Movement competence: Association with physical self-efficacy and physical activity

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ABSTRACT

Background: The purpose of this paper was to investigate whether physical self-efficacy mediates the relationship between movement competence (fundamental movement skills and perceived movement skill competence) and physical activity in children.

Methods: A purposive sample of 860 children (47.7% female, 10.9 ± 1.16 years) were recruited and completed assessments for physical self-efficacy (Physical Activity Self-Efficacy Scale), fundamental movement skills (Test of Gross Motor Development-3), perceived movement skill competence (Pictorial Scale of Perceived Movement Skill Competence), and physical activity (PACE+). A bootstrap mediation analysis was employed using movement competence as the predictor variable and physical activity as the outcome variable, and physical self-efficacy as the potential mediator of the relationship.

Results: The results from a bootstrap mediation analysis yielded a statistically significant mediation effect for physical self-efficacy, with the entire model explaining approximately 10.3% of the variance of physical activity. The indirect effect of perceived movement skill competence through physical self-efficacy was significantly larger than the indirect effect of fundamental movement skills through physical self-efficacy. Neither sex nor age acted as a covariate.

Conclusion: Movement competence (fundamental movement skills and perceived movement skill competence) acts as a source of information for children's physical self-efficacy, moreover physical self-efficacy mediates the movement competence – PA relationship. Findings highlight the need for interventions to target and improve movement competence as a whole for children.

1. Introduction

Regular physical activity (PA) is beneficial to the maintenance of good physical and psychological health (Cortis et al., 2017). Research has enhanced the understanding of correlates and determinants for PA, such as physical self-efficacy (PSE) (Mcauley & Blissmer, 2000) and movement competence (Barnett, Morgan, Van Beurden, Ball, & Lubans, 2011; Lubans, Morgan, Cliff, Barnett, & Okely, 2010). Yet, across the life-course people are not participating in enough PA to actually maintain good health (Andersen et al., 2016; Bauman et al., 2012).

A consistent correlate of PA for children is PSE (Bauman et al., 2012; Mcauley & Blissmer, 2000; Sallis, Prochaska, & Taylor, 2000). PSE is a key construct in social-cognitive theory (SCT), and is defined as belief in one's competency to complete a task in differing contexts (Bandura, 1982). PSE encompasses a personal assessment of one's competency to carry out PA (Annesi, 2006). According to Bandura (2004), PSE is central to the decision-making process to participate in PA. PSE levels are thought to determine how obstacles are viewed, with highly efficacious individuals perceiving barriers to PA as conquerable through increased effort (Bandura, 2004). Such traits have been found to be one of the strongest positive associations with PA for children (Van Der Horst,
Targeting PSE is an efficient approach, as promotion of PSE has been repeatedly shown to predict PA. Yet, regarding how to improve the psychological construct is still a knowledge gap. Moreover, knowing what sources of information are helping to explain the PSE – PA relationship is paramount (Bauman et al., 2012; Williams & French, 2011). Bandura (1977) proposed that self-efficacy is the consequence of four sources of information: enactive mastery experience, vicarious experience, verbal persuasion, and physiological arousal. Enactive mastery experience refers to competence of a behaviour/perception of competency, which ought to boost PSE (Bandura, 1977). Vicarious experience refers to observing a peer/role model performing physical activity, such an observation can generate a belief that an individual can also perform PA. Verbal persuasion is where others convey belief in the individual’s capabilities, although verbal influence is aimed mainly at raising outcome expectations rather than at enhancing self-efficacy. Physiological arousal, depending on the circumstances, might have informative value concerning ability to perform, although there is very little research into the impact of arousal on one’s PSE. Of these four sources of information, enactive mastery experience has been identified to produce the highest levels of self-efficacy (Ashford, Edmunds, & French, 2010). While there is previous research highlighting enactive mastery experience as a source of information that increases PSE, there still remains an insufficient understanding of what focus the source of information should be, with no research investigating movement competence as a potential explaining source of information for PSE (Ashford et al., 2010).

