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How transactive memory systems and reflexivity relate with innovation in healthcare teams

Pedro Marques-Quinteiro[*] / Luís Curral[**] / Ana Passos[***] / Kyle Lewis[****] / Catarina Gomes[*****]

[*] William James Center for Research, ISPA – Instituto Universitário, Lisboa, Portugal; [**] CICPSI, Faculdade de Psicologia, Universidade de Lisboa, Lisboa, Portugal; [***] ISCTE – Instituto Universitário de Lisboa, Lisboa, Portugal; [****] Technology Management Program, University of California Santa Barbara, California, USA; [*****] Centro de Administração e Políticas Públicas, Instituto Superior de Ciências Sociais e Políticas, Universidade de Lisboa, Lisboa, Portugal

Transactive memory systems promote the effective exchange of diverse information, and may therefore contribute to healthcare teams innovation. Prior research on performance outcomes, however, suggests that transactive memory systems might be most useful for repetitive, rather than novel tasks. We reconcile these conflicting predictions by arguing that the information processing efficiencies of a transactive memory system will benefit innovation because transactive memory systems will help team members also reflecting on their processes and goals. We tested our hypotheses in a sample of 256 healthcare nurses (N_{teams}=54). Our findings support prior research showing that reflexivity is positively related to team innovation in teams. Furthermore, we found that reflexivity fully mediates the relationship between transactive memory systems and team innovation. This study contributes to the literature by addressing how team cognitive structures and processes combine to affect innovation. This study makes practical contributions by offering ideas for organizing in healthcare settings.

Key words: Healthcare, Team reflexivity, Transactive memory systems, Team innovation.

There is growing interest in understanding the enabling conditions for team effectiveness in healthcare work environments (Bedwell, Ramsay, & Salas, 2012; Borrill, West, Shapiro, & Rees, 2000; Ortega, Van den Bossche, Sánchez-Manzanares, Rico, & Gil, 2013). Healthcare contexts are complex, often requiring work groups to deliver effective solutions under stressful and changing conditions (West & Wallace, 1991). Of particular interest is understanding how healthcare teams can behave innovatively in response to novel problems that arise in the workplace (Ortega et al., 2013; Tschan et al., 2009; West & Wallace, 1991). Research has shown that individuals whose teams are more innovative in healthcare contexts collaborate better, are more tolerant to a diversity of managerial approaches, and give greater support to the development and implementation of new ideas (West & Wallace, 1991). Research also suggests that team processes

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Correspondence concerning this article should be addressed to: Pedro Marques Quinteiro, William James Center for Research, ISPA – Instituto Universitário, Rua Jardim do Tabaco, 34, 1149-041 Lisboa, Portugal. E-mail: pquinteiro@ispa.pt

such as reflexivity are paramount for innovation in healthcare teams (Schippers, West, & Dawson, 2015). Reflexive teams are more aware of their task environment and share a greater amount of task-relevant information (Carter & West, 1998). A related stream of research on the effects of transactive memory systems on innovation suggests that teams that develop a transactive memory systems might draw upon members' knowledge resources to produce creative outcomes (Gino, Argote, Miron-Spektor, & Todorova, 2010). Such research is scarce, however, and the transactive memory systems – innovation relationship has not to our knowledge been extensively tested with either organizational or healthcare teams.

A transactive memory systems is a shared cognitive system that combines each member's memory system with a shared understanding of which members know, and are responsible for, what knowledge (Moreland, 1999; Wegner, 1987). Team cognition research suggests that by helping teams integrate the diverse knowledge of members, a transactive memory systems may help teams adapt to novel situations (Marques-Quinteiro, Curral, Passos, & Lewis 2013) and develop innovative solutions to complex problems (Gino et al., 2010). Transactive memory systems research also shows, however, that a transactive memory system benefits especially teams performing similar or identical tasks over time (Lewis, Lange, & Gillis, 2005), suggesting that a transactive memory systems may be less helpful when innovative problem solving is required. Motivated by the little attention that transactive memory systems have received in the healthcare literature and by the few studies that present conclusive evidence about the relationship between transactive memory systems and innovation, the objective of this study is to understand the combined influence of reflexivity and transactive memory systems on innovation in healthcare teams. Specifically, we propose that the effects of transactive memory systems on innovation are mediated by the extent to which team members engage in reflexive behaviors. We argue that reflexivity will help the team making better use of the expert knowledge distributed within the team (Lewis, Belliveau, Herndon, & Keller, 2007), and allow team members to innovate. This study contributes to the literature by resolving conflicting predictions about transactive memory systems and innovation and by examining the precursors of innovation in real healthcare teams.

