstad, 2003; Backström, 2018). The second hypothesis focus on the level of association between these factors in relation to produced design solution.

Hypothesis 2: *Groups producing high level of originality and functionality in design solutions on the CPS-task associate positively with group members experience of state flow and synchronized social interactions.*

For group member interaction to be considered creative the group should enable unregulated flow of divergent idea exchange, fluency in combining of those ideas and a broad scope of attention to integrate deviating articulations and values (Sawyer, 2021; Plucker, 2017). Group level creativity also entails explicit articulation of the problem constituents in order to maintain a shared understanding of the requirements of the jointly produced solution. In the last section of this introduction, we turn to the second research question focusing on group members perceptions of the groups' interaction quality.

Intragroup performance: Interaction quality

Intragroup performance is characterized by the group members' experience of the cooperation's quality of interaction, were the degree of effortlessness attention during flow, is a central factor. The notion of intragroup emergent qualities as consequences of social interaction and exchange is common in the research field of social groups e.g., feedback seeking (Tekleab et al., 2016; Edmonson, 1999); integrative behavior (Zhang & Kwan, 2019); level of cohesion (West et al., 2009; Tekleab et al., 2016), and trust (Liu et al, 2011). Research on group performance have presented positive correlation between group member belief (trust) in their group's capability and the group's task performance (e.g., West et al., 2009; Stout et al., 1994), a group whose members have confidence in the group's ability to manage interdependent tasks will cooperate effectively (Gully et al., 2002; Wang, 2016). Group members' experiences of cooperation, i.e., the intentional interactive exchange of individual efforts to complete interdependent tasks affect the emerging outcome (West et al., 2009; Wagner, 1995). Thus, the quality of interaction and exchange between group members affects the groups produced outcome (Olson & Braithwaite, 2004). Liu et al (2014) investigated the quality of interaction among group members. They described team members exchange as a pattern characterized by flexibility, discretion, and open-ended relationships among group members and found that interaction quality develop commitment and trust (ibid. p. 277). Their study also indicated that higher interaction quality in the exchange among group members can increase the group's performance and innovative output, however, they point out the need to study these relationships experimentally (Liu et al., 2014). Based on this account of interaction quality the third hypotheses focus on that association in relation to each of the twelve participating groups produced

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design solution.

Hypotheses 3: *Group composition with most divergent thinking members and high interaction quality between the group members, produce highly original and functional design solutions on the creative problem-solving task*.

In the subsequent section methodological perspective and design are presented, including the instrument for data collection and criteria of analysis. Then follows the presentation of results from the assessments of individual and group activities, statistical analysis of data collected through the three measuring instruments of the members experience and perceptions of the groups interaction quality and produced outcome, in accordance with the presented conceptual framework. Finally, the result is discussed in relation to hypotheses and consequences for interaction in social groups during intensive interaction and exchange during intense creative problem solving will be addressed, as well as recommendations for future research. The conclusion addresses practical/social implications of the discussed findings.

Materials and Methods

In line with West *et al*., (2009) and others (e.g., Compton, 2005; Peterson & Seligman, 2004) this hypothesis testing study include measurement of group members individual creativity capacity and their perceptions of the groups' interaction quality as well as the groups produced outcome, focusing on intragroup experiences of collaborative interaction and exchange and how these conditions can promote teamwork and emergent content. This study was designed as an experiment, where the participants were requested to perform a problem-solving task in groups, and to answer questionnaires regarding 1) subjects experience of state flow during the groups creative problem-solving task (FSS-2, Jackson & Eklund, 2004), 2) subjects experience of synchronized social interactions assessed with the Flow Synchronization Scale, (FSyQ, Magyarófi & Oláh, 2015). The subject's creativity capability was assessed utilizing the J&D-test (Österberg, 2012; Österberg & Köping Olsson, 2021).

The research design allowed for mobility in order for each group to participate in their own everyday environment, they needed an hour in total away from their regular duties. The researchers acted in several roles in relation to the study objects, the design of the experiment included different degrees of interaction with the groups and their members. The role of instructor was prominent since the lion part was group processes and each task needed spoken instructions in precise formulations, the researchers also acted as observers during the groups' problem-solving activities.

Participants, group and task characteristics

Twelve groups of a total of sixty-two participants took part in the experiment. Four of the twelve participating groups were organizational teams at four

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companies in central Sweden (n=17), the other groups (n=45) were students at two universities in central and southern Sweden. In accordance with previous studies (e.g. Zhang & Kwan, 2019; Adler & Chen, 2011; Liu *et al*., 2011) we control for group size (4 members in five groups, 5 members in two groups, 6 members in three groups, and 7 members in two groups), group history (four groups > 3 years, four groups < 1 year, and four groups ≈ 1 years of collaboration), group diversity (age and gender: 26 women, age M=30.12; SD=10.22). All participants were informed about the overall research purpose, ethical considerations and data protection regulation (GDPR) and requested to confirm consent to participation by signing a consent form.

Task characteristics: A creative problem-solving task was designed inspired by several experimental studies (e.g., Backström & Soederberg, 2016; Tekleab *et al*., 2016; Aubé *et al*., 2014; Zabelina & Robinson, 2010). The creative problem-solving task is characterized by 1) Open-endedness (Bardot, 2019). In order to promote creativity and enable creative solutions, the goal (a bridge design solution artefact) is defined with three criteria, primarily length and function, at a later assessment stage also originality. 2) Require creativity, i.e., high degree of task complexity (Stahl *et al*., 2010). According to Wang *et al*. (2019) a complex task requires frequent and in-depth discussions, exchanges of ideas, and coordination among team members' competences and suggestions. 3) Conjunctive, i.e., require high degree of interdependence, that is, in order to complete the task group members, need to cooperate and trust groupmates initiatives (Leung & Wang, 2015). 4) Face-to-face, i.e., low degree of virtuality. The task is structured to require interdependent interaction, 5) Functional diversity, i.e., the group's task requires that all members take the initiative and continuously contribute their skills and perspectives. According to Adler & Chen's (2011) classification of work tasks based on coordination requirements and creativity requirements, the problem-solving task in this study can be described in terms of high expectations of creativity in combination with coordination demands, i.e., the task invites creativity while allowing for some level of control in the form of instructions, materials, time frames and participants self-assumed or negotiated roles.

Procedure, materials and instruments

The experiment was performed in the same way with the same structure, instructions and work material for the twelve participating groups, as follows:

(1) General information (8 min): The experiment leader introduces the experiments time frame and overall structure. The consent form is distributed, including a brief explanation of the research project's purpose and signature to confirm consent to participate. On the back of the form, reference is made to The General Data Protection Regulation, GDPR. Instruction: "Read both sides and sign the form of consent."

(2) First task (10 min): Measurement of individual creativity utilizing the J&D-

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test. Instruction: "Combine the two shapes on the form by sketching as many meaningful objects as possible. If you do not understand what to do or become unsure, you can make your own interpretation or take chances."

(3) Group forming exercise (5min): The experiment leader composed participants in groups and conducted two warm-up exercises. Instruction, Exercise 1: "Walk around the room stop when someone stops and keep walking when someone starts walking." Exercise 2: "Stand in pairs opposite each other, give and receive each other gifts at a high tempo."

(4) Instructions for the second task (3 min), instructions: "The problem-solving task is for you as a group, to build as long a bridge as possible with the given material for 15 minutes. The result, the bridge construction, will be assessed based on the following three criteria: 1) the bridge length, 2) the function, and 3) the originality of solution."

(5) The group's planning and management (4 min): Opportunity to prepare for the joint task. The group is explicitly invited to plan the work and agree on whether the group should allocate functions (e.g., leader, decision maker, timekeeper) as well as discuss any questions before starting.

(6) Second task (15 min): Creative problem solving in group. Instructions: "Build your bridge together and check the function by driving the Lego car over the entire bridge construction."

