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Influence of transactive memory on perceived performance, job satisfaction and identification in anaesthesia teams

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Background. There is an increasing awareness in the medical community that human factors are involved in effectiveness of anaesthesia teams. Communication and coordination between physicians and nurses seems to play a crucial role in maintaining a good level of performance under time pressure, particularly for anaesthesia teams, who are confronted with uncertainty, rapid changes in the environment, and multi-tasking. The aim of this study was to examine the relationship between a specific form of implicit coordination—the *transactive memory system*—and perceptions of team effectiveness and work attitudes such as job satisfaction and team identification.

Methods. A cross-sectional study was conducted among 193 nurse and physician anaesthetists from eight French public hospitals. The questionnaire included some measures of transactive memory system (coordination, specialization, and credibility components), perception of team effectiveness, and work attitudes (Minnesota Job Satisfaction Questionnaire, team identification scale). The questionnaire was designed to be filled anonymously, asking only biographical data relating to sex, age, status, and tenure.

Results. Hierarchical multiple regression analyses revealed as predicted that transactive memory system predicted members' perceptions of team effectiveness, and also affective outcomes such as job satisfaction and team identification. Moreover, the results demonstrated that transactive memory processes, and especially the coordination component, were a better predictor of teamwork perceptions than socio-demographic (i.e. gender or status) or contextual variables (i.e. tenure and size of team).

Conclusions. These findings provided empirical evidence of the existence of a transactive memory system among real anaesthesia teams, and highlight the need to investigate whether transactive memory is actually linked with objective measures of performance.

Human factors have an important influence in complex group situations, especially in anaesthesia teams.[1] [2] Indeed, some non-technical skills such as leadership,[3] communication, and team coordination[4–6] seem to play a major role in the operating theatre. One of the most important features that emerged in anaesthetists' attitudes towards teamwork and safety was the need to encourage and acknowledge teamwork and information sharing among nurses and physicians.[7] [8] Although it has been noted that it is important for team members to *share knowledge and information*, researchers have pointed out that it is also crucial to *know the division in knowledge and information* among members.[9] Teams made fewer mistakes than do individuals, especially when each team member knows his or her responsibilities, as well as those of other team members.[10] In an in-depth investigation of the coordination practices of a medical trauma centre,[11] Faraj and Xiao have found that expertise coordination practices (e.g. reliance on protocols, community of practice and knowledge sharing) and the presence of a

transactive memory system are needed to manage evolving skill and knowledge interdependencies during treatment of patients. The concept of 'transactive memory' arose from Wegner[12] who described transactive memory as a shared system of encoding, storing, and retrieving information from different domains of knowledge that often develops in close relationships. The basic idea is that familiar individuals develop an implicit system of dividing the information processing responsibility in different domains of knowledge among them based on their shared agreement on the knowledge distribution in the group. In the system, individuals know the locations of expertise, and rely on one another to contribute. Transactive memory reflects a set of processes which enables a team to achieve a better performance than a similar number of isolated individuals by providing it with a larger distributed memory capacity than any single individual possesses. The benefits of transactive memory for collective performance have long been demonstrated in *ad hoc* experimental groups and organizational teams, for a wide variety of tasks such as assembling a radio kit,[13] [14] resolving rule-induction tasks,[15] memorizing verbal material,[16] or more ecological tasks of fulfilling the company objectives.[17] [18]

Despite this notable diversity, no empirical study has yet demonstrated the existence of transactive memory processes in anaesthesia teams. The first objective of this study was to examine whether a transactive memory system affects how anaesthetists and nursing staff perceive team effectiveness. On the basis of previous researches conducted with cross-functional teams in organizational context,[11] [17–19] we expected a positive correlation between transactive memory system and team effectiveness perceived by nurses and anaesthetists staff. The second objective of this study was to examine whether a transactive memory system is also linked with affective outcomes for team members such as job satisfaction and team identification. The results of researches on work attitudes such as job satisfaction are frequently inconsistent, but some studies have demonstrated that when team members fail to distribute necessary information, this creates division between team members and leads to lower levels of satisfaction.[20] Satisfaction will also suffer when team members fail to coordinate their roles and responsibilities towards the completion of the collective task.[21] [22] On the basis of these findings, we expect that transactive memory is likely to increase job satisfaction processes by enhancing the cooperative division of labour and teamwork. We also expect that when group members perceive that they can rely on others to help them if they are experiencing some difficulties, it facilitates shared identities such as identification with team.

