STATE FLOW, CREATIVITY AND FLOW SYNCHRONIZATION DURING GROUP BASED PROBLEM SOLVING TASK

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ABSTRACT

Research on group creativity needs to develop methods that capture data at a group level in different ways. This pilot study uses newly validated tools in an experimental design and primary statistical processing and analysis of data in order to investigate whether the design and the tools are appropriate for a full-scale experiment. The psychological experience called *Flow* is operationalized as an expression of creativity at the group level (*Team flow*) that may occur during the performance of challenging activities 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. This paper focuses on team members' motivation and learning, engagement, concentration, experience of synchronization and coordination during a group based problem solving task and also test how these dimensions of the group flow experiences relates to individual state flow experiences.

INTRODUCTION

Work in groups can be a motivation factor in itself (Cohen & Bailey, 1997). Some people enjoy to socialize and exchange ideas in a group, they become more effective and may even experience Flow while interacting and helping to improve the performance of other group members, which in turn could be triggered by the energy and satisfaction of jointly achieving highly appreciated results (Levine & Moreland, 2011). For others, group work is a malicious but necessary part of work, it rather prevents them from performing their duties because of the need to interact and discuss different solutions and make joint decisions (Paulus & Nijstad, 2003). Other aspects that may affect the individual's preference for participating in group work can be conditioned by the situation (Amabile, 1983) or work task characteristics (Amabile et al., 1994; Sawyer, 2007), however, in this pilot study these aspects are disclosed.

Grouping in workplaces often consists of individuals with similar educational background and experience in the profession, where they also perform complementary or comparatively similar tasks (Belbin, 2011; Sherman et al., 2010; Sears & Rowe, 2003). In work teams, specifically designed to work creatively and drive innovation processes (Cropley, 2006), collaborators with a greater degree of differences need to work together to produce results with innovative potential (Thompson & Choi, 2006; Caldwell & O'Reilly, 2003). Nevertheless, all types of working groups undergo some form of socialization development that can be described in terms of stages (Tuckman, 1965), where each stage is characterized by certain ways that the members interact and relate to the group (Levine & Moreland, 2011). In addition to this kind of differentiation, groups can consist of individuals who have long experience in performing work tasks in teams, such as professional teams, or groups (nominal) whose members have low or no experience of working in teams (Katzenbach & Smith, 1993). In addition to these types of difference in composition and experience, there are other ways to organize teamwork that have more volatile

constellations such as temporary teams, "knots" or X-teams (Ancona, Bresman & Kaeufer, 2002). In this pilot study we investigate how group flow relates to some the circumstances described above. Based on current research on individual state flow, we ask the following questions:

1. *How can state flow on an individual level relates to group flow experiences during collaborative problem solving?*
2. What impact does the dimension 'loss of self-consciousness', have on group flow experiences?
3. How does group members individual creativity relate to the experience of synchronization and coordination during a collaborative problem solving task?

Thus, this paper focuses on team members' motivation and learning, engagement, concentration, experience of synchronization and coordination during a group based problem solving task. In addition, we test how these dimensions of the group flow experiences relates to individual state flow experiences.

THEORY

Group interaction have the characteristic of volatility and continuously changing dynamics. Content, structures and states that arises through group members interaction and exchange may exist in the moment and be replaced in the next moment, but these emerging phenomena may also result in remaining content(structures). Examples of these slowly changing structures are such as roles, functions and relationships. While the volatile or faster changed state of affairs can be ways of interacting, the intensity of the idea exchange or the shift between different parts of tasks, etc. (Backström, 2016). At the same time these two types of phenomena are interrelated. These phenomena co-vary and establishes the character of the group. (meaning that those categorisations and explanations does not cover what is actually going on). The research question no. 1 is: "How can state flow on an individual level affect group flow experiences during collaborative problem solving?"

Tuckman & Jensen (1977) posed five stages of group development forming, storming, norming, performing and adjourning, interestingly researchers have not found corresponding developmental stages or phases of membership on individual members level (Levine & Moreland, 2011). In line with Levine & Moreland (Ibid) we hold that socialization and development is not a one-way street, i.e. they affect each other mutually, in addition can different members of the same group be in different membership phases at any given time (Levine & Moreland, 2011). This may suggest that the group as a whole can function on another development stage than its members.

