

## **Errorless strategy teaching for the sports skills learning. A systematic review**

### **Estrategia de enseñanza sin errores para el aprendizaje de las habilidades deportivas.**

#### **Una revisión sistemática**

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### **Abstract**

The objective of the study is to systematically review and evaluate the literature related to the effectiveness of the teaching strategy without errors for the teaching of sports skills, in order to know whether making mistakes benefits or impairs learning and / or performance. During the search process Web of Science, Scopus, SportDiscus With Full Text and PsycInfo databases were consulted along with other sources of research. Titles, abstracts, full texts and inclusion and / or exclusion criteria for eligibility were reviewed. The moderating variables were coded and the data were extracted for later analysis. We identified 10 prospective studies conducted between 2001 and 2016 that met the initial selection criteria. The results indicate that in relation to physiological, psychological and robust fatigue over time, it is the learning groups without errors that in 83.33% of the cases obtain positive results in their performance, compared to 16.67% of learning groups with errors. In general, we can affirm that the subjects benefit if the amount of information that is supplied is reduced to them. However, the results show the advantages of having two systems adaptative to environmental: incidental and intentional. These results should be analyzed with caution, due to the small number of localized studies and the heterogeneity of the designs used. It is proposed to carry out studies to verify the effects of these strategies in an ecological environment, with a longitudinal design, a larger sample size and different levels of expertise.

### **Keywords**

Errorless; incidental; sport; decision making; motor control.

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## Resumen

El objetivo del estudio es revisar y evaluar sistemáticamente la literatura relacionada con la estrategia de enseñanza sin errores para la enseñanza de las habilidades deportivas, con objeto de conocer si cometer errores beneficia o perjudica el aprendizaje y/o el rendimiento. Durante el proceso de búsqueda se consultaron las bases de datos Web of Science, Scopus, SportDiscus With Full Text y PsycInfo, además de otras fuentes de investigación. Se revisaron los títulos, resúmenes, textos completos y criterios de inclusión y/o exclusión para su elegibilidad. Se identificaron 10 estudios prospectivos realizados entre los años 2001 y 2016 que cumplieran con los criterios de selección establecidos inicialmente. Los resultados indican que, en relación a la fatiga fisiológica, psicológica y robustez al paso del tiempo, son los grupos de aprendizaje sin errores los que en el 83,33% de los casos obtienen resultados positivos en su rendimiento, frente al 16,67% de los grupos de aprendizaje con errores. En general podemos afirmar que los sujetos se benefician si se reduce la cantidad de información que se les suministra. No obstante, los resultados obtenidos evidencian las ventajas de tener dos sistemas adaptativos a los cambios ambientales: incidentales e intencionales. Estos resultados se deberían analizar con cautela, debido al reducido número de estudios localizados y a la heterogeneidad de los diseños utilizados. Se propone la realización de estudios que comprueben los efectos de estas estrategias en un entorno ecológico, con un diseño longitudinal, un mayor tamaño de las muestras experimentales y diferentes niveles de pericia.

## Palabras clave

Aprendizaje sin errores; incidental; deporte; toma de decisión; control motor.

## Basis

For years, the benefits of error-making in the context of sports learning has been a topic of thorough debate (Buszard et al., 2013). Studies show that making errors favors the learning of a skill (Milanese, Facci, Cesari y Zancanaro, 2008). However, in the past years, new research suggests that reducing the possibility of subjects making errors in the beginning stages of learning a new skill, grants benefits (Capio et al., 2012).

Scientific literature currently debates the benefits of explicit and implicit processes in motor learning and sporting performance. (Capio, Sit, Abernethy y Masters, 2012; Wulf, 2013; Carvalho, Correira y Araújo, 2013; Schlapkohl, Hohmann y Raab, 2012; Buszard, Farrow y Kemp, 2013; Camacho, 2013). Implicit or Incidental learning (IL) is understood as the learning of a skill without the

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corresponding verbal knowledge of said skill; it is not intentional and it is independent of the work memory (Masters y Maxwell, 2004). Skills learned through the implicit process reduce the need for attention of the player, avoid distraction from irrelevant signals, and favor a better performance (Maxwell, Masters, Kerr y Weedon, 2001). IL, furthermore, is for some authors the fundamental basis for specialized action (Masters y Maxwell, 2004). On the other hand, explicit learning (EL) is intentional and depends on work memory for the storage of information as well as for the retrieval and treatment of information, being moreover subject to interference of other secondary (Cooke, 2013). Supplying the player with instructions before and after motor learning promotes a declaratory basis with the risk of making the player dependent on their work memory resources. (Buszard, Reid, Farrow y Masters, 2013), and therefore favoring the deterioration of their performance.