Methods

The participants were 193 nurse and physician anaesthetists from eight French public hospitals. The questionnaire was administered by a research assistant during work time.

It was presented as a study about the quality of work in anaesthesia teams. No explicit reference was made about tacit group coordination or sharing knowledge among nurses and physician anaesthetists. When participants completed the questionnaire, they referred to the last team they belonged to a few weeks ago (e.g. 'Think about the work groups to which you currently belong. The items below ask about your relationship with your current team. Answer the following questions, as honestly as possible, using the provided response scales'). The questionnaire was designed to be completed anonymously, and only biographical data relating to sex, age, status, and tenure in the team were requested. Participants were ensured of confidentiality.

Measures

Transactive memory
Transactive memory was measured using the scale developed by Lewis[18] for measuring this process in field studies. This scale contains 15 items designed to assess three dimensions of transactive memory process: specialization, coordination, and credibility.[14] [19] Specialization refers to the acknowledgement of distributed expertise within the team (e.g. 'Different team members are responsible for expertise in different areas'), coordination refers to the ability of the team members to work together efficiently with greater cooperation, less confusion and misunderstandings (e.g. 'Our team worked together in a well-coordinated fashion'), and credibility refers to the degree to which group members trusted one another's task expertise (e.g. 'I was comfortable accepting procedural suggestions from other team members'). Each item was scored on a 5-point Likert-type scale ranging from 1 (*disagree strongly*) to 5 (*agree strongly*). The reliability and validity of this scale was demonstrated with different teams in various contexts and was adapted in French.[23] Cronbach alpha for this study was 0.74 for the global transactive memory scale.

Perceived team effectiveness
Group members were asked to evaluate the quality of their teamwork using a single-item measure ('Estimate the quality of work in our team'). The responses were given on a 10-point Likert-scale ranging from 1 (*very poor*) to 10 (*excellent*).

Job satisfaction
To assess anaesthetists' satisfaction with their work, we used the standard 20-item short form of the Minnesota Job Satisfaction Questionnaire (MSQ).[24] [25] The MSQ is a self-report instrument that measures job satisfaction across 20 different dimensions, with five questions on each dimension. The short-form MSQ consists of 20 items from the long-form MSQ that best represents each of the 20 dimensions. The responses were given on a 5-point Likert-scale

ranging from 1 (*very dissatisfied*) to 5 (*very satisfied*). Cronbach alpha for this scale was 0.88.

Team identification

To measure identification with the team, we adapted the group identification scale developed by Ellemers and colleagues.[26] The scale specifically designed to measure the three core aspects of social identity[27] includes nine items: three items for *awareness* (e.g. 'My team is an important reflection of who I am'), three items for *commitment to the team* (e.g. 'I would like to continue to work with my team'), and three items for *team self-esteem* (e.g. 'I feel my team has little to be proud of'). The responses were given on a 5-point scale ranging from 1 (*disagree strongly*) to 5 (*agree strongly)*. This measure has been repeatedly found to have psychometrically acceptable levels of reliability and validity for measuring group identification[28] and was used in French-speaking environments.[29] In line with such findings, Cronbach's alpha in the present study revealed a good reliability (α=0.87).

High scores on these different scales indicate higher transactive memory system, perceived team effectiveness, job satisfaction, and team identification.

To examine the relationship between different variables measured in the study, Pearson's *P*-correlation coefficient was found. The significance was assumed for a *P*-value of <0.05. The exact level is given in all results. A series of multiple regression analyses were also conducted to examine the specific contribution of transactive memory dimensions on each of the outcome measures (perception of team effectiveness, job satisfaction, and team identification). In each case, the predictors were entered into the equation in two stages. On the first step, status (1= physician anaesthetist, 2=nurse anaesthetist), gender (1=male, 2=female), tenure (continuous variable), and team size (continuous variable) were entered. After accounting for the variance as a result of sociodemographic variables (i.e. gender and status) and working conditions (i.e. tenure in team and size), the three transactive memory dimensions (i.e. coordination, credibility, and specialization) were entered on a second step. For all of these analyses, the Statistical Package for Social Sciences (SPSS 11.5) was used.