Background and hypotheses

Hospitals are dynamic and fast changing work environments. Healthcare teams have to cope with unpredictability and find effective solutions out of crisis (Ortega et al., 2013; Salas, DiazGranados, Weaver, & King, 2008). Healthcare teams are expected to gather data about patients, accurately diagnose illnesses and injuries, determine necessary procedures, and deliver patient care. Nevertheless it is often the case that clinical standard procedures or hospital policies do not provide the necessary conditions for delivering the best patient outcomes (Donabedian, 2005; West, 2002). Specialized equipment might not be immediately accessible or nearby, or a patient might require a non-routine combination of equipment or technologies. For example, an epileptic patient admitted for cardio-vascular distress would not only need an artificial respiratory system, but also a bed with padded straps and lateral supports in case of an epileptic episode. In this real-life situation, the cardio-vascular nursing team improvised a system of straps and supports using soft bandages, so that the patient did not need to be moved to a specially-equipped bed. This lessened the risk of a life-threatening seizure that might otherwise be caused by moving the patient. Other, more systemic problems (e.g., high wound reinfection rates) also require innovative thinking (e.g., developing new protocols for treating different types of wounds).

Situations such as these challenge healthcare teams to develop and implement innovative solutions. Team innovation can be regarded as the intentional introduction and application within a role, group or organization, of ideas, processes, products or procedures that are new and relevant to the team, and that significantly benefit the team and the systems in which it is embed (West & Farr,

1990). Researchers and practitioners have devoted considerable work identifying predictors of team innovation. For instance, findings point the roles of team size and support for innovation (Curral, Forrester, Dawson, & West, 2001), goal and task interdependence, and job-related diversity (Hülsheger, Anderson, & Salgado, 2009). There is also consistent evidence for the importance of team reflexivity in the prediction of innovation, particularly in healthcare work environments (West & Farr, 1990; West, 2002). Reflexivity is the extent to which team members collectively reflect upon the team's objectives, strategies and processes, as well as their wider organizations and environments, and adapt them accordingly (West & Farr, 1990). Reflexivity incorporates the discussion of *metalevel* concerns and the elaboration of task-relevant information to the team (Pieterse, van Knippenberg, & van Ginkel, 2011). Reflexivity stimulates the discussion of topics that might otherwise be ignored, and helps keep team members continuously updated regarding goal accomplishment, team strategy, and (un)anticipated change (Tjosvold, Tang, & West, 2004). We attempt to replicate research findings linking team reflexivity and innovation by testing the following hypothesis:

Hypothesis 1: Team reflexivity is positively related with team innovation in healthcare teams.

According to Burke, Stagl, Salas, Pierce and Kendal (2006) work teams' characteristics leading to adaptive outcomes such as innovation can be predicted by team level emergent cognitive structures like shared mental models (i.e., team members' shared knowledge structures regarding task, equipment, time or interpersonal relations) and transactive memory systems (DeChurch & Mesmer-Magnus, 2010; Marques-Quinteiro et al., 2013). Burke et al. (2006) further suggest that the ability of a team to deliver adaptive outcomes such as innovation depends on how team processes interact with group emergent cognitive structures such as transactive memory systems.

Transactive memory systems concern how individualized knowledge is combined to influence team processes and team related outcomes (Littlepage, Hollingshead, Drake, & Littlepage; Moreland, 2008). A transactive memory system can develop from team members' experience when training or working together (Lewis, Lange, & Gillis, 2005; Liang, Moreland, & Argote, 1995). When collaborating, team members implicitly divide the cognitive labor for a task such that different members become responsible for learning, remembering, and communicating information from different aspects of the team's task (Marques-Quinteiro et al., 2013). Trusting other team members for certain task-relevant knowledge frees up each member to deepen expertise in a specific area, rather than worry about learning new information that is already possessed by other members. This gives the whole team greater access to a large amount of task-relevant knowledge that can be brought to bear on team tasks (Moreland, 1999).