(7) Third task (10 min), instructions: "Immediately after completing the joint problem-solving task and without talking to each other, fill in your responses to all the questions in the two questionnaires (FSyQ and FSS-2)."

(8) The experiment ends with reflective discussion about the various activities and how the group succeeded in producing a solution to the problem under given conditions.

Material list for the bridge experiment: 4 sheets of paper, 160gr., 1 stapler with 1 tray, 5 scissors, 1 "adhesive daub", 10 paper clips, 4 balloons, 10 wooden sticks, 1 meter thread, 4 plastic mugs, 10 straws (10 pcs), and 1 Lego car.

Instruments: This experimental study involved newly developed measuring instruments to capture data regarding group interaction and synchronized experience of flow. In order to study group members perception of the groups interaction quality interactive the Flow Synchronization Questionnaire (FSyQ) developed by a Hungarian Research group at Eötvös Lórand University, Budapest (Magyaródi & Oláh, 2015) was utilized. The development of this instrument is based on both the rational and empirical test establishment traditions. The questionnaire contains 28 items and 5 latent factors that focus on the motivational and coordination (task- and relationship-focus) aspects of the experience: 1. Synchronization and effective cooperation with the partner (12 items, $\alpha = .93$); 2. Experience of engagement and concentration (5 items, $\alpha = .83$);

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3. Motivation and positive impact on the partner (3 items, α= .82); 4. Motivation and learning for the person (4 items, α= .80); 5. Coordination with the partner during the activity (4 items, α= .81). The internal consistencies of the subscales are adequate, and the Cronbach alpha reliability of the original questionnaire (total score) is α= .94 (Magyaródi & Oláh, 2015) (Appendix 1). The Swedish version was developed by first translating the original FSyQ from Hungarian into Swedish, using an independent translator and then back into Hungarian. After this, the original and the back translated FSyQ versions were compared, and a Swedish version was created. This procedure is according to the classic back-translation method developed by Brislins (1973, referenced in Cha, Kim & Erlen, 2007). We tested the Swedish version of the questionnaire on a small sample (n=62). The internal consistency of the questionnaire is adequate with a Cronbach's α = .93.

The subjects' individual experience of flow state level was measured using a subset of nine items from the Flow State Scale (FSS-2) (Jackson & Eklund, 2004), also used in previous studies (de Manzano *et al*. 2010, Harmat *et al*. 2015). Good psychometric properties of the FSS-2, as well as of the shorter Swedish 9-item version of the test, similar to the one employed here, have been demonstrated in several studies on different samples (Jackson and Eklund, 2002, 2004; Jackson *et al*., 2008; Kawabata *et al*., 2008). Items are formulated as statements about subjective experiences during an adjacent performance (e.g., "I had total concentration."), with which the respondent should agree or disagree. Answers are given on a Likert scale with nine steps ranging from 1 (strongly disagree) to 9 (strongly agree). The instrument measures a 9-dimension model of state flow experiences: 1. Challenge-skill balance, 2. Action-awareness merging, 3. Clear goals, 4. Unambiguous feedback, 5. High concentration, 6. Sense of control, 7. Loss of self-consciousness, 8. Transformation of time, 9. Autotelic experience (Nakamura & Csikszentmihalyi, 2001; Jackson & Eklund, 2004), (FSS-2, appendix 2).

For the measurement of subjects' individual creativity, divergent thinking, the experiment utilized the J&D-test developed by Österberg and Köping Olsson (2018; 2021) building on the research of Finke *et al*., (1989), Hocevar (1980) as well as the TTC-figural test (Torrance, 1981). The subjects were requested to produce as many meaningful combinations as possible out of two shapes formed as the letter J and D for 5 minutes, writing their responses on a paper. The respondent's individual creativity capacity was assessed in three dimensions (Beghetto & Kaufman, 2009; Torrance, 1981): 1) *Fluency* - the total number of objects constructed. 2) *Flexibility* (i.e., originality) – to what extent the subject used the graphical figures other than as letters. 3) *Combination* (i.e., divergence) - the number of combinations of both figures into meaningful objects, i.e., by rotating the figures.

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Assessments and analysis

The outcome of the creative problem-solving task, i.e., a bridge design solution, was assessed in three dimensions: *length*, *function* and *originality of the bridge.* The length and function are both measured directly adjacent to the experiment, length in centimeters and function by pushing/pulling a Lego car over and under the bridge to assess functionality. If the bridge does not hold when the Lego car runs the entire distance, the bridge is judged to have low functional level. These two dimensions are mentioned in the instructions as criteria of which the result will be assessed. The third dimension, originality, were assessed retrospectively by independent assessors. However, each group discusses the result after completion of the experiment and in that collective reflection the aspect of novelty of different solutions became central.

The assessment of the originality dimension of the groups' produced design solution for creative problem solving was carried out by four experts in accordance with Amabiles (1982) Consensual Assessment Technique (CAT), the expertise consisted of experience in assessing similar group-based CPS outcomes in other studies. The assessment of the originality dimension is an aggregate of three categories, 1) *Deviant Design*, 2) *Complexity* and 3) *Novel use of material* as follows: The solutions have varied designs which differ more or less from a standard definition, such as: suspension bridge, float bridge, tunnel bridge, sloping bridge, bridge of mugs and balloons as foundation. The definition of a bridge is: *a structure built to span physical obstacles without closing the way underneath… for the purpose of providing passage over the obstacle… carrying a road, path, railway, etc. across a river, road, or other obstacle* (the English Dictionary). Another part of the assessment of originality is the degree of complexity measured by how much of the proposed material is actually used. The third originality-dimension was the comparison between the ways of using the proposed material, for example, more or less novel use of the paper material.

Statistical analysis: Spearman's Rank Order correlation was used to measure the association between the different continuous variables. A Pearson's Chi-square test was conducted to test a significant association between state flow, flow synchronization and creative solutions produced by the groups (i.e., originality and functionality of the bridge). All statistical analyses were performed in StatSoft version 13.0.

Results

This section presents results based on statistical analyses (table 1 and table2) and descriptive data (figure 1).

The relationship state flow and synchronized interactions during the CPS task

Spearman's Rank Order correlation has been used to measure the association between state flow and synchronized interaction measured by FSyQ (n=62). We

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accepted Bonferroni adjusted p value (p > .006; αaltered = .05/9) in order to avoid Type I error. We found a strong positive association between state flow and subjectively perceived synchronized interactions during the CPS-task (rs = 0.67; p< 0.001) (See details in Table 1). These results are according to the first hypothesis. The dimension of the state flow scale such as sense of automatism (action-awareness merging), clear goals, concentration on the task, sense of control, loss of self-consciousness, transformation of time and autotelic experience yielded a moderate relationship with the Flow Synchronization.

Table 1: Spearman rank order correlations between the dimensions of the state flow (FFS-2) and Flow Synchronization Questionnaire (FSyQ).

	FSyQ					
	Synch an Cooperation	Engagement Concentration	Motivation Positive Impa	Motivation and learning from the partner	Coordination wi the partner	FSyQ mean scores
	Spearman R (n=62)					
Challenge-skills balance	-0,00	0,16	-0,09	-0,01	-0,09	-0,00
Action-awareness merging	0,37**	0,36**	0,22	0,16	0,30	0,37**
Clear goals	0,34**	0,51**	0,38**	0,32**	0,38**	0,45**
Feedback	0,20	0,41**	0,27	0,04	0,12	0,27
Concentration	0,41**	0,53**	0,51**	0,31	0,43**	0,53**
Sense of Control	0,50**	0,62**	0,47**	0,44**	0,52**	0,60**
Loss of self-consciousness	0,33	0,37**	0,27	0,12	0,43**	0,41**
Transformation of Time	0,13	0,08	0,37**	0,46**	0,29	0,33**
Autotelic experience	0,42**	0,46**	0,48**	0,62**	0,43**	0,58**
FSS-2 mean scores	0,52**	0,64**	0,54**	0,52**	0,54**	0,67**

Questionnaire (rs = .33 -.60). However, some of the dimension of FSS-2 such as *challenge-skills balance* and *unambiguous feedback* are not associated with the synchronized interactions during the group task. Both dimensions were partly independent from the social dimensions of the flow experience and therefore were removed from further analysis.