Bandura (1986) indicated that self-efficacy will only determine a behaviour when the necessary skills are in place. Fundamental movement skills (FMS) are stated to be necessary to children’s psychological and physical development, with studies beginning to show a causal relationship between FMS and PA (Barnett et al., 2011). FMS consists of object control skills that require efficient throwing, striking, and catching movements (e.g. Catch – the ability to catch a ball that has been tossed underhand), and locomotor skills that require fluid coordination movements of the body as the individual moves in one direction or another (e.g. Run – the ability to advance steadily by springing steps so that both feet leave the ground for an instant with each stride) (Logan et al., 2018; Ulrich, 2017). These movement skills are the building blocks of more complex movements required to participate in games, sports or other context specific PA (Logan et al., 2018). A relationship between FMS and PA has been established, and as such FMS can be considered key for developing physically active individuals. There is, however, more at play than just FMS directly explaining PA levels. Prior research has demonstrated that there are psychological components that support development of a physically active lifestyle, with literature highlighting that FMS has a positive relationship with such factors (Bardid et al., 2016). Therefore, it seems pertinent to understand if FMS are not only the building blocks to movement and PA but are the sources of information for psychological determinants that support children in developing and maintaining a physically active life, such as PSE.

Although competence of a behaviour can raise self-efficacy, the extent to which people enhance their efficacy also depends on perception of competence (Ashford et al., 2010; Bandura, 1977). Perceived movement skill competence (PMSC) is an individual’s perception of their basic capability of carrying out a skill (e.g. running or kicking a ball). In this regard, PMSC is considered important as it has been found to have a relationship with PA, and as children mature into adulthood it has been shown to drive confidence to try new physical activities (Barnett et al., 2011; Barnett, Morgan, van Beurden, & Beard, 2008; Bauman et al., 2012; Lubans et al., 2010). Considering this from a SCT framework, while an individual may objectively be competent in completing a skill, their perception of their competency to complete the skill is also helping explain one’s belief to participate and engage in PA (Annesi, 2006; Bandura, 1982).

The theory that more skilful children may increase their time in PA and persist with activities is congruent with PSE (Bandura, 2004). Moreover, Bandura (1986) indicates that self-efficacy will only determine a behaviour when the necessary skills are in place. When considering competence of movement skills, perception and competence are inextricably linked dimensions of our movement experience (Cairney, Clark, Dudley, & Kriellaars, 2019; Cairney, Dudley, Kwan, Bulten, & Kriellaars, 2019; Giblin, Collins, & Button, 2014). Therefore, this study looks at incorporating PMSC alongside FMS in an effort to capture movement experience and determine how this might contribute to PSE. With this in mind, this study will identify if the process that underlies the relationship between movement competence and PA is via the inclusion of PSE. Rather than a direct relationship between movement competence and PA, the study proposes that movement competence will influence PSE, which in turn will influence PA. Thus, does PSE serve to clarify the nature of the relationship between movement and PA.

2. Methods

2.1. Sample

Cross-sectional data were collected as part of a larger study entitled the ‘Moving Well-Being Well’ (MWBW) programme. Support in identifying schools was provided by gatekeepers (coaches) who were involved in the schools. The coaches were asked to recommend schools, after being provided with a purposive sampling criterion based on the Delivering Equality of Opportunity in Schools action plan for educational inclusion (Department of Education and Skills, 2017). Thirty schools were approached, and all consented to participate. Children from third to sixth class were invited to participate; 1053 children from a possible 1104 volunteered, after participants with missing data were removed the final sample consisted of 860 children (47.7% female, 10.9 ± 1.16 years). Children completed assent forms, meanwhile parents signed informed consent forms to confirm they understood the purpose of the research and participation rights (e.g., voluntary participation, right of withdrawal, and confidentiality of the data). Data collection took place from February 2017 to June 2017. Ethical approval was granted by the Dublin City University Research Ethics Committee (DCUREC/2017/029).
2.2. Procedures and materials