Dunbar have studied several research teams and found that a key factor to their achievements is situated in the group processes. The successful teams dealt with contradictory results, had some form of diversity in the composition and were engaged in the common reasoning (Dunbar, 1995). These kinds of teams can be the source of motivation and consequently of innovation when they pull advantages of different abilities and competences when developing ideas and preserved creative initiatives (Drach-Zahay & Somey, 2001; Cohen & Bailey, 1997). The combined and recurring actions in the form of initiatives and responses form something concrete when the group as a whole finds its way of interacting – it is circular and reinforcing, more of a certain state (guiding exchange) than process in several stages. The experience of this state is in itself a very strong motivational factor. Salas et al (2005) point out that it is teamwork that ensures the success of a team. A definition of team:

> *A work team is defined as any formal and permanent whole of at least two interdependent individuals who are collectively in charge of the achievement of one or several tasks defined by the organization.*

Definition of work team by Rousseau, Aubé & Savoie, (2006).

Coordinating factors for effective teamwork are *shared mental models* (e.g., Stout, Cannon-Bowers, Salas, & Milanovich, 1999), achievement of *mutual trust* (e.g.,Webber, 2002), and engagement in *closed-loop communication* (e.g., McIntyre & Salas, 1995). These factors will vary over the course of the team task as the team gains experience working together (Salas et al., 2005). Austin & Devin (2003) suggests an artful approach when coordinating team interaction. A process characterized by four qualities: Release, Collaboration, Ensemble and Play. Collaboration, the basic condition for this interaction to occur is the process of reconsideration. Those who collaborate reconsider a problem in the light of each and every contribution so that new and unpredictable ideas may emerge. This artful collaboration establishes something that is greater than a group of individuals, an ensemble. Ensemble, this concept refers to both a name and a quality. A group collaborating in an artful way articulates the notion of ensemble quality. This tautology characterizes artwork that might be one of the causes why knowledge originating out of traditional industrial domains meets difficulties in grasping what mechanisms artful collaboration activates. An ensemble is something qualitatively different from a conventional team (Köping Olsson, 2007). In that sense our research question no. 2 is relevant "What impact does the dimension 'loss of self- consciousness', have on group flow experiences?"

Wekselberg et al. (1997) have defined *group maturity* as a combination between group members' attitude regarding their capacity and the extent to which their perceptions of group goals are consistent, i.e. group cohesion. Köping Olsson (2015) elaborated on Wekselbergs et al. operationalization of group maturity from the perspective of creativity and suggested that creativity on group level rather should be understood

and evaluated as a relation between the complexity degree of *tasks characteristics* and the groups' capability to house processes for *evaluation* and criticism (quality) in combination with striving for originality in relation to the task at hand (Köping Olsson, 2015). Our third research question reads: "How does group members individual creativity relate to the experience of synchronization and coordination during a collaborative problem solving task?"

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).

Team 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 (van den Hout et al. in Harmat et al. 2016). van den Hout (ibid) posits that *team flow* can be considered a function of an individual's experience of flow during the execution of one's personal task in a team context with three core aspects: (1) it is an individual team member who experiences the mental state of flow by executing his/her personal task; (2) the team member derives flow from the team dynamic which is structured by a collective ambition that set the precursors which are shared goals (team and personal), high skill integration, open communication, safety, and mutual commitment; and (3) team members share a dynamic that reflects a state of flow as a whole. We used the Flow Synchronization Scale (FsyQ) in order to measure group flow experiences. This questionnaire focus on team members' motivation and learning, engagement, concentration, experience of synchronization and coordination.

METHODS AND PROCEDURE

The purpose was to measure participants' individual as well as group flow experiences during a group based problem solving task. All groups consisted of six members and got exactly the same material to use to solve the problem.

Participants Eighteen participants (9 females and 9 males, aged 21-47 years, M = 26.9), took part in the experiment. They were recruited by means of posters at Mälardalen University campus, Eskilstuna, Sweden.