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In addition, a multiple regression analyses were conducted to understand more about the relationship between FSS-2 and FSyQ. The total score from FSyQ was a dependent variable and the nine dimensions of FFS-2 was set up as an independent variable in the analyses. The F-test showed a significant model: (F (7.54) =8.57, p <0.001). Perceived synchronized interactions explained by individuals state flow more 50% of the variation (Adjusted R square = ,46). However only two dimensions of the state flow (i.e., sense of control and autotelic experience) were significant predictors of the highly synchronized social interactions during the CPS-task (see details in table 2). Hypothesis 1: Group members' experience of state flow positively associate with their perception of synchronized social interactions has been supported.

Table 2: Model coefficient – Flow Synchronization Scale

Predictor variables	Estimate (B)	SE B	Beta	t (54)	p
Intercept			2,193	2,780	0,007*
Action awareness merging	0,048	0,123	0,037	0,395	0,693
Clear goals	0,086	0,118	0,062	0,726	0,470
Concentration	0,020	0,127	0,017	0,160	0,872
Sense of Control	0,333	0,135	0,207	2,451	0,017*
Loss of self-consciousness	0,108	0,103	0,058	1,049	0,298
Transformation of time	0,141	0,109	0,080	1,291	0,202
Autotelic experience	0,319	0,129	0,210	2,473	0,016*

Relationship between state flow, perceived synchronized social interaction and produced design solution.

We found a positive relationship between state flow, flow synchronization and the groups produced design solution on CPS task. State flow and flow synchronization were continuous variables, and the group task outcomes were categorical variable (i.e., originality and functionality of the bridge). The continuous variables have been transformed into categorical ones. Based on the medians of the continuous variable authors set up high and low state flow groups and high and low flow synchronizations group. Pearson Chi –square test was performed to measure the association between state flow, flow

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synchronization and the produced design solution originality and functionality characteristics.

Flow synchronization (i.e., perceived synchronized social interaction) significantly associated with the functionality of the bridge $\chi 2$ (1, n=62) =6.62, $p < .01$. A chi-square test of independence showed that there were no significant association between originality and state flow or perceived synchronized social interactions. The results support hypothesis 2 in part and suggest that group members perceived synchronized social interactions associate positively with functional bridge design on the creative problem-solving task.

Group level analysis: the relationship between group members' creativity capacity and produced design solution functionality and originality.

The third hypothesis focus on the association of individual creativity capability (divergent thinking/fluency) and group members perception of interaction quality in relation to each of the twelve participating groups produced design solution. Hypothesis 3: *Group compositions with most divergent thinking members and high interaction quality between group members, produce highly original and functional design solutions on the creative problem-solving task*.

This hypothesis is partly supported regarding the influence of group members individual creativity capability on their own groups produced outcome functionality. To complement the statistical analyses and complete the answer of the third hypothesis a diagram presenting a visualization based on the spread of responses of the twelve social groups is presented (Figure 1). The diagram relates 1) group members idea generation fluency in J&D test and 2) perception of their own groups' interaction quality as well as 3) each of the twelve groups produced design solution assessed by three independent experts in two dimensions, high/low functionality and high/low originality.

The analysis of the social group's performance, presented in Figure 1 show that hypothesis 3 is completely confirmed by only two of the groups (producing both highly functional and highly original design solutions assessed by external experts). However, even those groups members (marked dark-blue color) are spread out in both the idea fluency-dimension as well as in the interaction quality-dimension. Hypothesis 3 is partly supported by four other groups (light-blue color: highly original solution but low functionality). In addition, four of the participating groups (n=21) does not support hypothesis 3. These results will be scrutinized in the subsequent discussion.

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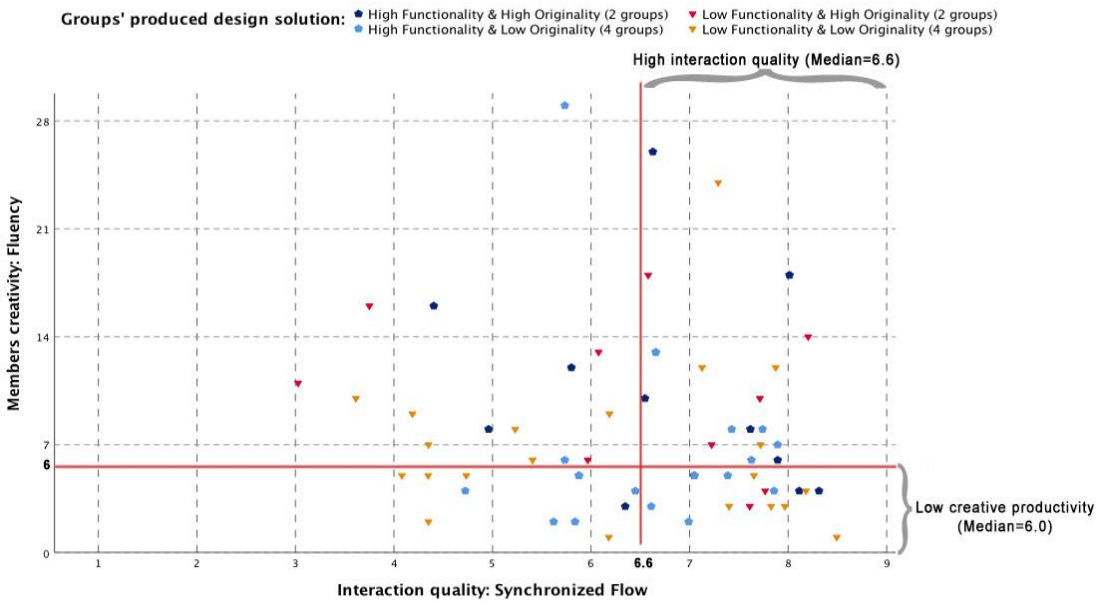

Figure 1: Group members creative productivity (fluency) * Perceived interaction quality (Synchronized Flow) * The groups produced design solution on the CPS task.

Discussion

To answer the research question and test the hypotheses it was necessary to first investigate the relationship between individual experience of state flow in relation to the group members' perception of synchronized social interaction (flow synchronization), and also check the quality of the scale for synchronized flow and make a tentative validation for the Flow Synchronization Scale (FSyQ).

State flow and synchronized interactions during collaborative creative problem solving

The presented results suggest that most of the dimensions of the state flow experience are associated with members' perceived quality of interaction in the social groups during intensive collaboration on the CPS task, and this finding can help us understand better the social dimensions of the flow experience (i.e., group flow) which will be discussed in this section. In addition, the multiple regression analysis showed that the two dimensions of the state flow scale "sense of control" and "autotelic experience" significantly predicted the group's social interaction quality (see details in Table 2). This result indicates a mediating effect on intragroup performance (i.e., quality of social interactions) since state flow correlate significantly with flow synchronization.

Amabile *et al*. (1994) stated that group members' experiences of interaction in social groups trigger motivational contagion and increase the commitment to complete the task, similar relationships are confirmed in this study showing strong correlations between interaction quality and group members' state flow. The results also suggest that interaction quality is significantly associated with the assessed functionality but not the originality of the groups produced design

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solution (the outcome). This answers the first research question, RQ1: *In what way and to what extent is group members experience of state flow and perceived quality of interactions associated to the groups' produced outcome on a collaborative creative problem-solving task?*

These components will be discussed in the next section.