Results

There were 77 nurse anaesthetists and 74 physician anaesthetists respondents out of 193 questionnaires administered in hospitals (*n*=151; response rate 78%) (Table 1). We have a typical sample of anaesthesia teams in public French hospitals[30] [31] consisting of predominantly male physician anaesthetists and female nurse anaesthetists, working full-time and reflecting an ageing population of physician anaesthetists.

Table 1 Details of the 151 participating nurse and physician French anaesthetists. All values are *n* (%)

Characteristics	Nurse anaesthetists	Physician anaesthetists
Gender		
Male	32 (41.56)	45 (60.81)
Female	45 (58.44)	29 (39.19)
Age		
<35 yr	17 (22.1)	19 (25.7)
36–45 yr	31 (40.3)	21 (28.4)
46–55 yr	27 (35.1)	21 (28.4)
>56 yr	2 (2.6)	13 (17.6)
Marital status		
Single	20 (26)	12 (16.22)
Married	57 (74)	62 (83.8)
Children		
Yes	62 (80.5)	56 (75.7)
No	15 (19.5)	18 (24.3)
Work time		
Full-time	61 (79.22)	69 (93.24)
Part time	16 (20.78)	5 (6.76)
Tenure in team		
<1 yr	11 (14.29)	20 (27.02)
2–5 yr	33 (42.86)	19 (25.67)
6–10 yr	17 (22.07)	18 (24.32)
>10 yr	16 (20.78)	17 (22.97)

The average team size was 28.31 (range, 5–45; SD=15.44). Anaesthetists had worked in the team for an average of 7.55 yr (range, 0–35 yr; SD=8.0), no statistical difference was observed between nurse and physician anaesthetists.

Intercorrelations

As predicted, the analysis of correlations revealed that the strongest positive correlations were between transactive memory system and perceptions of team effectiveness (*r*=0.48), job satisfaction (*r*=0.43), and identifications with team (*r*=0.55) (Table 2), indicating that higher scores of transactive memory were related with stronger perceptions of teamwork, job satisfaction, and team identification. Of the three components of transactive memory, the specialization component was the only component that was not correlated with perceptions of team effectiveness and members' work attitudes (i.e. job satisfaction and team identification).

The correlations relating to the influence of sociodemographic variables (i.e. gender and status) or other variables related to working conditions (i.e. tenure in team and team size) were small (<0.29) and should be interpreted with caution.[32] Gender was weakly correlated with coordination and specialization components (respectively, *r*=−0.18 and 0.16), indicating that women tended to report lower coordination and higher specialization scores than men. Gender was also negatively and weakly associated with job satisfaction (*r*=−0.18) and team identification (*r*=−0.16), indicating that women tended to report lower job satisfaction and team identification than men.

Table 2 Descriptive statistics and inter-correlations between variables (Pearson's coefficients). Note: $n=151$. *$P<0.05$, **$P<0.01$, two-tailed. (Gender: 1=male, 2=female; status: 1=physician anaesthetist, 2=nurse anaesthetist)

Variables	Mean	SD	1	1a	1b	1c	2	3	4	5	6	7	8
1. Transactive memory	54.68	6.75	—										
a. Coordination	18.39	4.05	0.73**	—									
b. Credibility	17.25	2.16	0.65**	0.41**	—								
c. Specialization	19.03	3.88	0.62**	−0.005	0.15	—							
2. Perceived effectiveness	7.21	1.44	0.48**	0.56**	0.34**	0.06	—						
3. Job satisfaction	3.38	0.54	0.43**	0.45**	0.32**	0.11	0.48**	—					
4. Team identification	4.17	0.66	0.55**	0.54**	0.43**	0.15	0.57**	0.52**	—				
5. Gender			−0.02	−0.18*	−0.02	0.16*	−0.10	−.18*	−0.16*	—			
6. Status			−0.08	−0.13	−0.07	0.03	−0.04	−0.13	−0.07	0.18	—		
7. Tenure	90.63	95.66	0.11	0.09	−0.06	0.13	0.21**	0.18*	0.18*	−0.08	−0.03	—	
8. Size	28.31	15.44	−0.13	−0.06	−0.15	−0.08	−0.08	−0.28**	−0.12	0.10	−0.19*	−0.16*	—