A transactive memory systems is also theorized to help generate new knowledge, built from the integration of members' knowledge (Wegner, 1987). While the relationship between transactive memory systems and team performance is well established, the relationship between transactive memory systems and innovation is much less so (Ren & Argote, 2011). Team innovation results from collaborative group processes and is sensitive to a team's ability to adequately reflect about the groups' priorities and ways of working (West, 2002). Transactive memory systems have been shown to foster team member communication and collaboration in problem solving (Moreland & Myaskovsky, 2000). A transactive memory systems might not be sufficient, however, for producing team innovation. Indeed, relying on expertize might cause a reduction in team members' participation in decision making and innovative practices (Salas, Rosen, & DiazGranados, 2010). In one of the few studies examining transactive memory systems and creativity, Gino et al. (2010) found that laboratory teams with more developed transactive memory systems produced more creative outcomes, presumably because knowing 'who knows what' helps members envision how different knowledge can be combined in new ways. On the one hand, the processes that are facilitated by a transactive memory systems – knowledge exchange and access to divergent expertise possessed by different members that can be combined and recombined – are likely to

lead to more creative outcomes (Hargadon & Bechky, 2006). On the other hand, the efficiencies that a transactive memory systems produces, in both information exchange and task performance, may be most useful for tasks that are repetitive in nature (Lewis et al., 2005; Liang et al., 1995). Indeed, once a team has developed a transactive memory systems, disruptions to established and otherwise effective routines can be extremely detrimental to team performance (Lewis et al., 2007).

Together, these findings suggest that the relationship between transactive memory systems and innovation may depend on other factors related to the team or team processes. We argue that reflexivity is one such teamwork factor. Given that a transactive memory system produces efficiencies in information exchange, and that innovative solutions to novel problems may be thwarted by having developed a transactive memory systems, it seems that teams would benefit from cognitive activities aimed at pausing and reflecting. Pausing and reflecting on the problem and on members' expertise may help a team overcome the inertial effects of a transactive memory systems by helping members recalibrate how members' expertise might be used and recombined in new ways. In support of this idea, Lewis et al. (2007) found that teams that experienced partial turnover (a type of disruption) were less likely to rely on obsolete transactive memory systems knowledge when old-timers reflected about their own expertise before a newcomer joined the team, and paused to consider how members' knowledge might be combined to respond to novel circumstances. Although we expect that transactive memory systems alone will not significantly predict innovation, we hypothesize that a transactive memory systems in combination with reflexive processes will lead to innovative outcomes:

Hypotheses 2: Transactive memory systems are positively related with team innovation, through team reflexivity.

Method

Participants

Fifty-four healthcare hospital nursing teams (N=256 individuals) from an integrated health care unit in the Portuguese island of Madeira participated in this study. Team membership and team structures were stable among these teams, and work was organized in shifts. Nursing teams in this hospital were responsible for performing such tasks as taking patients' clinical histories, measuring vital signs, verifying heart rate and body temperature, administering medicine, performing cardio-pulmonary resuscitation, preparing patients for surgery, and assisting in all medical interventions (e.g., surgery; checkup visits to patients; clinical analysis). Nursing teams were also expected to deliver social care (e.g., providing emotional support to patients and their families), prepare patients for discharge, and arrange for patients to be transferred to another facility (Silva et al., 2013). The size of the participating teams varied between 3 and 7 members, with an average of 4.98 individuals per team. The age average of team members was 35.89 years (SD=9.26 years) and 78% of the participants were female. On average, participants had 8.89 years of experience working together in the same team, and worked an average of 37.20 hours per week.

Procedure

After contacting the local Hospital Directorate, we presented a detailed description of the study's objectives and how we intended to treat data to the hospital's ethics committee. As soon as we obtained authorization from the hospital's ethics committee, we emailed each department's director

to ask for his/her permission to collect data on site, by inviting nurses to collaborate in the study. Three researchers visited the hospital on five occasions. Data were collected by visiting each sub-unit of the hospital and inviting each member of the in-shift nursing team to complete an anonymous paper and pencil questionnaire. Team members responded to questions regarding transactive memory systems, team reflexivity, and team innovation.