Procedure of experiment

a) (5min) The experiment leader introduces the experiments time frame and overall structure.

b) (3min) The consent form is distributed. 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 University Information Office and the Personal Information Act (PUL). Instruction: *Read both sides and sign the form of consent.*

c) (5+5min) Perform first task individually, the J&D-test. Instruction: "*Form as many meaningful things as possible. If you do not understand what to do or become unsure, you can make your own interpretation or take chances*."

d) (5min) The experiment leader composes participants in temporary groups, as well as conducting some exercises with groups. 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 pace.*

e) (7min) Instructions for the second task: *The problem solving task is for you as a group, to build as long a bridge as possible with the given material during 15 minutes. The result will be assessed based on the following three criteria: 1) the bridge length, 2) the function (to drive a lego-car over the bridge), and 3) the originality of solution. Note! The group gets four minutes and are requested to plan the work, allocate tasks and discuss any questions within the group.*

f) (15 min) Perform the second task – problem solving in group, Instructions: Build your bridge together and check the function by driving the Lego car over the entire bridge.

e) (10 min) Answer the distributed survey questions.

Instruments

In order to study optimal experience on a group level, we used the Flow Synchronization Questionnaire (FSyQ) Magyaródi & Oláh, 2015). This questionnaire focus on the motivational and coordination (task- and relationship-focus) aspects of the experience such as (1) synchronization and effective cooperation with the partner, (2) experience of engagement and concentration, (3) motivation and positive impact on the partner (4) Motivation and learning for the person, (5) coordination with the partner during the activity. We also aimed to measure these factors in relation to a 9 dimensions of state flow (FSS-2) in order to understand more about the characteristics of state flow on individual and team level.

The subjects' individual state flow level is measured using a subset of nine items from the Event Experience Scale (FSS-2) (Jackson and Eklund 2004). Items are formulated as statements about subjective experiences during a previous performance (e.g., "I had total concentration."),with which the respondent should agree or disagree. Answers are given on a Likert scalewith nine steps ranging from 1 (strongly disagree) to 9 (strongly agree). The instrument measures a 9 dimension model of state/trait 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 and Eklund 2004). In addition we used the J&D test to measure creativity of the participants.

ANALYSIS OF DATA

Analysis of individual creativity: In order to measure and analyze subjects individual creativity the J&D-test (Österberg, 2012; Österberg & Köping Olsson, 2017) was used. The subjects were requested to produce as many meaningful combinations of the figures J and D as possible during five minutes on an empty paper in A3 format. To assess the result we used the same procedure as (Österberg & Köping Olsson, 2017), i.e. one of the experiment leader took the role of assessor. The assessment was performed based on instructions given both orally and written in connection to the performance, as well as the purpose of measuring individual creativity. The overall assessment on a nine-point scale was based on the following parameters: 1) total number of combinations (*frequency*), 2) the degree of *combination* (both figures combined), 3) use of the figures in other than the letters (*originality*). The overall assessment of these three parameters was given a number between 1 and 9 representing the subjects creativity index.

Statistical analyses: We used Pearson`s Product-moment correlation to measure the association between state flow/team flow/J&D-test. A p value of .05 was used as the limit of significance in all statistical tests. The statistical analysis were performed using SATISTICA 13.0 (SatSoft. Inc, USA).

RESULTS

Group differences in performance, creativity and flow

We divided our participants in three groups to work on the given problem solving task. Group1 built a bridge that was 270 cm long, had low functionality, i.e. the lego could not drive across the bridge, but the construction was considered to be original both in the design and use of available materials. Group 2 worked with the same tasks in parallel to Group 1, but none of the groups could see what and how the other group did. Group 2 built a bridge that was 510 cm long but despite that had high functionality, i.e. the Lego car could be driven over the entire length. This bridge was considered less original due to its design and use of available materials. Group 3 collaboration to solve the given problem resulted in a bridge that was 220 cm long and had a functionality

The collaboration in Group 3 to solve the given problem resulted in a bridge that was 220 cm long and a functionality better than Group 1, but somewhat worse than group 2, i.e. the lego car could be driven over almost the entire bridge. The originality assessment placed Group 3 work between Group 1 and Group 2. This was mainly because Group 3 did not use all available materials as both Group 1 and Group 2 did.