There are numerous studies that prove the benefits of IL to avoid the worsening of performance under pressure (Lam, Maxwell y Masters, 2009) while multitasking (Maxwell, Masters y Eves, 2003) and under physical fatigue (Poolton, Masters y Maxwell, 2007). It is for this reason that some authors have created specific IL with the purpose of avoiding dependency on work memory and therefore favoring performance (Glockner, Heinen, Johnson y Raab, 2012; Wulf, 2013; Correia et al., 2012; Headrick et al., 2012; Lopes, Araujo, Duarte, Davids y Fernandes, 2012). A focus designed to prevent a worsening of sports skills under pressure, and maintaining an IL outlook was the design for the errorless learning (ELL) tasks, given that according to Capio et al. (2012), the process of ELL appears to confer an implicit quality of performance during learning.

The design of ELL tasks was

According to Maxwell et al. (2001), this strategy is an effective method to encourage the use of Incidental Learning processes, reasoning that the reduction of errors limits the need for subjects to experiment with other hypotheses or solutions of movement, for the movement is efficient, considerably limiting the use of the work memory, and minimizing the accumulation of declarative knowledge, and subsequently reducing the deterioration of learning or performance of said skill, just as the studies by Poolton et al. (2007), Masters and Maxwell (2005) and Maxwell et al. (2001) demonstrate. On the contrary, when errors have been made, the subject creates hypotheses on how to correct them and, therefore, adopts a selective learning strategy. There are few studies that strive to contextualize said hypothesis in the framework of sports, and in most cases the results favor ELL. (Poolton et al., 2007). But, on the contrary, there are studies that showcase the benefits of learning with errors (ACE) (Abernethy, Schorer, Jackson y Hagemann, 2012), Therefore deep researching and investigation about the effects of errorless and errorful learning needs to take place in order to

ascertain why studies about the same topic obtain different results.

Thus, the objective of the study is to systematically review and evaluate studies associated with the strategy of learning without errors in the context of teaching sports skills, with the purpose of discovering whether error-making benefits or hinders learning and/or performance.

## Method

For the purpose of this study, we have carried out a systematic review of scientific literature. Given that the data, the variables analyzed, the size of the samples, and the materials used for evaluation varied significantly, meta-analysis was not used, such as in the study by Holfelder y Schott (2014), just as Slavin (1995) suggests, favoring therefore an associative freedom of new ideas and greater verbal interpretation. In order to thoroughly represent literature regarding the strategies of ELL during the process of teaching, an extensive review through the various processes of research was conducted: (a) Electronic Data bases. The databases Web of Science, Scopus, SportDiscus With Full Text y PsycInfo (until 05/03/2017), were consulted. For the selection of search descriptors (“errorless”, “errorfull”, “sport”, “athlete”) The thesaurus and different experts from each subject were consulted as well. (Table 1).

Table 1. Search descriptors used

Related with	Descriptores
Strategy of teaching	“errorless”, “errorful”, “aprendizaje sin error” “aprendizaje con error”
Sport	“sport*”, “athlete*”

A combination of said descriptors for the configuration of the different phases of research was carried out. Of the references found, those pertaining to the most studied thematic areas in this field were selected, (b) direct consultation of magazines specialized in systematic review (Annual Review of Psychology, Exercise and Sport Science Reviews, European Physical Education Review, International Review of Sport & Exercise Psychology, y Psychological Review), (c) manual research of the indexes of specialized magazines related to the theme at hand. (Journal of Sport & Exercise Psychology, The Sport Psychologist, Journal of Sport Sciences, International Journal of Sport and Exercise Psychology, Research Quarterly for Exercise and Sport, Journal of Applied Sport Psychology, International Journal of Sport Psychology, Journal of Sport Behavior, Psychology of

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Sport & Exercise, Judgment and Decision Making, Motor Control, y Revista de Psicología del Deporte), (d) consultation of Tesis Doctorales (Proquest Dissertation & Theses Full Text y Teseo), (e) Ascending review of recovered literature with the goal of finding new studies that had not been identified previously during the process of research, and (f) gray literature, referring to non-published, or underground-published documents. We consulted the following databases (American Psychological Association) and SIGLE (System for information on Grey Literature in Europe).