Finally, tenure in the team was weakly positively correlated with perceptions of team effectiveness ($r=0.21$) and work attitudes, indicating that the long-standing team members reported higher level of work quality ($r=0.21$), job satisfaction ($r=0.18$), and identification with team ($r=0.18$). Team size was negatively correlated with job satisfaction ($r=−0.28$), indicating that members of large teams tended to report a lower level of job satisfaction.

Regression analyses

Hierarchical regression analyses were conducted to determine whether transactive memory accounted for significant variance in perceived team effectiveness, job satisfaction, and identification with team after controlling for socio-demographic variables (gender and status) and other variables related to working conditions (tenure and size). Table 3 shows the variables entered on each step, the beta coefficient when entered in the equation (standardized beta), the total variance explained (Adj.R^2), and the additional variance explained at each step (R^2_{change}).

For the measure of perceived team effectiveness, the results yielded a small effect of socio-demographic variables (Step 1) [$F(4, 150)=2.14$, $P=0.056$, Adj.$R^2=0.03$] with only one significant contribution of tenure in team ($\beta=0.20$, $P=0.015$). Entering the effects of each transactive dimension into the regression equation (Step 2) yielded a significant increase in the explained variance

[$F(7, 150)=11.50$, $P<0.0001$, Adj.$R^2=0.33$] with a high contribution of coordination ($\beta=0.49$, $P<0.001$), a small contribution of credibility ($\beta=0.15$, $P=0.053$) and no effect of specialization ($\beta=0.02$, ns).

An identical pattern of results was obtained for job satisfaction and team identification measures (Table 3). The effect of socio-demographic variables (Step 1) were small (Adj.$R^2=0.12$ for job satisfaction and Adj.$R^2=0.04$ for team identification). The introduction of transactive memory components (Step 2) yielded a significant increase in the explained variance ($R^2_{\text{change}}=0.16$ for job satisfaction and $R^2_{\text{change}}=0.31$ for team identification), with a high contribution of coordination ($\beta=0.34$, $P<0.0001$ for job satisfaction and $\beta=0.40$, $P<0.0001$ for team identification), a small contribution of credibility ($\beta=0.14$, $P=0.058$ for job satisfaction and $\beta=0.26$, $P=0.001$ for team identification), and no effect of specialization.

Discussion

This is the first study designed to survey systematically the 'process of division of knowledge and information' among real anaesthesia teams. Specifically, the present study aimed at demonstrating the impact of the transactive memory system on perceived team effectiveness and

Table 3 Multiple regression analysis predicting perceptions of team effectiveness, job satisfaction, and team identification from transactive memory dimensions and control variables (gender, status, tenure, and size of team). Note: *$P<0.05$, **$P<0.01$, ***$P<0.001$

Step	Entered	Perceptions of team effectiveness			Job satisfaction			Team identification		
		Beta	R^2	R^2_{change}	Beta	R^2	R^2_{change}	Beta	R^2	R^2_{change}
1	Gender	−0.07	0.03		−0.11	0.12		−0.13	0.04	
	Status	−0.03			−0.16*			−0.06		
	Tenure	0.20**			0.12			0.15*		
	Size of team	−0.09			−0.28**			−0.09		
2	Coordination	0.49***	0.33	0.30***	0.34***	0.28	0.16**	0.40***	0.35	0.31***
	Credibility	0.15*			0.14*			0.26**		
	Specialization	0.02			0.07			0.11		

anaesthetists' work attitudes such as job satisfaction and team identification.