Measures

To evaluate *team reflexivity* we used the team reflexivity scale developed by Swift and West (1998), and adapted by Curral (2005). The scale had 12 items (e.g., "the team often reviews its approach to getting the job done") and participants gave their responses on a 5-point Likert type scale ranging from *totally disagree* (1) to *totally agree* (5). Cronbach α=.82.

Transactive memory systems were measured using Lewis' (2003) transactive memory systems scale, adapted by Marques-Quinteiro et al. (2013). The scale had 15 items (e.g., "each team member has specialized knowledge of some aspect of our project"). Participants gave their answers on a 7-point scale Likert type scale, ranging from *totally disagree* (1) to *totally agree* (7). Cronbach α=.71.

Team innovation was assessed using the work role innovation questionnaire (West, Shackleton, Hardy, & Dawson, 2001), adapted by Curral (2005). The scale had 5 items (e.g., "to what extent did your teams introduce new methodologies to facilitate goal accomplishment?"). Participants gave their responses on a 5-point Likert type scale ranging from *never* (1) to *always* (5). Cronbach α=.94.

As *control measures* we used team size (i.e., the number of individuals in the team; Curral et al., 2001), and team tenure (i.e., the time team members have been working together as a team; LePine, Piccolo, Jackson, Mathieu, & Saul, 2008). While research by Curral et al. (2001) suggests that team size is related to the extent to which teams engage in innovation processes, research by LePine et al. (2008) has shown that previous experience working together can also influence team processes and team outcomes.

Aggregation procedures

In this study we used a composition model to aggregate our variables to the team level (Costa et al., 2013). We followed Chan (1998) recommendations regarding model specifications to assess higher level constructs using composition models. We used a referent-shift consensus model to aggregate data because it allows assessing higher level constructs that are derived, yet different, from the consensus between lower level units (Chan, 1998). To statistically justify the aggregation of variables, values concerning the inter-rater agreement, reliability and consistency were obtained using $r_{wg(j)}$ (James, Demaree, & Wolf, 1984), ICC (1) and ICC (2) (Bliese, 2000), respectively. Aggregation is considered deemed for $r_{wg(j)}$ and ICC (2) when both indexes are ≥.70, whereas ICC (1) values should range be ≥.05, .20≤ (Bliese, 2000; James et al., 1984).

Results

Table 1 provides the means and standard deviations, aggregation indexes, and correlations for the research variables. Team innovation was positively and significantly correlated with team reflexivity, r=.46, p<.001, and transactive memory systems, r=.31, p<.05. Team reflexivity and transactive memory systems were positively and significantly correlated as well, r=.58, p<.001.

Table 1

Descriptives, aggregation indexes, and correlations

	M	*SD*	Rwg	ICC1	ICC2	1	2	3	4
Team tenure	9.02	5.68	-	-	-	1	-	-	-
Team size	4.76	1.04	-	-	-	.20	1	-	-
Transactive memory systems	5.31	.34	.87	-	-	.22	-.08	1	-
Team reflexivity	3.48	.28	.86	.13	.37	.28*	-.08	.58**	1
Team innovation	3.18	.39	.75	.10	.31	.19	-.03	.31*	.46**

Note. **p<.001, *p<.05; N=54 teams; The ICC values for transactive memory systems are not reported since these could not be computed, $F(53,202)=.986$, $p=.51$.

Regarding aggregation indexes, the inter-rater agreement index for transactive memory systems, $r_{wg(j)}=.87$, team reflexivity, $r_{wg(j)}=.86$, and team innovation, $r_{wg(j)}=.75$, was satisfactory hence suggesting enough within team agreement to consider participating teams as *real* teams (James et al., 1984). The ICC1 values for team reflexivity and team innovation suggest that team members' responses regarding both variables were more similar within teams, than between teams. Although the ICC2 values were below the recommended threshold, such values can still be accepted (Bliese, 2000). Additionally, since the $r_{wg(j)}$ and ICC1 indexes were within standards aggregation was deemed as possible. Regarding transactive memory systems, the absence of a significant F value, $F(53,202)=0.99$, $p=.509$, unable us to estimate both ICC1 and ICC2 values. The absence of a significant difference between team members' ratings of transactive memory systems suggests that these teams were homogenous in regard to their transactive memory system. Thinking in terms of transactive memory systems theory (e.g., Lewis, 2003; Wegner, 1987), this finding is not surprising since the work that healthcare nurse teams do requires them to know exactly which colleague is an expert on what topic and to be capable of using that unique knowledge. Additionally, on average, team members had nine years of experience working together which is enough to allow transactive memory systems to mature (Wegner, 1987). Therefore, relying on the $r_{wg(j)}$ index only, we decided to aggregate individual team members estimations of their team's transactive memory systems to the team level.