The following criteria were applied: (a) academic piece of work published completely, (b) reviewed by peers, (c) related to the topic at hand, which is: Acquisition of a sports skill through an ELL strategy, (experimental study and (e) with a random selection of the groups, or otherwise that the different selection was done homogenously with a corresponding justification. During the first phase, we revised the titles and summaries of all studies, and during the second phase we analyzed the full texts of all resultant studies.

We drafted a codification manual in which we explain the selection of variables that could be influencing the result. In accordance with to Lipsey (1994), the codified variables were classified into three groups: (1) Uncontrollable Variables, (2) Methodologic Variables, (3) External Variables.

The processes of search, selection, and codification of studies were used by three independent reviewers, and previously making a random selection of 33% of the total studies.

## Resultados

### Search and selection of studies

We found 1021 potentially relevant documents (see Figure 1). The duplicates were eliminated (n=81), reducing to a total of 940 documents. In the following phase we excluded those studies that didn't meet the criteria of selection previously established after reviewing titles and abstracts (n+819) and the complete texts (n=112), leaving a total of 9 documents (10 studies), created between the years 2001 and 2016, during which the ELL strategy was created.

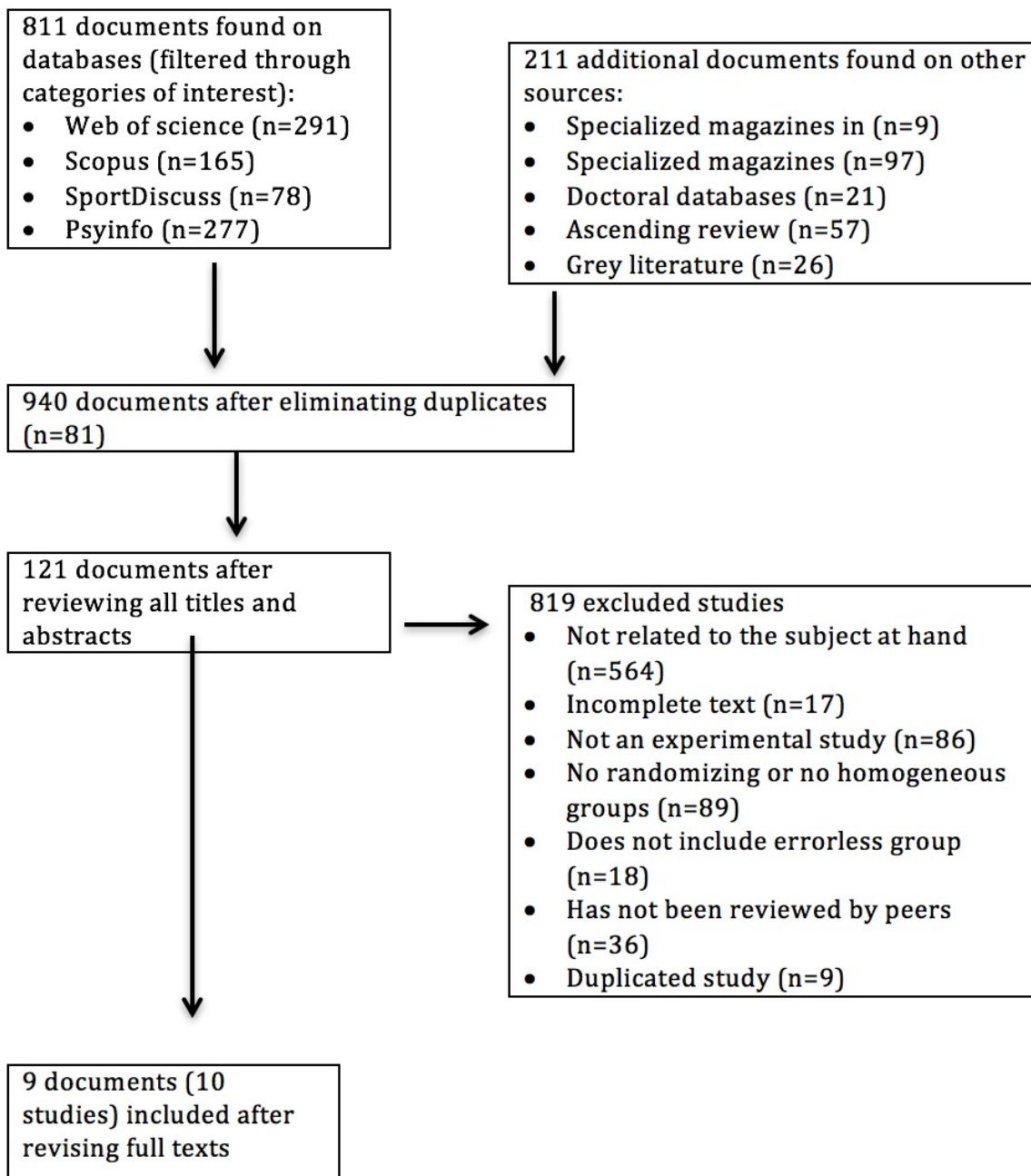


Figure 1. Flow diagram (own design)