Associations between group creativity and flow synchronization

The assessed functionality of the produced design solution associated with members perceived interaction quality and that the assessed originality of the produced outcome did not to the same extent relate to the group's interaction quality. An explanation of why interaction quality has a greater effect on functional characteristics of the produced solution of bridge design than for its originality could be attributed to differences of what is required to produce originality or functionality in order to be characterized as creative (e.g., Barron, 1955; Sternberg & Lubart, 1999). The challenge in social groups creativity is to enable ongoing combination of group members creative initiatives with sustainable long-term ways of collaborating that result in highly functional outcome.

The descriptive data presented in Figure 1 show that the groups' quality of interaction has a greater impact on the produced outcome functional characteristic than the members' individual creative characteristics. Especially, the two groups that produced design solutions that were assessed highly functional as well as highly original consisted of most members reporting high interaction quality during the interdependent creative problem-solving task, i.e., the experience of synchronized flow (FSyQ), where the latent factors "*Synchronization and effective cooperation with the partner"* and "*Motivation and learning for the person"* are strong. However, these members' creativity productivity was low level in the J&D-test.

Furthermore, the groups that produce design solutions assessed to be of low originality as well as low functionality by the independent assessors also produced the shortest bridges. Interestingly most of these group members achieved the highest levels on the creativity productivity assessment of all participants. Thus, original outcome is to a larger extent depending on each individual group member's initiatives and specific contributions in terms of perspective and knowledge than to continued building on and combining introduced contributions on a collaboratively constructed group idea.

The level of perceived social interaction quality could thus be a predictor of functionality in produced design solution. However, these relationships are not exclusive. There were four groups consisting of high-level individual creativity and state flow experience that did not produce an original design solution. This does not mean that these solutions therefore are highly functional, i.e., these

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groups solutions were assessed to be neither high original nor high functional.

The result stresses the importance of enabling and facilitating the coordination of several crucial factors such as diverging competences and perspectives as well as interdependent initiatives that need to be considered in order to accommodate all quality properties that a highly functional design solution consists of. Since group members creativity seems to drive the group problem-solving process towards a functional rather than original design solution, it is not reasonable to reduce the function of creativity only to early phases of such development processes, which unfortunately is common in such process models (e.g., Hyypiä & Parjananen, 2013; Isaksen & Tidd, 2006). Instead, group members' creativity has the strongest impact on the group's capability in iterative combination of initiatives, competencies and proposals rather than propelling extreme or deviating individual ideas. Therefore, the benefit of individual creativity in social interaction needs to be re-understood in terms of openness that enables and allows for the integration of differences as increasing potential. Group members idea generating capabilities (flexibility and fluency) should be encouraged and trained in order to increase the groups' efficiency of performing interdependent tasks.

This reasoning confirms findings in recently published studies on group based creative processes suggesting that the group need to switch between joint and individual activities (e.g., Backström & Söderberg, 2016; Zenk et al. 2021), but also develops and deepens this line of reasoning with arguments based on the empirical findings presented in this paper. In the final section of this discussion conditions that enable and facilitate the quality of interaction and creative performance in social groups will be addressed.

Intragroup conditions for interaction quality and creative productivity.
This section addresses the second research question regarding group conditions and members capacity of divergent thinking and their perceptions of the groups' interaction quality: *What is the association between group members' divergent thinking capabilities, their perception of the groups' synchronized social interactions and the collaboratively produced creative problem solving?*

The literature suggests that there are several ways in which individuals experience of flow could be causally related to their creative productivity. Firstly, divergent thinking involves cognitive processes as discussed above and possibly that the process of combining meaningful objects establish a certain state of mind that could be linked to the experience of flow, and secondly the experience of flow has been proposed to play a role as a motivating factor for task engagement and long-term achievement, which would apply in practically any domain (see for review, Harmat *et al*. 2021). One reason to expect an association between flow and creativity is that there are several elements of

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flow that are also important for cognitive fluency and flexibility (Csikszentmihalyi, & Nakamura, 2010). These associations are indicated in this study between creative productivity and the state flow dimensions "Unambiguous feedback" and "Transformation of time". In addition, the state flow dimension "Unambiguous feedback" and "Challenge-skills balance" did not correlate with interaction quality (Table 1). The reason why the state flow dimension Unambiguous feedback did not correlate with interaction quality may be due to the characteristics of the task, i.e., if the group members perceive that the nature of creativity is unpredictability and that producing something creative implies that it cannot be planned, the response will be low. This indicate a difference between genuinely creative group activities compared to tasks where creativity is not required.

Beside group members creative productivity and fluency, the creativity productivity-test was also used to assess level of activation of executive functions (Andersson *et al*., 2002) and thus members readiness to take initiatives and contribute to the interdependent CPS-task of a social group. Acar *et al*. (2019) confirmed the temporal order effect, i.e., the more original combinations or ideas are generated later and that the traditional ideas are generated first. The degree of originality in idea generation (i.e., an effect of divergent thinking) becomes higher when the subjects begin the idea generation quickly (e.g., Acar *et al*., 2019). The variance in responses on the idea generation test may depend on the order effect, were respondents who take initiative quickly and start sketching on the paper immediately usually produce more original ideas than those who need longer time to come up with suggestions. What is of particular relevance in the explanation of the current results is the findings of Colzato *et al*. (2013) who relate the order effect in idea generation to the individuals' executive functions. Thus, the result indicates that fluency in idea generation had a stronger positive effect on the groups outcome on functionality than on originality. The explanation is that idea generation activates executive function which increases the probability to take initiatives, discuss and decide on alternative solutions, an ability which may be regarded as a predictor of outcome functionality rather than originality. Thus, creativity evokes cognitive processes that are important for the individual's social ability to interact and exchange thoughts and understanding of how each other's suggestions and ideas can be improved by combination (Österberg & Köping Olsson, 2021). This may explain why groups which members show higher creative productivity take more initiatives and exchange suggestions for solutions to the CPS-task. The order effect thus becomes important not only for the individual but also for the groups capacity to interdependently produce functional outcome.

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Conclusions

This study has investigated the relationship between group members' individual creativity capabilities and experience of flow state in relation to the group's interaction characteristics, performance, and produced design solution. The presented results indicate a connection between creativity and functionality that group members' flexibility and fluency in idea generation establishes openness for integration of differences, which exerts a greater impact on groups' collective task performance than creating original design solutions. Group members creativity increases the group's collective ability to integrate differences rather than to produce original outcome.

Creativity factors in social groups. An implication of this result may be to avoid arguing for group members' creativity, especially the ability to generate ideas fluently, as a prerequisite for increased originality production but instead training creativity in order to improve group collaboration and performance. Consequently, the notion that creativity has its function (only) in the early stages of innovation and development processes should be reconsidered. Strategies for developing working group's efficiency should include training of creative capabilities, idea generation and divergent thinking and action, since these exercises activates executive functions and flexibility (c.f. attentional scope), which is beneficial for collaboration through all process and development stages.

Motivational factors. Group members experience of individual state flow correlate with the perception of social synchronization of flow, especially the autotelic experience dimension predict this level of group interaction quality. Instructions should therefore encourage creative attitudes and initiatives as well as enable meta-conversation regarding group members' understanding of task requirements, in order to increase the experience of being in control, knowing what to do, and thereby increasing interaction, which according to this study improves groups' creativity performance and thus the ability to produce functional results.

Future research. Despite the presented findings there are several limitations of this study. Firstly, the sample size of the study is small. This study has shown a widespread in the analysis of categories and scales, in addition to increasing the number of respondents involved, it may also be required to increase the number of causal relationships (independent variables) in order to investigate interaction quality in terms of predictor of different types of produced results. Secondly, the participants experience of transformation of time and the level of engagement during the CPS-task can function as evaluation of the experimental setup and methods, including the instructions and facilitation of the process. For future research we suggest continued investigation of group flow and creativity during group interaction in workplace situations. Thirdly, the purpose with the

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experimental design was to use a general task description to establish generic conditions that could be of reasonable challenging level for all participant groups. However, given that there is a skill aspect in Flow theory, further studies should investigate the type of skills that enhance the experience of synchronized flow in group interaction. Fourthly, flow in social context should be investigated further deploying other types of research designs, such as interventionistic, training participants creativity, dialogical competence and group improvisation as well as measuring the effect on a daily work groups' collaborative and interdependent task. The effect of synchronized flow in social groups over a longer time period using a longitudinal research design is therefore also suggested.