A ratio of 1 researcher to 5 children was employed for all measures. The questionnaire was completed on tablets (8” display; The Alcatel PIXI 3) via ‘Survey Anyplace’ in class. Children were encouraged to take their time, reflect on their answers, and to be as honest as possible. Children were provided with a definition (PA is any activity that increases your heart rate and makes you get out of breath some of the time) and examples of common physical activities. To measure physical activity, children completed the PACE (Prochaska, Sallis, & Long, 2001), a validated and reliable measure for this age (Murphy, Rowe, Belton, & Woods, 2015). The first item asked them to report the number of days (0–7) they were physically active for at least 60 min per day in the past seven days. The second item asked the same question with respect to a typical or usual week. An average value of the two items yielded a score of days per week that participants accumulated 60 min of moderate-to-vigorous physical activity (MVPA). Spearman correlations between self-reported PA levels and accelerometer derived minutes of MVPA per day are small ($r = 0.27$; seven valid days). This low correlation is consistent with findings in the literature (Dumith, Gigante, Domingues, & Kohl, 2011). Test-retest reliability has been conducted on the instrument, where it was found to have acceptable reliability with intraclass correlation coefficients (ICC) ranging from 0.6 to 0.8 (Vuori et al., 2005).

To assess barriers, support seeking and positive alternatives in PA, a modified version of the original Physical Activity Self-Efficacy Scale (PASES) (Mullan, Markland, & Ingledew, 1997) was used. Originally developed as a three-factor model, the PASES has been adapted for primary school children into an 8-item single factor scale (Bartholomew, Loukas, Jowers, & Allua, 2006) and is consistent with self-efficacy definitions (Bandura, 1977, 1982, 1997), having shown good psychometric properties in children (Bartholomew et al., 2006). An example item of the PASES is: “I have the skills I need to be physically active”. Items were scored using a 3-point likert-type scale with “No” (0), “Not Sure” (1), and “Yes” (2) as the three choices. Cronbach’s alpha coefficient for PASES was good ($\alpha = 0.88$).

The pictorial scale of PMSC for young children aligned with the Test of Gross Motor Development-3 (TGMD-3) was administered (Barnett, Ridgers, Zask, & Salmon, 2015; Ulrich, 2017). The pictorial scale of PMSC assesses six locomotor (run, gallop, hop, skip, horizontal jump, and slide) and seven object competency skills (two-hand strike of a stationary ball, one-hand stationary dribble, kick, two-hand catch, overhand throw, forehead strike of a self-bounced ball, and underhand roll), based on the TGMD-3. Administration of the pictorial scale of PMSC replicated the process of Barnett et al. (2015), where an extensive protocol is provided. To summarise, skills on the pictorial scale of PMSC were arranged in an order so that a cartoon picture of a child depicting a skill competently was opposite to an image of a child depicting a skill not so competently. Children either pick a cartoon portraying a child who is competent at a skill or the cartoon portraying a child who is not so competent at a skill. If children select the competent cartoon they are asked: ‘are you really good at …’ (score of four) or ‘pretty good at …’ (score of three), if children pick the not so competent cartoon, they are asked: are you ‘not that good at (score of one) or sort of good at …’(score of two). The result is a four-point Likert scale response variable (range 1–4). The test-retest, internal reliability, face validity (Barnett et al., 2015) and construct validity (Barnett et al., 2016) of the pictorial scale of PMSC has previously been established. Cronbach’s alpha coefficient for PMSC was good ($\alpha = 0.70$). Some of the skills required further description beyond the visual picture provided. For instance, during development of the PMSC children previously requested a demonstration of the gallop and the slide (Barnett et al., 2015), thus to remain consistent all children in this study were provided with a physical demonstration of the skills by a trained researcher.

Once the questionnaire was completed FMS were assessed using the TGMD-3 (Ulrich, 2017), the TGMD-3 evaluates FMS of typically developing children between 3 and 11 years of age. With consideration of developmental ability incorporated into the scoring and interpretation. The TGMD-3 assesses 13 fundamental movement skills, subdivided into two subscales: Locomotor competency and object control competency. This is a direct observation, process-oriented skill assessment looking at 3–6 performance criteria per skill that reflect the most mature movement pattern, with consideration of developmental ability incorporated into the scoring and interpretation. The subtest scores were then summed to give an overall gross motor quotient (GMQ) score (maximum possible score = 100). The TGMD-3 has been shown to be a valid and reliable tool when measuring children’s FMS (Ulrich, 2017). Prior to motor skill competency assessment, a data set was pre-coded by the lead researcher with researchers’ blind to the conditions of coding. Inter-rater and intra-rater reliability of the TGMD-3 were assessed using the ICC and corresponding 95% confidence intervals. Researchers ($n = 22$) were required to reach a minimum of 90% intra-rater, and 95% inter-rater agreement for all of the skills, such results are similar to percent agreement in reliability assessments of the TGMD-3 (Rintala, Sääkslahti, & Iivonen, 2017). Furthermore, the ICC reliability coefficients demonstrated excellent level of significance for inter-rater 0.91, 95% CI (0.80, 0.96) and intra-rater 0.95, 95% CI (0.84, 0.98).