### Variables potentially affecting results

While researching, selecting, and encoding the studies, we obtained a level of concordance Kappa

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(Cohen, 1960) which matched by 0.80, 0.84, and 0.82 respectively, a “very good” resemblance according to Landis and Koch (1997). Finally, the discrepancies were agreed upon through discussion.

We then grouped together the selected studies in two big groups: first, those relating to skills in individual sports (Maxwell et al., 2001; Poolton et al., 2005), developed in a stable environment and characterized for being predominantly regular just as Knapp (1963) affirms, and secondly, those studies relating to collective sports (Poolton et al., 2007; Masters, Poolton y Maxwell, 2008), developed in an ever-changing environment, uncertain and varying, considering their skills as predominantly perceptive, open, and subject to external influence.

Learning, transfer, and retention tests were performed in order to determine whether ELL was more resilient against physiological fatigue and the passing of time than EFL

Regarding individual sports, a total of 7 studies published between 2001 and 2016 in which ELL was implemented were selected. These studies had a total pool of 254 subjects (63 females 53 males, and 102 unidentified), with an average age of 19 with a low and moderate skill levels in the performed tasks.

The tasks performed by the subjects were semi-specific, technical, individual, and of low and moderate difficulty. In 6 of the studies, the task was to place a golf ball inside a hole from varying distances. In only one study, the goal was to stay in balance for 60 seconds on a platform. The dependent variables were the precision in the putting, and the time maintaining balance on the platform (stabilometer).

During the learning tasks, the ELL groups obtained better results than the EFL groups. In the transfer tasks where secondary tests that activated incidental learning were used, avoiding, therefore, the creation of new hypotheses of movement while the task is being done, the ELL groups got better results except for the equilibrium task (Orrell et al., 2006), in which ELL, learning through analogy (LTAN), and learning through discovery obtained similar results. Regarding transfer tests (whether a skill set can be used for another task or sport), ELL groups showed better results.

Regarding retention checks, ELL groups performed better, except in the study carried out by Orrell et al. (2006), in which they performed an equilibrium test and a retention check a year after the initial learning and transfer tests.

Regarding group sports, we selected a total of 3 studies published between 2007 and 2012 in  
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which ELL techniques were in place, with a total pool of 135 subjects (gender not specified), all three being independent samples, with an average age of 23, and a low and moderate skill level in the performed tasks.

All of the tasks performed were of non-specific or semi-specific nature, technical, and of low and moderate difficulty. The tasks were the same in all cases; throwing a ball at a bullseye or goals from different distances (ascending in distance except for the errorful group). The dependent variable analyzed was the precision of the throws. The duration of the tasks and the number of practice runs were similar in all studies.

The results indicate that during anaerobic and psychologic fatigue, the group that obtains more stable results is the ELL group (Incidental learning), compared to the EFL group (intentional). However, in the study carried out by Poolton et al. (2007), the errorless and EFL groups did a retention check a year after the rugby throwing test, and neither of the groups showed any decline in performance in any way.

Synthesis of the studys' results on tables 2 and 3.

Table 2. Studies about ELL on single-player sports

Study	Task/Design of the study	Subjects/Groups	Skill level	Results
Maxwell, Masters, Kerr and Weedon (2001)  (Experiment 1)	Golf: place a golf ball inside a hole from varying distances.	29 (M=20, SD=2)	Low	Learning
	ELL: from 25 to 200 cm			ELL > EFL, R
	EFL: from 200 to 25 cm	ELL, EFL, R	Retention	ELL > EFL, R
	AA: random distances		Transfer (secondary task)	ELL > EFL, R