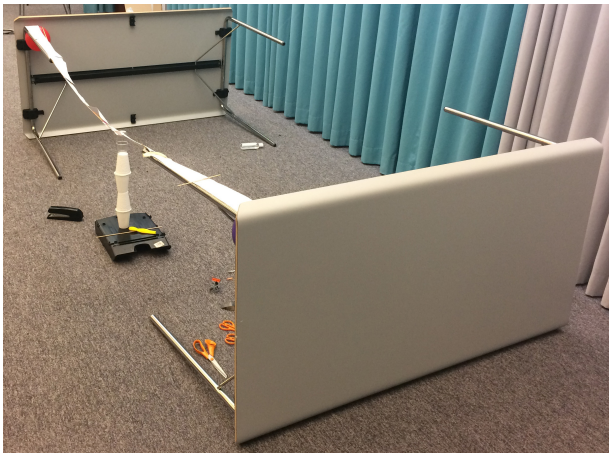

Figure 1. An example of bridge as result of a group based problem solving task.

Correlations between dimensions of individual state flow and group flow experiences on motivation and coordination.

We used Pearson`s Product-moment correlation to measure the association between state flow/team flow/J&D-test (Table 1, in Appendix). *Sense of automatism in action* (action-awareness merging), *control, and autotelic experience* positively correlated with the mean scores in FSyQ. We suggest these dimension in individual state flow may support group flow experiences in a motivational and coordination/synchronization aspects during a group action. We didn't find significant association between means scores of FSyQ and the dimension in individual state flow such as challenge skills in balance, clear goals, unambiguous feedback, concentration, loss of self-consciousness and transformation of time. However loss of self-consciousness in FSS-2 had a significant association with the factor of engagement and concentration in FSyQ. These individual flow dimensions seems partly independent experiencing flow on a group level when we focus on the motivational and coordination aspect of the experience.

We investigated also the association between the 9 dimension in FSS-2 (see details in the introduction) and the 5 factors in FSyQ. such as (1) synchronization and effective cooperation with the partner, (2) experience of engagement and concentration, (3) motivation and positive impact on the partner (4) Motivation and learning for the person, (5) coordination with the partner during the activity. *Sense of automatism in action* (i.e. action-awareness merging) and *control* correlated with factors 1, 2, 4, 5 and autotelic experiences with factors 1 and 2, 4 however there was a tendency for significance in factor 5 ($p<0.1$) (coordination with the partner).We found significant relationship between *sense of control* with all the five dimensions in FSyQ. These trait dimensions may support flow on a group level. In addition loss of self-consciousness in FSS-2 had a significant association with factor 2 (engagement and concentration) in FSyQ.

Finally, we have not found significant relations between creativity measured in J&D index with the state flow or group flow scales, however J&D had a tendency for a negative correlation ($p<0.1$) with factor 5 (coordination with the partner during the activity) in FSyQ. This result suggest that high individual creative achievement may not support the coordination with team members during a group based problem solving task.

DISCUSSION

With the perspective of positive psychology embracing interpersonal interaction as complex, proactive and intentional. This pilot study builds on flow research and group creativity research, utilizing an experimental design including newly validated tools. The intention was also to explore new ways of study ongoing group interaction, fruitfully performed a core capability in co-creative activities such as participatory and team-based innovation. As stated above, we focused on group members motivation and learning, engagement, concentration, experience of synchronization and coordination during group based flow experiences, and also test how these dimensions of the group flow experiences relates to individual state flow experiences.

First, we will discuss the results between the groups who had different achievement on the problem solving "the bridge task" in state/trait/group flow and creativity and later the most important associations between state flow on individual and group level according to our hypothesizes.