As expected, the present results suggest that during the operating process, nurse and physician anaesthetists tacitly coordinated their individual efforts to perform the assigned tasks efficiently, and these coordinated practices had a positive impact on perceptions of team effectiveness. Thus, anaesthetists perceived that factors related to teamwork depended on whether team members could *recognize* and *utilize* the knowledge and expertise of its members (i.e. whether the groups developed an effective transactive memory system). Such findings are consistent with previous researches conducted with cross-functional teams in organizational contexts[11] [17–19] and extend data to medical teams. The results also indicated that the transactive memory system predicts anaesthetists' work attitudes. As predicted, transactive memory system positively affects job satisfaction and team identification. When group members sense that they can rely on others to help them if they are experiencing difficulties, they are likely to have increased job satisfaction and shared identities. Such results provided empirical validation of the researches, suggesting that job satisfaction and team identification was affected by the cooperative division of labour and the communication of team knowledge.[21] [22]

These findings also revealed that socio-demographic characteristics (gender or status) of anaesthetists have a weak influence on members' work attitudes and teamwork. More importantly, the effects of socio-demographic variables became small or non-significant when the transactive memory components (i.e. coordination, specialization, and credibility) are introduced into analyses. Thus, it seems that transactive memory system does exist among team members regardless of professional roles or gender. Similarly, working conditions related to size of team and tenure have small effects on the perception of team effectiveness and members' work attitudes.

Overall, the present results provide an empirical evidence with *real* anaesthesia teams that information sharing among nurses and physicians,[7] [8] and especially the presence of a *Transactive Memory System*,[9] [11] [12] is the most important factor contributing to perceptions of teamwork by anaesthetists and nursing staff.

Limitations and future research directions

Despite the interest of the present findings, some limitations need to be emphasized.

First, the nature of the questionnaire data and the cross-sectional design did not allow us to establish causal relationships. Future researches with a longitudinal design in which the development of a transactive memory system would be assessed are needed. Secondly, we used only self-report measures. The magnitude of the effects observed may have been biased because of common method variance and the wish of participants to answer consistently.[33] However, the perception of team effectiveness and work attitudes was not significantly correlated with all transactive memory components and this provides some evidence that common method bias did not systematically influence the observed correlations. The use of different types of scales (i.e. scales differ from their anchors and number of response options) limits the problem of common method variance bias.[34] Nevertheless, we believe that future studies will greatly benefit from including objective measures. The transactive memory system scale used in the present study was developed for use in many occupations and was not specifically designed for anaesthesia. Behavioural observations with medical simulators may be used to measure transactive memory processes. For evaluating team performance, objective indices might be considered such as the number of adverse events in service or the existent taxonomy for examining non-technical skills in anaesthesiology (e.g. the Anaesthetists' Non-Technical Skills taxonomy).[4] [35] [36] Finally, absenteeism or turnover might be used as fruitful indicators of job satisfaction and team identification.

Another limitation concerns the individual-level analysis used. Indeed, the transactive memory system refers to a model of teams as information-processing systems, and, unfortunately, the questionnaire focused on individual perceptions of these processes. However, the small sample size at group level in the present study (i.e. eight teams) has prevented us from using group-level analysis with confidence. Future studies need to consider more anaesthesia teams in order to aggregate individual scores and make a group-level analysis.

A final limitation concerns the mechanisms that might explain the relationship between transactive memory and perceptions of anaesthetic teamwork. Future studies should examine, through regression path analyses, some variables that could mediate this relationship. Some recent researches suggest that the frequency and quality of communication (e.g. openness of communication) between team members[8] might be mediator variables.

In summary, this study is a first attempt at testing empirically the concept of transactive memory system in anaesthesia teams. A number of theoretical and empirical questions are unresolved and replications with large sample are needed. We also need a better understanding of the emergence of coordinated practice and the development of a transactive memory system. Training for anaesthetists is starting to include not only technical skills but also the development of coordinate activities, learning from errors, and recognizing that others can contribute to problem solving.[6–8] It would be interesting in future researches to explore the effects of medical team training programmes and some specific to anaesthesia such as Anaesthesia Crisis Resource Management (ACRM)[37] on the development of a transactive memory system. We also need more objective measures of team performance.

Acknowledgements

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