Table 2

Hypotheses testing results

Effect of transactive memory systems on team reflexivity, $R^2=.36$, $MSE=.05$, $F(3,50)=9.45$, $p<.001$						
					95% CC	
	B	*SE*	*t*	*p*	LL	UL
Constant	1.10	.55	1.99	.05	-0.078	2.206
Transactive memory systems	.45	.10	4.57	.00	.252	.648
Team size	-.02	.03	-.57	.57	-0.082	.046
Team tenure	.01	.01	1.48	.15	-0.003	.021
Effect of transactive memory systems and team reflexivity on team innovation, $R^2=.22$, $MSE=.13$, $F(4,49)=3.49$, $p=.014$						
					95% CC	
	B	*SE*	*t*	*p*	LL	UL
Constant	.84	.88	.95	.35	-0.941	2.615
Transactive memory systems	.06	.18	.36	.72	-0.299	0.429
Team reflexivity	.57	.22	2.61	.01	0.130	1.008
Team size	-.005	.05	-.10	.92	-0.103	0.094
Team tenure	.005	.009	.52	.61	-0.014	0.024
Effect of transactive memory systems on team innovation through team reflexivity						
					95% CC	
	B	*SE*			LL	UL
Team reflexivity.	.26	.12			0.066	0.548

Note. N=54 teams; Bootstrap=5000 samples.

To test the research hypotheses, we used PROCESS, which is a computational tool to analyze "mediation process models" that are path analysis based (Hayes, 2013). PROCESS estimates the coefficients of a model using OLS regression (for continuous outcomes) and allows the estimation of the mediation effects using bootstrap analysis.

Our findings suggest that team reflexivity is related with team innovation, B=.57, *SE*=.22, *t*=2.61, *p*=.01, 95% CI [0.130, 1.008]. This finding supports hypotheses 1 and replicates previous research in the teamwork literature (e.g., West & Farr, 1990). The results also suggest that transactive memory systems are positively related with team reflexivity, B=.45, *SE*=.10, *t*=4.57, *p*<.001, 95% CI [0.252, 0.648], and that the relationship between TMS and team innovation is fully mediated by team reflexivity, B=.26, SE=.12, 95% CI [0.066, 0.548]. These results support hypotheses 2.

Discussion

Understanding team work dynamics in healthcare is fundamental for identifying the drivers and inhibitors of patient quality care service (Donabedian, 2005). This study contributes to reinforce previous research regarding the relationship between reflexivity and innovation in teams. Indeed, the results suggest that reflexivity positively predicts team ratings of innovation, thus replicating previous studies showing that team reflexivity is important to understanding team innovation in healthcare (e.g., West, 2002).

Moreover, in examining how transactive memory systems and reflexivity relate to predict team innovation, this study contributes to the innovation literature by bridging team process and team cognition research. Our findings highlight the importance of transactive memory systems in helping to understand team innovation in healthcare. Our findings suggest that the relationship between transactive memory systems and team innovation exists because transactive memory systems help team members engaging in reflexive action. Specifically, the fact that team members are well aware of the distribution of expert knowledge within the team and are capable of using such knowledge seems to help team members reflecting, and such reflection positively contributes to team innovation. Additionally, our findings suggest no direct influence of transactive memory systems on innovation. This reinforces the importance of team reflexive strategies to help transferring collective knowledge structures into day-to-day, innovation related behaviors.