The relationship between individual and group is important in understanding the research method for group creativity, e.g. what is relevant to ask individual group members about or observe in order to understand the group, i.e. what overlaps between individual and group as well as what is not valid at group level but relevant at individual level. In our research question no. 1 we asked how state flow on an individual level can affect group flow experiences during collaborative problem solving. In this study, we found evidence that some of the dimensions in individual group flow is important (i.e. action-awareness merging, sense of control, and autotelic experiences) to experiences flow on a group level and some other factors remain partly independent such as *challenge-skill in balance, clear goals feedback, concentration, loss of self-consciousness and transformation of time.*

Based on these findings, it should be relevant to ask group members about their deliberate actions in relation to the group's joint actions. It is also important that the individual experience that she is in control of the situation. One of the most central dimension to ask group members about is what the participation in the group means for them individually, that is, what the group interaction itself means to the individual group member - the common endeavor to solve a problem. Amabile et al. (1983, 1994) research on intrinsic / extrinsic motivation in relation to the situation is in line with this result. In comparison with her motivational concepts our study and measurement tools focus on motivation (e.g. autotelic experiences) that arises through group interaction. In addition, both Cohen and Bailey (1997) and Salas, et al. (2005) maintain that teamwork seems to be a motivational factor in itself and that the level of this motivation factor can predict team success.

The challenge-skill balance is an important dimension in experiencing state flow, however we have not found any significant correlations between these factors in FSyQ. Nevertheless, it is an interesting question how participants perceive challenge-skill balance when they work in groups. We speculate that participants during a collaborative work may share the responsibility to solve the problem and perceive the challenge-skill balance in a different way than when they work alone. We assume that this is an important question for future researches. Of course, another explanation is that the factors in FSyQ do not focus on that dimension on a group level.

Based on our results we also suggest that the experience of synchronization with other group members relates to the level of engagement and concentration on the task and this may in turn provide an autotelic experience for each individual. Interestingly we found a significant association between *autotelic experience* and factor 1, *synchronization and effective cooperation* with the partner, factor 2 experience of *engagement and concentration*, and also with factor 4 *motivation and learning* in FSyQ.

We also aimed to measure how the level of self-consciousness can be changed/altered from individual to group flow experiences and how individual state/group flow experience relates to creative achievement. In our second research question we looked for an answer on what impact the dimension *loss of self- consciousness*, have on group flow experiences. In a pilot study to this pilot-study we found that a loss of self-consciousness had no significant association with the mean score of FSyQ, however there was a positive correlation with factor 2, *experience of engagement and concentration*. The question about loss of self-consciousness was the following in FSS-2: "I was not worried about what others may have thought of me". In our explanation, we suggest that if we do not worry about critics from others group members in connection with our behaviour during the activity it can increase the engagement and concentration with the group based task. As we discussed about the findings of RQ1 above, there is a certain level of group members action awareness and experience of control in group flow. This may indicate a paradox in relation to the outcome of RQ2 regarding the "loss of self-consciousness" dimension. However, this may be an issue about prioritizing the individual's own more or less conscious intention and needs on the one hand and the group's task and perception of what initiatives are required to reach the group's common goals, on the other hand. The question of self-consciousness does not concern the extent to which the

individual ceases to exist in favor of the group, it is about deliberately giving priority to the collective in front of the individual.

Furthermore, the pilot study indicated that group members' score on creativity in J&D test had a tendency for a negative correlation ($p<0.1$) with factor 5 (coordination with the partner during the activity) in FSyQ. We speculate that high individual creative achievement may have negative influence on perceived coordination during collaborative work. Backström (2016) discusses differences between individual-based creativity and group-based creativity, arguing that the group does not get more creative because it consists of more creative individuals. The result of this pilot study may, to some extent, confirm this by showing negative correlation between the group members' individual creativity index and the experienced coordination with other group members. This finding may indicate a difference in characteristic between group creativity and individual creativity - high individual creative achievement does not in an obvious way elevate group creativity, under certain circumstances it may rather be counterproductive. Thus, members of a group that are expected to achieve creative results need to develop other abilities than those that drive individual creativity. Under what circumstances this is valid and what specific skills the team members should develop are important questions for further research. Besides this, it should also be noted that this result may in turn depend on the type of task the group is working on as well as on other factors such as leadership and development stage of the group.