References:

Andersson, P. (2002). Assessment and Development of executive function (EF) during childhood. *Child Neuropsychology*, Vol. 8, No. 2, pp.71-82. https://doi.org/10.1076/chin.8.2.71.8724

Amabile, T. M. (1982). Social psychology of creativity: A consensual assessment technique. *Journal of Personality and Social Psychology*, Vol. 43, No. 5, 997-1013. https://doi.org/10.1037/0022-3514.43.5.997

Amabile, T.M., Hill, K. G., Hennessey, B. A., and The, E. M. (1994). The Work Preference Inventory: Assessing Intrinsic and Extrinsic. Motivational Orientations. *Journal of Personality and Social Psychology,* Vol. 66, No. 5, 950-967. https://doi.org/10.1037/0022-3514.66.5.950 https://doi.org/10.1037/0022-3514.66.5.950

Amabile, T. M., Conti, R., Coon, H., Lazenby, J., & Herron, M. (1996). Assessing the work environment for creativity. *Academy of Management Journal, 39(5),* 1154 –1184. https://doi.org/10.5465/256995

Backström, T. (2018). Understanding and Facilitating Creative Group Processes: The GroPro Model. Work paper August 27, 2018. *Published on Researchgate*.

Backström, T and Söderberg, T. (2016). Self-Organisation and Group Creativity. *Journal of creativity and business innovation,* Vol.2, pp.65-79. ISSN 2351 – 6186

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, 84, pp. 191-215. https://doi.org/10.1037/0033-295X.84.2.191

Barron, F. (1955). The disposition towards originality. *Journal of Abnormal and Social Psychology*, 51(3), 478–485. https://doi.org/10.1037/h0048073

Berger, K., Surovek, A., Jensen, D., and Cropley, D. (2014). Individual creativity and team engineering design: A taxonomy for team composition. Volume 2015-February, Issue February, 17 February 2015, Article number 7044131, 44th Annual Frontiers in Education Conference, FIE 2014; Melia Castilla Hotel and Convention Center Madrid; Spain; 22 October 2014 through 25 October 2014; Category number CFP14FIE-ART; Code 113076.

Beersma, B., and De Dreu, C. K. W. (2005). Conflict's consequences: Effects of social motives on postnegotiation creative and convergent group functioning and performance. *Journal of Personality and Social Psychology*, Vol. 89, No. 3, pp. 358-374. https://doi.org/10.1037/0022-3514.89.3.358

Bonner, B. L., Baumann, M. R., & Dalal, R. S. (2002). The effects of member expertise on group decision-making and performance. *Organizational Behavior and Human Decision Processes*, 88(2), 719–736. https://doi.org/10.1016/S0749-5978(02)00010-9

Bottger, P. C., and Yetton, P. W. (1988). An integration of process and decision scheme explanations of group problem solving performance. *Organizational Behavior and Human Decision Processes*, 42(2), 234–249. https://doi.org/10.1016/0749-5978(88)90014-3

Brislin R.W. (1970) Back-translation for cross-cultural research. *Journal of Cross-Cultural Psychology* 1, 185–216. https://doi.org/10.1177/135910457000100301

JOURNAL OF CREATIVITY AND BUSINESS INNOVATION

Journal of Creativity and Business Innovation, Vol. 8, 2022.

www.journalcbi.com
ISSN 2351 – 6186

This paper is available at: https://www.journalcbi.com/impact-of-creativity-flow-and-interaction-quality-on-collaborative-design-solutions-in-social-groups.html

Campion, M. A., Medsker, G. J., and Higgs, A. C. (1993). Relations between work group characteristics and effectiveness: Implications for designing effective work groups. *Personnel Psychology,* Vol. 46, pp. 823-850. https://doi.org/10.1111/j.1744-6570.1993.tb01571.x

Cha E. S., Kim, K. H. and Erlen J. A. (2007). Translation of scales in cross-cultural research: issues and techniques *Journal of Advanced Nursing* 58(4), pp. 386–395. doi: 10.1111/j.1365-2648.2007.04242.x

Chrysikou, E. G. (2019). Creativity in and out of (cognitive) control. *Current Opinion in Behavioral Sciences*, Vol. 27, pp. 94-99. https://doi.org/10.1016/j.cobeha.2018.09.014

Cropley, D. (2015). Creativity in engineering. In Corazza, G. E. and Agnoli, S. (Eds.) Multidisciplinary contributions to the science of creative thinking. Singapore: Springer.

Csikszentmihalyi, M., and Csikszentmihalyi, I. S. (ed.) (1988). *Optimal Experience. Psychological Studies of Flow in Consciousness*. Cambridge, UK: Cambridge University.

Csikszentmihalyi, M., and Nakamura, J., (2010). Effortless attention in everyday life: a systematic phenomenology. In: Bruya, B. (Ed.), *Effortless Attention: A New Perspective in the Cognitive Science of Attention and Action*. The MIT Press, Cambridge, MA, pp. 179–190.

De Jong, B. A., Dirks, K. T., and Gillespie, N. (2016). Trust and Team Performance: A Meta-Analysis of Main Effects, Moderators, and Covariates. *Journal of Applied Psychology*, Vol. 101, No. 8, pp. 1134–1150. https://doi.org/10.1037/apl0000110

DeBono, E. (1971). *Lateral thinking in management*. New York: American Management Association.

Edmonson, A. (1999). Psychological safety and learning behaviour in work teams. *Administrative Science Quarterly*, vol. 44, pp. 350-383. https://doi.org/10.2307/2666999

Feist, G. J. (1999). The influence of personality on artistic and scientific creativity. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 273-296). Cambridge, UK: Cambridge University Press.

Gaggioli, A., Mazzoni, E., Milani, L., & Riva G. (2013). The creative link: Investigating the relationship beween social network indices, creative performance and flow in blended teams. *Computers in Human Behavior*, 42, 157-166. https://doi.org/10.1016/j.chb.2013.12.003

Getzels, J., & Csikszentmihalyi, M. (1976). *The creative vision: A longitudinal study of problem-finding in art.* New York, NY: Wiley.

Guilford, J.P. (1950). Creativity. *American Psychologist*, 5(9), pp. 444-454.

Gully, S. M., Beaubien, J. M., Incalcaterra, K. A., & Joshi, A. (2002). A meta-analysis of team-efficacy, potency and performance: Interdependence and level of analysis as moderators of observed relationships. *Journal of Applied Psychology*, 87(5), pp. 819–832. https://doi.org/10.1037/0021-9010.87.5.819

Harmat, L., Andersen, F. Ø., Ullén, F., Wright, J. and Sadlo, G. (eds.) (2016). *Flow Experience: Empirical Research and Applications.* Cham: Springer.

Harmat, L., de Manzano, Ö., Theorell, T., Högman, L., and Fischer, H. (2015). Physiological correlates of the flow experience during computer game playing. *International Journal of Psychophysiology*. 97(1), 1-7. https://doi.org/10.1016/j.ijpsycho.2015.05.001

Harmat L., de Manzano Ö., and Ullén F. (2021). Flow in Music and Arts. In: Peifer C., Engeser S. (eds) *Advances in Flow Research*. Springer, Cham. https://doi.org/10.1007/978-3-030-53468-4_14

Hatfield, E., Rapson, R. L., Le, Y.L. (1994). Emotional Contagion and Empathy. In: *The social Neuroscience of Empathy* (Eds. J. Decety and W. Ickes). Boston, MA: MIT Press.