	1 session, 550 tries			Transfer (new task)
				ELL > EFL, R
	Golf: : place a golf ball inside a hole from varying distances.	55 (M=21, SD=2)		Learning
(Experiment 2)	ELL: from 25 to 200 cm	ELL, CELL,	Low	ELL, ACSE > EFL, ACCE
	EFL: from 200 to 25 cm	EFL, CEFL		Transfer (secondary task)
				ELL, CELL > EFL, CEFL
	1 session, 200 tries			
Zhu, Poolton, Wilson, Maxwell and Masters (2011)	Golf: place a golf ball inside a hole from varying distances.	8 (ELL: M=22, SD=1)		Learning
	ELL: from 25 to 150 cm		Low	ELL > R
(Experiment 2)	R: random distances	R, ELL		Transfer under stress (filming the activity)
				ELL > R
	2 sessions, 320 tries			Retention
				ELL > R
Poolton, Masters and Maxwell (2005)	Golf: place a golf ball inside a hole from varying distances.	35 (11h, 24m; M=21, SD=1)		Learning
	ELL: from 25 to 200 cm	ELL-EL, EL	Low	ELL-EL = EL
	EL: 8 rules			Transfer (secondary task)
				ELL-EL > EL
	1 session, 550 tries			Retention (1 year)
				ELL-EL = EL
Orrell, Eves and Masters (2006)	Equilibrium task: maintaining equilibrium on a platform for 60 seconds	36 (M=20, SD=1)	Moderate	Learning
		LD, ELL, APD		LTAN, ELL > LD
				Transfer (secondary task)

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	2 sessions, 22 tries			LTAN = ELL = LD
				Retention (2 weeks)
				LTAN = ELL = LD
	Golf: place a golf ball inside a hole from varying distances.	36 (22h, 14m; M=21, SD=2)		Learning
				ELL > EFL
Lam, Maxwell and Masters (2010)	ELL: from 25 to 200 cm		Low	Transfer (new distance)
	EFL: from 200 to 25 cm	ELL, EFL		ELL > EFL
				Retention (1 year)
	1 session, 600 tries			ELL > EFL
	Golf: place a golf ball inside a hole from varying distances.	45 (25h, 20m; M=9, SD=1)		Transfer (secondary task)
				ELLHMS, ELLMS>EFLHMS, EFLMS
Maxwell, Capio and Masters (2016)	ELL: from 25 to 200 cm	ELLHMS,	Low	
	EFL: from 200 to 25 cm	ELLMS, EFLHMS, EFLMS		Learning ACECMA, ACECMB < 4 Retention groups
	1 session, 550 tries			

Note: ELL = errorless; EFL = errorful; CELL = controlled ELL; CEFL = controlled EFL; R = random; EL = explicit; ELL-EL = errorless/explicit; LTAN = analogy; LD = through discovery; ELLHMS = errorless and high motor skills; ELLMS = errorless and low motor skills, EFLHMS = errorful and high motor skills, EFLMS = errorful and low motor skills.

**Table 3. Studies about the ELL strategy in group sports**

Study	Task/Design of the study	Subjects/Groups	Skill level	Results
	Rugby: Throwing a rugby ball with the hand in order to hit three squares of 30, 100, and 150 cm in diameter.	46 (ELL, EFL: M=23, SD=4)		Learning
Poolton, Masters and Maxwell (2007)			Low	ELL > EFL, C
		C, ELL, EFL		Transfer (secondary task)
	ELL: from 100 to 250 cm			ELL > EFL, C
	EFL: from 600 to 400 cm			Retention (1 year)

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				ELL = EFL
	1 session, 150 tries			Physical exhaustion test
				ELL > EFL, C
				Learning
	Rugby: Throwing a rugby ball with the hand in order to hit three squares of 30, 100, and 150 cm in diameter.	49 (M=20, SD=1)		ELL > EFL, C
				Transfer
				(tired performance)
Masters, Poolton and Maxwell (2008)	ELL: from 100 to 250 cm		Low	ELL > EFL, C
	EFL: from 600 to 400 cm	ELL, EFL		Retention
				ELL > EFL > C
	1 session, 100 tries			Physical exhaustion test
				ELL > EFL, C
				Learning
Savelsbergh, Cañal Bruland and Van der Kamp (2012)	Football: Shoot a football with the foot at a goal from different distances	40 (M=2, SD=1)	Moderate	ELL > EFL, R, CD
				CD < R, EFL
	1 session, 165 tries	ELL, EFL, R, CD		Retention
				ELL > EFL, R, CD

Note: ELL = errorless; EFL = errorful; C = control, R = random, CD = constant difficulty.

## Discussion

The main purpose of our research was to evaluate the efficiency of ELL to improve Incidental Learning (IL) in the context of sport-skills-learning with the goal of avoiding a deterioration of performance during a competition. In our research, we analyzed a total of 10 studies which met the pre-established criteria, and which's authors analyzed whether making errors benefits or damages athletes. Studies also questioned whether ELL is superior or not to EFL in different circumstances.