SUMMARY AND FUTURE RESEARCH

As mentioned in the introduction research on group creativity is in need of developing methods for data collection. The results presented from this pilot study contributes to this development by building on perspectives and transforming measurements from current research on individual state flow to the study of group flow. This pilot study has given interesting results in terms of tendencies and indications showing that the newly validated measurement tools have the intended function by factors in the statistical analysis is consistent with other theories.

In this pilot study we have used an non-validated way of measuring individual creativity, the J & D-test which however is based on research by Finke, Pinker & Farah (1989) and Hocevar (1979). Its strength is that the subjects do not need to perform self-estimates of their own creativity, instead they are requested to performing a task based on the above-mentioned research. Nevertheless, we see the need to measure individual creativity in several ways, for example could Torrance's Test of Creative Thinking (TTCT) (Kim, 2006) be an appropriate tool.

As mentioned above, further research is needed that investigates differences as well as similarities between individual creativity and group creativity, such as, which abilities that needs to be developed and encouraged in order to promote the group's creativity, but also what circumstances and conditions in the environment that have positive impact on the group's creative performance. Other aspects in need of development regards facilitation of interaction and exchange as well as how instant feedback and forms of leadership based on new knowledge regarding conditions for group flow. In relation to the issue of feedback the research on group flow also provides new questions concerning support through visualization of emerging content during group interaction.

Furthermore, we suggest that future studies should measure other components of the team flow such as trust and holistic focus (van den Hout 2016). Another dimension in need of development is knowledge regarding team members' abilities and skills to interact. This area addresses the ability to listen in different ways, to interpret and understand what other team members say and do in relation to common goals and emerging content. The starting point for this type of study is that team members seems to be bad listeners in general and that misconceptions and misunderstandings have contributed to fatal conclusions and decisions (Janis, 1972).

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APPENDIX

	Syncronization and Cooperation	Engagement and Concentration	Positive impact on the partner	Motivation and Learning	Coordination with the partner	FSyQ Mean
J&D Index	-,2631 p=,292	-,3549 p=,148	-,2095 p=,404	-,3310 p=,180	-,4065 p=,094	-,3625 p=,139
Challenge-Skills balance	-,1884 p=,454	,1963 p=,435	-,3612 p=,141	-,0215 p=,932	-,2987 p=,229	-,1907 p=,448
Action awareness merging	,6721 p=,002*	,5747 p=,013*	,3227 p=,191	,6227 p=,006*	,6447 p=,004*	,6509 p=,003
Clear goals	,1358 p=,591	,1293 p=,609	-,0070 p=,978	-,1352 p=,593	,2460 p=,325	,0782 p=,758
Feedback	-,0170 p=,947	,3754 p=,125	-,0614 p=,809	-,2061 p=,412	-,0252 p=,921	-,0217 p=,932
Concentration	,0379 p=,881	,3533 p=,150	-,0765 p=,763	-,0507 p=,842	-,0991 p=,696	,0021 p=,993
Control	1 p=,000**	,6117 p=,007*	,5166 p=,028*	,6188 p=,006*	,8420 p=,000**	,8023 p=,000
Loss of self consciousness	,1876 p=,456	,5841 p=,011*	-,0416 p=,870	,1888 p=,453	,1843 p=,464	,2183 p=,384
Time	,3982 p=,102	,0403 p=,874	,4572 p=,056	,2150 p=,391	,3746 p=,126	,3667 p=,134
Autotelic experience	,6437 p=,004*	,6398 p=,004*	,3681 p=,133	,5587 p=,016*	,4460 p=,064	,5958 p=,009*
Flow total	,2358 p=,346	,3229 p=,191	-,0163 p=,949	,2938 p=,237	,0794 p=,754	,1922 p=,445

Note: * indicates significant correlation on a level p < .05; ** indicates significant correlation on a level p < .001

Tabell 1. Correlation matrix between J&D index and the nine dimensions of FSS-2 with the 5 factors in SFyQ.