Hocevar, D. (1979). Ideational Fluency as a Confounding Factor in the Measurement of Originality. *Journal of Educational Psychology*, 71 (2), 191-196. https://doi.org/10.1037/0022-0663.71.2.191

Isaksen, S. G., & Tidd, J. (2006). *Meeting the innovation challenge: leadership for transformation and growth*. Chichester: Wiley, ISBN 0-470-01499-7

Ivcevic, Z., & Brackett, M. A. (2015). Predicting Creativity: Interactive Effects of Openness to

JOURNAL OF CREATIVITY AND BUSINESS INNOVATION

Journal of Creativity and Business Innovation, Vol. 8, 2022.

www.journalcbi.com
ISSN 2351 – 6186

This paper is available at: https://www.journalcbi.com/impact-of-creativity-flow-and-interaction-quality-on-collaborative-design-solutions-in-social-groups.html

Experience and Emotion Regulation Ability. *Psychology of Aesthetics Creativity and the Arts*, 9(4), 480-487. doi:10.1037/a0039826

Jackson, S. (1992). Athletes in flow: a qualitative investigation of flow states in elite figure skaters. *Journal of Applied Sport Psychology*, 4, 161-180. https://doi.org/10.1080/10413209208406459

Jackson, S. A., Eklund, R. C., 2004. *The Flow Scales Manual.* Publishers Graphics, Morgantown, WV.

Katzenbach, J. R. & Smith, D. K. (1993). *The Wisdom of teams: Creating the high-performance organization.* Boston: Harvard Business School.

Kaufman, J. C., Baer, J., Cropley, D. H., Reiter-Palmon, R., & Sinnett, S. (2013). Furious activity vs. understanding: How much expertise is needed to evaluate creative work? *Psychology of Aesthetics, Creativity, and the Arts, 7*(4), 332–340. https://doi.org/10.1037/a0034809

Kaufman, J. C. and Sternberg, R. J. (eds) (2010). *The Cambridge handbook of creativity*. New York: Cambridge.

Kaufman, S. B., Quilty, L. C., Grazioplene, R. G., Hirsh, J. B., Gray, J. R., Peterson, J. B., and DeYoung, C. G. (2016). Openness to Experience and Intellect Differentially Predict Creative Achievement in the Arts and Sciences. *Journal of Personality*, 84:2, pp. 248-258. https://doi.org/10.1111/jopy.12156

Kawabata, M., Mallet, C. J., and Jackson, S. A. (2008). The Flow State Scale-2 and Dispositional Flow Scale-2: Examination of factorial validity and reliability for Japanese adults. *Psychology of Sport and Exercise* 9, pp. 465–485. https://doi.org/10.1016/j.psychsport.2007.05.005

Keller, J., Bless, H., Blomann, F., Kleinböhl, D. (2011). Physiological aspects of flow experiences: skills–demand–compatibility effects on heart rate variability and salivary cortisol. *J. Exp. Soc. Psychol.* 47(4), 849–852. https://doi.org/10.1016/j.jesp.2011.02.004

Khessina, O. M., Goncalo, J. A., and Krause, V. (2018). It's time to sober up: The direct costs, side effects and long-term consequences of creativity and innovation. *Research in Organizational Behavior*, 39, pp. 107-135. https://doi.org/10.1016/j.riob.2018.11.003

King, L. A., Walker, L. M., & Broyles, S. J. (1996). Creativity and the five-factor model. *Journal of Research in Personality*, 30, 189-203. https://doi.org/10.1006/jrpe.1996.0013

Kohn, N.W., Paulus, P. B., & Choi, Y. (2011). Building on the ideas of others: An examination of the idea combination process. *Journal of Experimental Social Psychology*, 47(3), 554–561. doi:10.1016/j.jesp.2011.01.004.

Kurtzberg, T. R. & Amabile, T. M. (2001). From Guilford to Creative Synergy: Opening the Black Box of Team-Level Creativity. *Creativity Research Journal*, 13(3), 285-294. https://doi.org/10.1207/S15326934CRJ1334_06

Köping Olsson, B. and Harmat, L. (2018). State Flow, Creativity and Flow Synchronization During Group Based Problem Solving Task. *5th Participatory Innovation Conference*, Eskilstuna, Sweden, January 9-11.

Köping Olsson, B. (2015). Creativity and maturity in team-based innovation - a model for assessment of interaction quality in relation to task characteristics. *The 1st ARTEM organizational creativity international conference,* Thursday, 26 and Friday, 27 March 2015 in Nancy, FRANCE.

Köping Olsson, B. & Florin, U. (2011). Idea exchange and shared understanding: Tools stimulating thought and conveying ideas. *Design principles and practices: An international journal,* Vol. 5, 487-502. ISSN 1833-1874.

Köping Olsson, B. (2008). Descriptive languages in and for creative practice: Idea development during group sessions. In Swedish Beskrivningsspråk i och för kreativ praxis: Idéutveckling under gruppsession, *Doctoral Dissertation* 1651–4238; 68. Mälardalen University, Västerås, Sweden.

Köping Olsson, B. (2007b). Languages for creative interaction: descriptive language in heterogeneous Groups. The 10th European conference on creativity and innovation, ECCI-X. Copenhagen 14 – 17 October 2007.

Larson, R., (1988). Flow and writing. In: Csikszentmihalyi, M., Csikszentmihalyi, I.S. (Eds.), *Optimal*

JOURNAL OF CREATIVITY AND BUSINESS INNOVATION

Journal of Creativity and Business Innovation, Vol. 8, 2022.

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This paper is available at: https://www.journalcbi.com/impact-of-creativity-flow-and-interaction-quality-on-collaborative-design-solutions-in-social-groups.html

Experience: Psychological Studies of Flow in Consciousness. Cambridge University Press, Cambridge, UK, pp. 150–171.

Leung, K., & Wang, J. (2015). Social processes and team creativity in multicultural teams: A socio-technical framework. *Journal of Organizational Behavior*, 36(7), 1008–1025. https://doi.org/10.1002/job.2021

Libby, R., Trotman, K. T., & Zimmer, I. (1987). Member variation, recognition of expertise, and group performance. *Journal of Applied Psychology*, 72(1), 81–87. https://doi.org/10.1037/0021-9010.72.1.81

Limb, C. J., and Braun, A. R. (2008). Neural Substrates of Spontaneous Musical Performance: An fMRI Study of Jazz Improvisation. *PLoS ONE* 3(2): e1679. doi: 10.1371/journal.pone.0001679

Liu, Y., Keller, R. T., and Shih, H-A. (2011). The impact of team-member exchange, differentiation, team commitment, and knowledge sharing on R&D project team performance. *R & D Management,* Vol. 41, No. 3, pp. 274-287. https://doi.org/10.1111/j.1467-9310.2011.00636.x

Magyaródi, T. and Oláh, A. (2015). Flow Synchronization Questionnaire: Measuring the mechanism of optimal experience in interactions. *Mentálhigiéné és Pszichoszomatika,* 16(4), 271—296.

Magyaródi, T. and Oláh, A. (2017). The effect of social interaction on flow experience. *International Journal of Psychology and Behavior Analysis.* Volume 3, 126. 10-15344.

Martin, A. J., and Jackson, S. A. (2008). Brief approaches to assessing task absorption and enhanced subjective experience: Examining 'short' and 'core' flow in diverse performance domains. *Motivation and Emotion*. 32:141–157. https://doi.org/10.1007/s11031-008-9094-0

McCrae, R. R., & Costa, P. T. J. (1990). *Personality in adulthood*. New York, NY, USA: Guilford.