Based on the idea that learning is characterized by the testing of a hypothesis, tasks were designed so that a student formulates a hypothesis about how to carry out the task, and then uses

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feedback to evaluate them (Lam et al., 2010). They then limit the learning environment in order to reduce the possibilities of the test subjects to fail (Maxwell et al., 2001), reducing the need to test hypotheses or solutions of alternative moves that impose a request over the cognitive resources, participation, and dependency on work memory, and therefore worsening performance.

In the learning and transfer tests, the groups that used an ELL strategy obtained better results, showing more stability under physiologic (Masters et al., 2008) and psychological fatigue (Zhu et al., 2011) than a motor-skill learning activity using an EFL strategy, confirming, therefore, that cognitive demand is greater during training after an error is made, both during preparation as well as during execution of the movement (Lam et al., 2010).

However, in the study carried out by Poolton et al. (2005), the group that used a sequential learning strategy, (errorless - explicit), incidental – intentional, obtained similar results as the group using the EL strategy during the learning and retention phases, just like in the study by Lola, Tzetzis y Zetou (2012). The authors of this study argue that if the role of work memory is reduced during the first stages of learning, the accumulation of declarative knowledge could benefit afterwards of the accumulation of procedural knowledge.

Similar results were collected in the study by Orrel et al. (2006), in which the subjects carry out a dynamic equilibrium activity over a platform for periods of 60 seconds. In this study, the experimental groups used LTAN strategies as well as ELL strategies and they obtained the same results. These discoveries show once more that limiting the number of rules in the work memory only favors the performance of the subjects because LTAN gives the subject a single explicit instruction in the form of a metaphor or a single biomechanical piece of information, covering several rules in one, and avoiding, therefore, the declarative stage of learning associated with the preparation, control, and correction of movement (Cooke, 2013), proving its benefits in numerous studies (in swimming Komar, Chow, Chollet y Seifert, 2013; golf Schücker, Hagemann and Strauss, 2013).

In the retention checks, ELL groups showed better results than errorful learning (EFL) groups, which show less stability with the passing of time. However, in the study executed by Poolton et al. (2007), during a retention check done a year after, the performance of EFL testers didn't decrease, furthermore, subjects had less declarative knowledge than in the initial tests. A possible explanation, just as the authors explain, is the stabilization and consolidation of knowledge in time, which favors the activation of incidental processes, avoiding with it the intentional control of movement.

Based on the statement made by Lam et al. (2009), that one of the factors that have influence

over the deterioration of performance is the amount of information that is being processed by the work memory. Our results confirm said premise, given than the groups who use ELL strategies obtain better results in 86.66% of the cases (Savelsbergh et al., 2012; Masters et al., 2008; Zhu et al., 2011), against the 13.34% in which both strategies (errorless and errorful) obtain similar results (Poolton et al., 2005 in the learning and retention tests; Orrell et al., 2006 in the transfer and retention tests).

These results prove the advantages of, first, limiting the information available in the work memory for the gaining of certain sports skills (Komar et al., 2013), and second, having two systems adaptive to environmental changes, one which allows for reasonable decision making given that there is enough time to make the decision, and two which permit an intuitive decision to be made without and intervention of the conscience (Camacho 2013). Depending on the combination of restrictions subjects might face, we encourage the activation of incidental and or intentional processes to a greater or lesser extent. We advocate for an integral model that includes both types of cognitive mechanisms, unlike today where one is considered more important than the other (Lam et al., 2009; Masters y Maxwell, 2004), however we must study the relative contribution of both processes, just as Schlapkohl et al. (2012) states, both will lead to improvements in behavior.

## Conclusion

In accordance with the results obtained in the selected studies for the systematic review, it seems to be that, in general terms, the subjects improve their performance if the amount of information they consciously process is reduced, given that the importance of attention is considerably reduced. Giving subjects a large amount of instructions is not necessary to learn specific motor skills. On regards to the type of learning strategy used, that which reduces the amount of errors made, ELL, triggers the incidental or intuitive processing mechanisms in the players, reduces the number of times they make a relation hypothesis, the level of dependency on conscious processing to control movement, and the possibility of deterioration of performance under pressure, physical fatigue, and multitasking conditions, unlike with skills learnt through and EFL strategy that require more attention from subjects towards the tasks, interfering and interrupting the automatic responses, reducing the speed and/or precision of the responses. We must also mention that skill level is a key factor when choosing the right learning strategy when teaching sports skills, since in some cases, athletes with low skills can benefit from ELL during a motor-skill learning activity, and athletes with high skills can benefit from using an EFL strategy in order for them to learn from their errors, and not repeat them in the future.