Participants performed the skill on 3 occasions: 1 familiarisation practice and 2 performance trials (Ulrich, 2017). Assessment of the TGMD-3 repeated Behan and colleagues (Behan, Belton, Peers, O’Connor, & Issartel, 2019), where an extensive protocol is provided.

2.3. Statistical analysis

Means, standard deviations and bivariate correlations were calculated for all variables. Statistical analyses were conducted using IBM SPSS Statistics 24.0 software and the macro PROCESS; significance threshold was set at 0.01. PROCESS is a logistic regression path analysis modelling tool for SPSS used for estimating direct and indirect effects in single and multiple mediator models. Mediation is when the strength of the relationship between two variables is reduced by involving another variable.

This approach tests the indirect effects of mediators and uses bootstrapping to estimate 95% bias corrected unstandardized confidence intervals (CI). First, the mediating assumption was tested by assessing the separate pathways a) the direct relationship...
between FMS and PA, by excluding PSE and PMSC, b) the direct relationship between PMSC and PA, by excluding PSE and FMS, c) The direct relationship between movement competence and PA, by excluding PSE, c) the first pathways in mediation by using PSE as the dependent variable, and d) the second pathway in mediation by using PSE as the predictor variable and self-reported PA as the dependent variable. Finally, PROCESS was used to test the full model that incorporates the direct relationship between movement competence and self-reported PA, plus the indirect relationship: PSE mediating between the movement competence – PA relationship (Hayes, 2013). Sex and age were entered into the model as a covariate.

3. Results

Table 1 provides descriptive statistics and correlations of the variables. Self-reported PA was significantly (p < .01) and positively associated with PSE, FMS, and PMSC. All assumptions were met with FMS having a direct positive relationship with self-reported PA ($R^2 = 0.03$, p < .001) and PSE ($R^2 = 0.05$, p < .001). Additionally, PMSC to self-reported PA ($R^2 = 0.06$, p < .001) and PSE ($R^2 = 0.09$, p < .001) met assumptions with direct positive relationships. Also, FMS and PMSC (movement competence) in the same model had a direct positive relationship with PSE ($R^2 = 0.12$, p < .001) and self-reported PA ($R^2 = 0.07$, p < .001). Thus, a model to test whether PSE mediates the relationship between movement competence and self-reported PA was justified.

There was a significant indirect effect of FMS on self-reported PA through PSE, $b = 0.008$, 99% BCa CI [0.004, 0.013], with the individual direct relationship from FMS to self-reported PA explaining 3% of the variance ($R^2 = 0.03$). Meanwhile, there was a significant individual indirect effect of PMSC on self-reported PA through PSE, $b = 0.018$, 99% BCa CI [0.010, 0.030], with the individual direct relationship from PMSC to self-reported PA explaining 6% of the variance ($R^2 = 0.06$). In the overall model, the three direct pathways to PA were significant (Table 2). Neither sex, $b = −0.13$, 99% BCa CI [−0.416, 0.155], or age, $b = 0.04$, 99% BCa CI [−0.050, 0.136], were found to be a statistically significant covariates and thus were removed in the final model. Also, there was a significant indirect effect of movement competence (FMS and PMSC) on self-reported PA through PSE, $b = 0.015$, 99% BCa CI [0.007, 0.025]. The direct relationship from movement competence to self-reported PA explained 7% of the variance ($R^2 = 0.07$). PSE as a mediating variable helped to explain 10% of variance of overall self-reported PA ($R^2 = 0.10$) as demonstrated in Fig. 1.