McMahon, K., Ruggeri, A., Juliane E. Kämmer, J. E., and Katsikopoulos, K. V. (2016). Beyond Idea Generation: The Power of Groups in Developing Ideas. *Creativity Research Journal*, 28:3, 247-257, DOI: 10.1080/10400419.2016.1195637

McNeill, W. H. (1995). *Keeping together in time: Dance and drill in human history.* Cambridge, MA: Harvard University Press.

Metcalfe & Wiebe, 1987). Intuition in insight and noninsight problem solving. *Memory & Cognition*. 15(3), 238-246. https://doi.org/10.3758/BF03197722

Meece, J. L., & Holt, K. (1993). A pattern analysis of students' achievement goals. *Journal of Educational Psychology*, 85(4), 582–590. https://doi.org/10.1037/0022-0663.85.4.582

Michalko, M. (2001). *Cracking Creativity - The Secrets of Creative Genius for Business and Beyond*. Berkeley, CA: Ten Speed Press.

Nakamura, J., and Csikszentmihályi, M. (2001). "*Flow Theory and Research".* In C. R. Snyder Erik Wright, and Shane J. Lopez. Handbook of Positive Psychology. Oxford University Press. pp. 195–206.

Nijstad, B. A., De Dreu, C. K. W., Rietzschel, E. F., & Baas, M. (2010). The dual pathway to creativity model: Creative ideation as a function of flexibility and persistence. *European Review of Social Psychology*, 21, 34-77. doi:10.1080/10463281003765323

Österberg, P. (2012). *Generative learning management - A dual-role leadership model for creativity in organizations*. Doctoral thesis. Department of Psychology, Lund University, Sweden.

Österberg, P. & Köping Olsson, B. (2018). The Influence of music experience and body movement prior to ideational fluency. Proceedings of *the 5th Participatory Innovation Conference,* 11-13 January in Eskilstuna, Sweden.

Österberg, P. & Köping Olsson, B. (2021). Dancing: a strategy to maintain schoolchildren's openness for idea generation. *Journal of Physical Education, Recreation and Dance*, 92 (3), pp. 20-25. DOI: 10.1080/07303084.2020.1866719

Paulus, P. B. (2001). Groups, teams, and Creativity: The Creative potential of idea-generating groups. *Applied Psychology: An International Review.* Vol. 49(2), pp. 237-

JOURNAL OF CREATIVITY AND BUSINESS INNOVATION

Journal of Creativity and Business Innovation, Vol. 8, 2022.

www.journalcbi.com
ISSN 2351 – 6186

This paper is available at: https://www.journalcbi.com/impact-of-creativity-flow-and-interaction-quality-on-collaborative-design-solutions-in-social-groups.html

262. https://doi.org/10.1111/1464-0597.00013

Paulus, P. B. & Nijstad, B. A. (Eds.) (2003). *Group creativity: Innovation through collaboration.* New York: Oxford University.

Pels, F., Kleinert, J., and Menningen, F. (2018). Group Flow: A scoping review of definitions, theoretical approaches, measures and findings. *PLoS ONE,* Vol. 13, No. 12; e0210117, pp. 1-28. https://doi.org/10.1371/journal.pone.0210117

Perkins, D. N. (1981). *The Mind´s best work*. London: Harvards University Press.

Plucker, J. A. (Ed.) (2017). *Creativity and innovation – theory, research and practice*. New York: Taylor & Francis.

Prince, G. M. (1972). *The practice of creativity through synectics: the proven method of group problem* solving. New York: Collier.

Rawlinson, J. G. (1981). *Creative thinking and brainstorming*. Farnborough: Gower.

Rennung, M., & Göritz, A. S. (2016). Prosocial consequences of interpersonal synchrony: A Meta-Analysis. Zeitschrift Fur Psychologie / *Journal of Psychology,* 224(3), 168–189. https://doi.org/10.1027/2151-2604/a000252.

Rhodes, M. (1961). An Analysis of Creativity. *The Phi Delta Kappan,* Vol. 42, No. 7, pp. 305-310.

Rothenberg, A., & Hausman, C. R. (1976). *The creativity question*. Durham, NC: Duke University Press.

Runco, M. A. (2007). *Creativity, theories and themes: Research, development, and practice*. London: Elsevier.

Runco, M. A., and Jaeger, G. J. (2012). The Standard Definition of Creativity, *Creativity Research Journal*, 24:1, 92-96. https://doi.org/10.1080/10400419.2012.650092

Salas, E., Sims, D. E., and Burke C. S. (2005). Is there a ''Big Five'' in Teamwork? *Small Group Research,* Vol. 36, No. 5, pp. 555-599. https://doi.org/10.1177/1046496405277134

Sawyer, R. K. (2000). Improvisation and the creative process: Dewey, Collingwood, and the aesthetics of spontaneity. *Journal of Aesthetics and Art Criticism*, Vol. 58, no. 2, pp. 149-161. https://doi.org/10.2307/432094

Sawyer, R. K. and DeZutter, S. (2009). Distributed Creativity: How Collective Creations Emerge from Collaboration. *Psychology of Aesthetics, Creativity, and the Arts*. Vol. 3, No. 2, 81–92. https://doi.org/10.1037/a0013282

Sawyer, R. K. (2015). Group flow and group genius. *The NAMTA journal*, 40 (3), 29-52.

Sawyer, R. K. (2017). Group genius: the power of collaboration. New York: Basic Books.

Sawyer, R. K. (2021). The Dialogue of Creativity: Teaching the Creative Process by Animating Student Work as a Collaborating Creative Agent, Cognition and Instruction, DOI: 10.1080/07370008.2021.1958219

Shamay-Tsoory, S. G., Adler, N., Aharon_Peretz, J., Perruy, D., and Mayseless, N. (2011). The origins of originality: The neural bases of creative thinking and originality. Neuropsychologia, Vol. 49, pp. 178-185. https://doi.org/10.1016/j.neuropsychologia.2010.11.020

Silvia, P. J., Wigert, B., Reiter-Palmon, R., & Kaufman, C. J. (2012). Assessing Creativity with Self-Report Scales: A Review and Empirical Evaluation. *Psychology of Aesthetics, Creativity, and the Arts*, 6 (1), 19–34. https://doi.org/10.1037/a0024071

Stein, M. (1953). Creativity and culture. *Journal of Psychology*, 36, 311–322.

Stein, M. I. (1974). Stimulating creativity, vol. 1, Individual procedures. New York: Academic Press.

Stein, M. I. (1975). Stimulating creativity vol.2, Group Procedures. New York: Academic Press.

Sternberg, R. J., Lubart, T. I., Kaufman, J. C., & Pretz, J. E. (2005). Creativity. In K. J. Holyoak & R. G. Morrison (Eds.), *Cambridge handbook of thinking and reasoning* (pp. 351–370). Cambridge: Cambridge.

Sternberg, R. J. and Kaufman, J. C. (2018). *The nature of human creativity*. Cambridge: Cambridge.

Stout, R. J., Cannon-Bowers, J. A., Salas, E., & Milanovich, D. M. (1999). Planning, shared mental models, and coordinated performance: An empirical link is established. *Human Factors*, 41, 61-71. https://doi.org/10.1518/001872099779577273

JOURNAL OF CREATIVITY AND BUSINESS INNOVATION

Journal of Creativity and Business Innovation, Vol. 8, 2022.

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Tekleab, A. G., Karaca, A., Quigley, N. R., and Tsang, E.W.K. (2016). Re-examining the functional diversity-performance relationship: The roles of behavioral integration, team cohesion, and team learning. *Journal of Business research,* Vol. 69, pp. 3500-3507. https://doi.org/10.1016/j.jbusres.2016.01.036

Thompson, L. & Choi, S. H. (Eds.) (2006). *Creativity and innovation in organizational teams.* New Jersey: Lawrence Erlbaum.

Torrance, E. P. (1981). Empirical validation of criterion-referenced indicators of creative ability through a longitudinal study. *Creative Child and Adult Quarterly*, 6, 136–140.