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## Improvements and Limitations

In the selected studies, we found some limitations that should be taken into account for future reviews in order to reduce the effect of said limitations. The design of the tasks was non-specific or semi-specific, a recurring theme in recent studies, just as Rodríguez, Mato and Pereira (2016) and Zurita et al., (2016) demonstrate. This style makes it inconvenient to transfer the data to a real-life competition. A transversal design was used in all of the studies, which hinders the establishment of a cause-and-effect relation between the analyzed variables. The size of the samples is small ( $M=38,9$ ) and the skill level of subjects was low in 80% of the cases.

We propose designing tasks in an ecologic manner, respecting the internal logic of the sport at hands, create prolonged studies or of longitudinal sense, using larger samples of different populations and skill sets. Furthermore, we consider of interesting value exploring the emotional benefits of the ELL strategy during the initial stages of learning a sport skill, since it can contribute to an improvement in the auto-efficiency of the subject, and this can, therefore, favor their performance.

## Bibliographic References

1. Abernethy, B., Schorer, J., Jackson, R.C. y Hagemann, N. (2012). Perceptual training methods compared: The relative efficacy of different approaches to enhancing sport-specific anticipation. *Journal of Experimental Psychology: Applied*, 18(2), 143-153.
2. Buszard, T., Farrow, D. y Kemp, J. (2013). Examining the influence of acute instructional approaches on the decision-making performance of experienced team field sport players. *Journal of Sports Sciences*, 31(3): 238-247.
3. Buszard, T., Reid, M., Farrow, D. y Masters, R.S.W. (2013). Implicit motor learning: Designing practice for performance. *Coaching and Sport Science Review*, 60(21), 3-5.
4. Camacho, P. (2013). El valor del aprendizaje incidental en la toma de decisión y control motor en baloncesto. *Cuadernos de Psicología del Deporte*, 12(S1), 9-12.
5. Capio, C.M., Sit, C., Abernethy, B. y Masters, R.S.W. (2012). The possible benefits of reduced errors in the motor skills acquisition of children. *Sports Medicine, Arthroscopy, Rehabilitation, Therapy & Technology*, 4, 1, 1-4.

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*Sportis Sci J*, 3 (3), 621-638. DOI:<https://doi.org/10.17979/sportis.2017.3.3.2021>

<http://revistas.udc.es/>

6. Carvalho, J., Correira, V. y Araújo, D. (2013). A constraints-led approach to skill enhancement in tennis. *Coaching and Sport Science Review*, 60(21), 10-11.
7. Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement*, 20, 37-46.
8. Cooke, A. (2013). Readyng the head and steadying the heart: A review of cortical and cardiac studies of preparation for action in sport. *International Review of Sport and Exercise Psychology*, 6(1), 122-138.
9. Correia, V., Araujo, D., Duarte, R., Travassos, B., Passos, P. y Davids, K. (2012). Changes in practice task constraints shape decision-making behaviours of team games players. *Journal of Science and Medicine in Sport*, 15(3), 244-249.
10. Glockner, A., Heinen, T., Johnson, J. G. y Raab, M. (2012). Network approaches for expert decisions in sports. *Human Movement Science*, 31(2), 318-333.
11. Headrick, J., Davids, K., Renshaw, I., Araujo, D., Passos, P. y Fernandes, O. (2012). Proximity-to-goal as a constraint on patterns of behaviour in attacker-defender dyads in team games. *Journal of Sports Sciences*, 30(3), 247-253.
12. Holfelder, B. Y Schott, N. (2014). Relationship of fundamental movement skills and physical activity in children and adolescents: A systematic review. *Psychology of Sport and Exercise*, 15, 382-391.
13. Knapp, B. (1963). *La habilidad en el deporte*. Valladolid: Miñón.
14. Komar, J., Chow, J.-Y., Chollet, D. y Seifert, L. (2013). Effect of analogy instructions with an internal focus on learning a complex motor skill. *Journal of Applied Sport Psychology*, 26(1), 17-32.
15. Lam, W.K., Maxwell, J.P. y Masters, R. (2009). Analogy learning and the performance of motor skills under pressure. *Journal of Sport and Exercise Psychology*, 31(3), 337-357.
16. Lam, W. K., Maxwell, J.P. y Masters, R.S.W. (2010). Probing the allocation of attention in implicit (motor) learning. *Journal of Sports Sciences*, 28(14), 1543-1554.