Breakdown of the model showed the direct effect between movement competence and PSE was stronger than the direct effect between movement competence and self-reported PA. Additionally, the direct effect between FMS and PSE was stronger than the direct effect between FMS and self-reported PA. Similarly, the direct effect between PMSC and PSE was stronger than the direct effect between PMSC and self-reported PA.

4. Discussion

This is the first study to demonstrate that PSE mediates the movement competence – PA relationship. The model explained 10% of the variance, such results reflect previous studies in the PSE (Annesi, 2006) and movement domains (Holfelder & Schott, 2014). The direct relationship between movement competence and PA is weak, yet PSE is significantly impacting the movement competence – PA relationship. Moreover, the direct relationship between movement competence and PSE is stronger than the movement competence – PA relationship. This article has taken the first steps in acknowledging that for children there are mediating sources of information that help to explain the movement competence – PA relationship. This can be via enactive mastery experience such as FMS or PMSC. The current study, from a movement paradigm, has applied Bandura’s (1986) theory that self-efficacy will only.

### Table 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physical Self-Efficacy (0–2 scale)</td>
<td>1.66</td>
<td>0.28</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2. Self-Reported PA (0–7 days)</td>
<td>4.83</td>
<td>1.68</td>
<td>0.26$^{**}$</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>3. Fundamental Movement Skills (0–100 scale)</td>
<td>78.73</td>
<td>11.10</td>
<td>0.23$^{**}$</td>
<td>0.17$^{**}$</td>
<td>–</td>
</tr>
<tr>
<td>4. Perceived Movement Skill Competence (1–4 scale)</td>
<td>50.85</td>
<td>5.82</td>
<td>0.31$^{**}$</td>
<td>0.24$^{**}$</td>
<td>0.29$^{**}$</td>
</tr>
</tbody>
</table>

$^{**}$ Correlation is significant at the 0.01 level (2-tailed).

### Table 2

<table>
<thead>
<tr>
<th>Overall Model</th>
<th>Direct $\beta$</th>
<th>Direct b</th>
<th>LLCI</th>
<th>ULCI</th>
<th>Indirect $\beta$</th>
<th>Indirect b</th>
<th>LLCI</th>
<th>ULCI</th>
<th>Total $\beta$</th>
<th>Total b</th>
<th>LLCI</th>
<th>ULCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fundamental Movement Skills</td>
<td>0.016$^{**}$</td>
<td>0.045</td>
<td>0.019</td>
<td>0.071</td>
<td>0.05$^{**}$</td>
<td>0.015</td>
<td>0.007</td>
<td>0.025</td>
<td>0.21$^{**}$</td>
<td>0.059</td>
<td>0.034</td>
<td>0.085</td>
</tr>
<tr>
<td>Physical Self-Efficacy</td>
<td>0.03$^{**}$</td>
<td>0.018</td>
<td>0.005</td>
<td>0.031</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0.08$^{**}$</td>
<td>0.026</td>
<td>0.013</td>
<td>0.039</td>
</tr>
<tr>
<td>Perceived Movement Skill Competence</td>
<td>0.06$^{**}$</td>
<td>0.050</td>
<td>0.025</td>
<td>0.076</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0.10$^{**}$</td>
<td>0.070</td>
<td>0.044</td>
<td>0.093</td>
</tr>
</tbody>
</table>

**Abbreviations:** $\beta = \text{Beta – standardised coefficients}$; b = $\text{Beta – unstandardized coefficients}$; LLCI & ULCI = lower & upper levels for confidence interval. 

Note: The confidence interval for the indirect effect is a BCa bootstrapped CI based on 10,000 samples

- $^* p < .05$.
- $^{**} p < .001$. 

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determine a behaviour when the necessary skills are in place, with results indicating that movement competence’s determination of PA is partially explained by movement competence’s determination of PSE.