Ullén, F., de Manzano, O., Theorell, T., Harmat, L.: The Physiology of Effortless Attention: Correlates of state flow and flow pronenness. In: Brian J. Bruya (ed.): *A New Perspective in the Cognitive Science of Attention and Action*, MIT Press Cambridge 2010: 205-219.

Valdesolo, P., Ouyang, J., & DeSteno, D. (2010). The rhythm of joint action: Synchrony promotes cooperative ability. *Journal of Experimental Psychology*, Vol. 46, pp. 693–695. https://doi.org/10.1016/j.jesp.2010.03.004

Wagner, J. A. (1995). Studies of individualism-collectivism: Effects on cooperation in groups. *Academy of Management Journal*, 38, 152–172. https://doi.org/10.5465/256731

van den Hout, J. J. J., Davis, O. C., and Walrave, B. (2016). The Application of team flow theory. In Harmat *et al*. (2016). *Flow Experience: Empirical Research and Applications.* Cham: Springer.

van den Hout, J. J. J., Gevers, J. M. P., Davis, O. C., and Weggeman, M. C. D. P. (2019). Developing and testing the team flow monitor (TFM). *Cogent Psychology*, 6: 1643962, pp.1 – 27. https://doi.org/10.1080/23311908.2019.1643962

Wang, K. (2016). The Effect of Autonomy on Team Creativity and the Moderating Variables. *Journal of Creativity and Business Innovation*, Vol. 2, pp. 160-171.

Wang, J., Cheng, G. H-L., Chen, T., and Leung, K., (2019). Team creativity/innovation in culturally diverse teams: A meta-analysis. *Journal Organizational Behavior*, Vol. 40, pp. 693-708. https://doi.org/10.1002/job.2362

Weick, K. E., & Sutcliffe, K. M. (2006). Mindfulness and the quality of organizational attention. *Organization Science*, 17, 514-524. doi:10.1287/orsc.1060.0196

Weisberg, R. W. (2006). *Creativity: understanding innovation in problem solving, science, invention, and the arts*. Hoboken, N.J: Wiley, ISBN 0-471-73999-5.

Wekselberg, V, Goggin, W. C, & Collings, T. J. (1997). A multifaceted concept of group maturity and its measurement and relationship to group performance. *Small Group Research*, 28, 3-28. https://doi.org/10.1177/1046496497281001

West, B. J., Patera, J. L., and Carsten, M. K. (2009). Team level positivity: investigating positive psychological capacities and team level outcomes. *Journal of Organizational behavior*, Vol. 30, pp. 249-267. https://doi.org/10.1002/job.593

Wright, J. J., Sadlo, G., & Stew, G. (2006). Challenge-skills and mindfulness: An exploration of the conundrum of flow process. *OTJR Occupation, Participation and Health*, 26(1), 25–32. https://doi.org/10.1177/153944920602600104

Wronska M. K., Kolan´czyk A. and Nijstad B. A. (2018). Engaging in Creativity Broadens Attentional Scope. *Front. Psychol.* 9:1772. doi: 10.3389/fpsyg.2018.01772.

Zabelina, D. L., and Robinson, M. D. (2010). Creativity as flexible cognitive control. *Psychology of Aesthetics, Creativity, and the Arts.* Vol. 4, No. 3, pp. 136-143. https://doi.org/10.1037/a0017379

Zenk, L., Primus, D. J., and Sonnenburg, S. (2021). Alone but together: flow experience and its impact on creative output in LEGO® SERIOUS PLAY®. European Journal of Innovation Management Vol. ahead-of-print No. ahead-of-print. **https://doi.org/10.1108/EJIM-09-2020-0362**

Zhang, X. and Kwan, H. K. (2019). Team behavioral integration links team interdependence with team performance: an empirical investigation in R&D teams. *Frontiers of Buiness Research in China,* Vol.13, No. 7, pp. 1-19. https://doi.org/10.1186/s11782-019-0054-1

Yetton, P. W., & Bottger, P. C. (1982). Individual versus group problem solving: an empirical test of the best-member strategy. *Organizational Behavior and Human Performance*, 29, 307–

JOURNAL OF CREATIVITY AND BUSINESS INNOVATION

Journal of Creativity and Business Innovation, Vol. 8, 2022.

www.journalcbi.com
ISSN 2351 – 6186

This paper is available at: https://www.journalcbi.com/impact-of-creativity-flow-and-interaction-quality-on-collaborative-design-solutions-in-social-groups.html

321. https://doi.org/10.1016/0030-5073(82)90248-3

Appendix 1

- Flow Synchronization Questionnaire (Magyaródi and Oláh, 2015)

The internal consistencies of the scales are adequate. The face validity of the questionnaire is also satisfying, its convergent validity related to flow is appropriate, as the scales of FSyQ correlate moderately with the factors of flow. *Conclusions*: The development of the FSyQ can contribute to the operationalization of the concept of flow synchronization and the future empirical studies of flow in interactive activities.

1. I felt to have a positive impact on the task solving of my partner.
2. At the end of the task I felt myself more energized than at the beginning of it.
3. My partner motivated me during carrying the task out.
4. Our communication was effective during the task.
5. I was encouraged by my partner's` performance.
6. I felt a mutual trust in each other.
7. I learned something new from my partners.
8. I felt that we mirrored each other during the performance.
9. I felt our behavior was synchronized during the activity.
10. I felt that we were doing well.
11. I focused only on the common task.
12. I am willing to work together with my partners at another time.
13. I could motivate my partners to perform the task.
14. I felt a kind of harmony between us.
15. Our behavior was well-coordinated.
16. I felt that we had a better relationship with my partner.
17. I felt that I can count on my partners.
18. I would like to work with my partners in the future.
19. We were able work together automatically.
20. I could react well to my partners' behavior.
21. I was completely absorbed in the task.
22. I felt I had a positive impact on my partners' performance.
23. I felt that we were almost synced with each other.
24. I felt refreshed after the activity.
25. I was able learn from my partner.
26. I could respect my partners' skills.
27. We could cooperate well.
28. I was totally relaxed.

Reference: Magyaródi, T., Oláh., A. (2015): Flow Synchronization Questionnaire: Measuring the mechanism of optimal experience in interactions. Mentálhigiéné és pszichoszomatika. 16(3):271-298. (Article in Hungarian, Abstract in English)

Appendix 2

- The State flow Scale (FSS-2)

The participants' level of flow was estimated using a subset of the Flow State Scale, which has been shown to be a reliable and valid measure of the flow construct (Jackson &

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Eklund, 2004). Items in this self-report questionnaire are formulated as propositions about the trial experience, with which the respondent will agree or disagree, answering on a Likert-scale. Nine items were selected from the original questionnaire to probe each dimension. Those items were chosen that according to the test manual (Jackson & Eklund, 2004) load most on each flow dimension respectively. Answers were given on a 9-step scale, from strongly disagree (1) to strongly agree (9).

1. Challenge-skill balance: (29) My abilities matched the challenge of the situation.
2. Action-awareness merging: (30) I did things spontaneously and automatically without having to think.
3. Clear goals: (31) I knew what I wanted to achieve.
4. Unambiguous feedback: (32) I had a good idea while I was performing about how well I was doing
5. High concentration: (33) I had total concentration.
6. Sense of control: (34) I had a feeling of total control.
7. Loss of self-consciousness: (35) I was not worried about what others may have thought of me.
8. Transformation of time: (36) The way time passed seemed to be different from normal.
9. Autotelic experience: (37) I found the experience extremely rewarding.

References: Jackson, S. A., & Eklund, R. C. (2004). The Flow Scales manual. Morgantown, WV: Publishers Graphics, and de Manzano, Ö., Theorell, T., Harmat, L., Ullén, F., 2010. The psychophysiology of flow during piano playing. Emotion 10, 301–311.

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