17. Landis, J.R. y Koch, G.G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33, 159-174.
18. Lipsey, M.W. (1994). Identifying potentially interesting variables and analysis opportunities. En H.M. Cooper y L.V. Hedges (Eds.), *The handbook of research synthesis* (pp. 111-123). Nueva York: Sage.
19. Lola, A.C., Tzetzis, G.C. y Zetou, H. (2012). The effect of implicit and explicit practice in the development of decision making in volleyball serving. *Perceptual and Motor Skills*, 114(2), 665-678.
20. Lopes, J. E., Araujo, D., Duarte, R., Davids, K. y Fernández, O. (2012). Instructional constraints on movement and performance of players in the penalty kick. *International Journal of Performance Analysis in Sport*, 12(2), 331-345.
21. Masters, R.S.W. y Maxwell, J. P. (2004). Implicit motor learning, reinvestment and movement disruption: What you don't know won't hurt you? En A. M. Williams y N. J. Hodges (Eds.), *Skill acquisition in sport: Research, theory and practice* (pp. 207-228). London: Routledge.
22. Masters, R.S.W., Poolton, J.M. y Maxwell, J.P. (2008). Stable implicit motor processes despite aerobic locomotor fatigue. *Consciousness and Cognition*, 17(1), 335-338.
23. Maxwell, J., Capio, C. y Masters, R.S.W. (2016). Interaction between motor ability and skill learning in children: Application of implicit and explicit approaches. *European Journal of Sport Science*, 17(4), 407-416.
24. Maxwell, J.P., Masters, R.S.W., Kerr, E. y Weedon, E. (2001). The implicit benefit of learning without errors. *The Quarterly Journal of Experimental Psychology*, 54(4), 1049-1068.
25. Maxwell, J.P., Masters, R.S.W., Eves, F.F., (2003). The role of working memory in motor learning and performance. *Consciousness and Cognition*, 12(3), 376-402.
26. Milanese, C., Facci, G., Cesari, P. y Zancanaro, C. (2008). Amplification of error: A rapidly effective method for motor performance improvement. *Sport Psychologist*, 22(2),

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<http://revistas.udc.es/>



164-174.

27. Orrell, A.J., Eves, F.F. y Masters, R.S.W. (2006). Implicit motor learning of a balancing task. *Gait & Posture*, 23, 9-16.
28. Poolton, J. M., Masters, R.S.W. y Maxwell, J.P. (2005). The relationship between initial errorless learning conditions and subsequent performance. *Human Movement Science*, 24(3), 362-378.
29. Poolton, J.M., Masters, R.S.W. y Maxwell, J.P. (2007). Passing thoughts on the evolutionary stability of implicit motor behaviour: Performance retention under physiological fatigue. *Consciousness and Cognition*, 16(2), 456-468.
30. Rodríguez, J.E., Mato, J.A. y Carmen, M. (2016). Análisis de los métodos tradicionales de enseñanza-aprendizaje de los deportes colectivos en Educación Primaria y propuestas didácticas innovadoras. *Sportis*, 2(2), 303-323.
31. Savelsbergh, G., Cañal-Bruland, R. y Van der Kamp, J. (2012). Error reduction during practice: A novel method for learning to kick free-kicks in soccer. *International Journal of Sports Science & Coaching*, 7(1), 47-56.
32. Schlapkohl, N., Hohmann, T. y Raab, M. (2012). Effects of instructions on performance outcome and movement patterns for novices and experts in table tennis. *International Journal of Sport Psychology*, 43(6), 522-541.
33. Schücker, L., Hagemann, N. y Strauss, B. (2013). Analogy vs. technical learning in a golf putting task: An analysis of performance outcomes and attentional processes under pressure. *Human Movement*, 14(2), 175-184.
34. Slavin, R.E. (1995). Best evidence synthesis: An intelligent alternative to meta-analysis. *Journal of Clinical Epidemiology*, 48(1), 9-18.
35. Wulf, G. (2013). Attentional focus and motor learning: A review of 15 years. *International Review of Sport and Exercise Psychology*, 6(1), 77-104.
36. Zhu, F.F., Poolton, J.M., Wilson, M.R., Maxwell, J.P. y Masters, R.S.W. (2011). Neural

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co-activation as a yardstick of implicit motor learning and the propensity for conscious control of movement. *Biological Psychology*, 87(1), 66-73.

37. Zurita, F., Pérez, J.A., González, G., Castro, M., Chacón, R. Y Ambris, J. (2016). Estilos de enseñanza de entrenadores y su relación con la ansiedad de los jugadores en diferentes categorías de fútbol base. *Sportis*, 2(3), 390-411.