In fact, when breaking down movement competence, the direct effect of PMSC and the indirect effect through PSE is significantly larger than FMS. These findings support past research in that PMSC is playing a critical role in increasing PA, even more critical than FMS (Bardid et al., 2016), underlining that children need to perceive competence in order to be efficacious to carry out PA in differing circumstances. The current research is compatible with similar work that has analysed the contribution of FMS and PMSC on autonomous motivation (Bardid et al., 2016). Bardid et al. (2016) point out that the ‘underestimation’ of competence is unfavourable, with low PMSC having a negative impact on children’s autonomous PA motivation regardless of FMS ability. This study furthers the advocacy of PMSC, by suggesting that children’s perception of competence in their movement is the greater explanation for confidence to interact with peers in physical activities or choosing to be physically active over sedentary behaviours, key tenets of PSE.

Although PMSC is important individually, it is important to consider movement competence as a whole construct; it seems reasonable to consider that FMS competency and perception of FMS competency is contributing to determinants of participation in PA. As research assesses FMS and PMSC together and their explanation of determinants of PA it will allow for intervention design and evaluation to take into consideration how fostering and assessing more than just FMS is important. This research highlights FMS is an important foundation to build upon, but other key components such as PMSC are helping promote children’s confidence that they can be physically active. Accuracy of children’s PMSC is proposed to increase with age and cognitive development, this leads to them drawing upon past experiences of skill difficulty and social comparisons, these perceptions reinforce interactions in PA setting (Bolger, Bolger, O’neill, & Coughlan, 2018). The direct relationship with PSE highlights the importance of movement competence as a whole construct. Thus, interventions need to focus on not only the physical building blocks required to participate in games, but for children to receive feedback, directions and encouragement regarding their movement that will develop their ‘belief building blocks’ to participate.

This study is not without limitations. For instance, when using self-report measures of PA children can have problems identifying frequency, duration, and intensity of PA, as well as response bias which usually leads to overestimation of physical activity (Hidding, Chinapaw, van Poppel, Mokkink, & Altenburg, 2018; J. Sallis & Saelens, 2000). Although, the PACE+ has strong percentage of agreement with accelerometers (Hidding et al., 2018; Murphy et al., 2015), plus self-report avoids the increased costs and the logistics of fitting accelerometers to a large sample of children. The large sample size and the use of validated and tested FMS, PMSC, and PSE measures add to the strength of this study. There are many studies demonstrating that movement and perception of movement are significant variables linked to PA engagement (Bolger et al., 2018; Famelia, Tsuda, Bakhtiar, & Goodway, 2018; Pesce, Masci, Marchetti, Vannozzi, & Schmidt, 2018). The relationship between movement and the psychological benefits, however, have remained uncertain. Clearing these uncertainties will advance evidence on the benefits associated with movement (Laibans et al., 2010). Similar to the relationship between PMSC, FMS, and motivation for PA (Bardid et al., 2016), the main strength of this work is the inclusion of PSE from a movement paradigm, as there is a lack of certainty between movement variables and this important determinant of PA.

5. Conclusion

This research among primary school children revealed that both FMS and PMSC act as sources of information for PSE, that mediates the movement competence – PA relationship. In addition, the results showed the direct and indirect effect of PMSC through PSE is significantly larger than the effect of FMS. These findings emphasise that fostering children’s PMSC is just as crucial to improving their PSE and PA. As Bardid et al. (2016) found targeting movement competence as a whole improves motivation toward PA, this study also champions movement competence as a form of enactive mastery experience when trying to nurture PSE. Application of results from previous research and the current study can help build perspectives of how to inform future interventions in
terms of goals and instructional approach. Additionally, future movement skill research should consider FMS and PMSC’s position when contributing to the dynamic relationship between the various components of an individual which support them in developing and maintaining a physically active life.

Authors’ note

The Moving Well-Being Well project was financially supported by the Insight Centre for Data Analytics; The Gaelic Athletic Association; and the Dublin County Board of the Gaelic Athletic Association. This publication has emanated from research supported in part by a research grant from Science Foundation Ireland (SFI) under Grant Number SFI/12/RC/2289, co-funded by the European Regional Development Fund, with assistance from the GAA’s Research and Games Development department and Dublin GAA. We gratefully acknowledge the cooperation of the participating children, their parents, and teachers. The first author also wishes to thank the trained researcher (Stephen Behan) for his majestic physical demonstration of skills.

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