These results also find explanation in previous research by van Ginkel, Tindale, and van Knippenberg (2009) suggesting that a constructive dissent strategy such as the one implicit in reflexivity, may elicit new information necessary for a novel solution. According to van Ginkel et al. (2009), team reflection has a stronger effect on group members' task representations and group information elaboration in groups whose members hold different task representations (or information). Having access to diverse knowledge such as the one in a transactive memory systems is likely to facilitate the elaboration of information to produce creative ideas (Hargadon & Bechky 2006). However, delivering innovation is far more complex than simply having a creative idea (West, 2002). For instance, when a group of experts debates about clinical procedures to diagnose cancer, it might happen that an idea for a new procedure emerges from the debate. This emergence might be facilitated by the fact that this group of experts holds a well-developed transactive memory systems. However, the creative idea alone is not innovative in the sense that it was not tested or implemented. As previously stated, innovation incorporates both the creation and implementation of ideas (and not the idea alone) (West, 2002). The implementation of ideas is a rather complex process as individuals and teams are often challenged with obstacles that prevent them to pursuit the innovative goal (e.g., organizational resistance; lack of resources). Whereas

transactive memory systems imply the identification and allocation of expert knowledge, reflexivity emphasizes the decision processes used to determine whether that knowledge is useful and how it can the used. Additionally, reflexivity allows teams to identify alternative ways to implement new solutions, thus making reflexivity a necessary requisite for team innovation.

Theoretical and practical implications

There has been little attention given to how team cognitive structures such as transactive memory systems explain team innovation. Whether transactive memory systems and reflexivity relate to predict team innovation has been equally neglected. This study addresses these gaps by examining how transactive memory systems predict team innovation, through the level of reflexivity in healthcare nursing teams. Importantly, the current study validates this finding in organizational, rather than laboratory teams.

Despite the fact this study was done within a specific work environment (i.e., healthcare hospital), and with a particular sample (i.e., nurses) our findings can be generalized to other teams operating in a variety of work environments. Indeed, organizations whose work teams perform complex tasks can benefit from developing transactive memory systems and learning about how to implement effective reflexive processes. Both might be accomplished with team-based training on team reflexivity, which will not only help members develop reflexivity processes but also help create the structures and processes necessary to transactive memory systems development (Liang et al., 1995).

Limitations and future research directions

One limitation of this study is its cross-sectional design. Although cross-sectional research is useful for examining the relationships between constructs it gives a limited understanding of how the variables of interest influence each other over time or across levels of analysis. Another limitation it's the fact that responses derived from the same informants, and all data were collected through self-report questionnaires.

Future research should extend these findings within a longitudinal framework by dynamically examining the conditions under which reflexivity and transactive memory systems interact over time. Indeed literature has provided research supporting that team processes and cognitions influence each other over time (Santos & Passos, 2013). Using a longitudinal approach, researchers could examine which factors trigger work teams to engage in reflexive behavior and which factors trigger the use of transactive memory systems, and how does this combine to influence team innovation over time.

General conclusion

The study of team work innovation in healthcare is paramount to identify the key psychological factors that foster ongoing quality care. Understanding the interactive dynamics between team processes and cognition is important for healthcare professionals and managers to think and design the enabling conditions for reflexive action. Furthermore, facilitating expert location awareness can contribute to the mitigation of healthcare problems that happen when teams lack the time, or conditions, to think about what they are doing and how to develop innovative solutions.

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Como os sistemas de memória transitiva e a reflexividade se relacionam com a inovação em equipas hospitalares

Os sistemas de memória transitiva promovem a troca eficiente de informação, contribuindo para a inovação das equipas hospitalares. Estudos anteriores sugerem que os sistemas de memória transitiva podem ser mais úteis para tarefas repetitivas. Neste estudo, conciliamos estes resultados contraditórios argumentando que as eficiências de processamento dos sistemas de memória transitiva beneficiarão a inovação, porque os sistemas de memória transitiva ajudarão os membros da equipa a refletirem sobre os seus processos e metas. A amostra deste estudo incluiu 256 enfermeiros hospitalares (*N*=54 equipas). Os resultados sugerem que a reflexividade medeia positivamente a relação entre os sistemas de memória transitiva e a inovação das equipas. Este estudo contribui para a literatura ao clarificar de que forma é que as estruturas e processos cognitivos das equipas se combinam para influenciar a inovação das equipas hospitalares; e para a prática ao oferecer ideias para a gestão de equipas em ambiente hospitalar.

Palavras-chave: Hospitais, Inovação da equipa, Reflexividade da equipa, Sistemas de memória transitiva.

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