Malaysian Journal of Sport Science and Recreation
Vol.17. No 1, 35 – 49, 2021
DOI: https://doi.org/10.24191/mjssr.v17i1.12723

THE EFFECTS OF ANALOGY INSTRUCTIONS ON SPRINT PERFORMANCE AND KINEMATICS

Hanisah Abdullah

Jeffrey Low Fook Lee

Sultan Idris Education University (UPSI)

Received: 13 May 2020 **Accepted: 22 July** **Published: 15 March 2021**

Correspondent Author

Hanisah Abdullah
Email : hanisahchan95@gmail.com
Sultan Idris Education University (UPSI)

PENERBIT PRESS
UNIVERSITI TEKNOLOGI MARA

Malaysian Journal of Sport Science and Recreation
Vol.17. No 1, 35 – 49, 2021
DOI: https://doi.org/10.24191/mjssr.v17i1.12723

THE EFFECTS OF ANALOGY INSTRUCTIONS ON SPRINT PERFORMANCE AND KINEMATICS

Hanisah Abdullah., & Jeffrey Low Fook Lee.

Sultan Idris Education University (UPSI)

Abstract

The purpose of this study was to examine the effects of analogy and explicit instructions on 50-m sprint performance and their running kinematics. Forty-five male Physical Education undergraduates participated in this study and were randomly divided into three groups, (i.e. analogy, explicit and control). Their sprint performances were assessed using wireless timing gate while the kinematic data was assessed by Kinovea software. The analogy group received three analogies which were "run tall", "chin to pocket" and "claw the track" throughout the intervention sessions whereas the explicit group received "keep the body posture in an upright position and aligned, head and butt not tilting outward", "arms should maintain a 90-degree angle at the elbow throughout the upswing as well as backswing" and "the foot landing should always be on the balls of the feet". The control group did not receive any instruction throughout the intervention period. All participants were tested again after three weeks for the post test and retention test a week after. A 3 group x 3 tests mixed design ANOVA was used to analyze the sprinting performance whereas the kinematic data was analyzed by using one way MANOVA test. Results displayed that there was no significant difference in sprint performance among the groups. However, the post hoc test showed that the analogy group improved significantly in the post test. The kinematic data showed that both intervention groups were significantly better than the control group. This study concluded that both analogy and explicit instructions resulted in better running mechanics but only the analogy group elicited better in performance. Thus, analogy instructions are suggested to be an effective method to coach sprinters.

***Keywords**: Analogy, explicit, sprint performance, kinematics*

INTRODUCTION

One of the most critical contributors in skill acquisitions is via practice (Hodges & Williams, 2012). Despite sheer number of practice trials, other factors that may influence the extent and rate of learning include action observation, movement demonstration, imagery, feedback, and instruction (Wulf & Lewthwaite, 2010). Often, the coaches use verbal instruction to communicate to an athlete as a corrective mechanism and there are numerous types of verbal instructions (Benz, Winkelman, Porter & Nimphius, 2016). These types can give differing effects on how the athletes direct their focus of attention during sport performance.

Although the majority of coaches nowadays continue to use explicit instruction which mainly focuses on body parts, research investigating the concept of implicit learning showed that a significant degree of learning can happen if ones attention is not consciously directed to the mechanics of movement production, favoring an automatic control. This was explained in the constrained action hypotheses.

In coaching process, instructions given should be short and easily understood (Magill & Anderson, 2017). Therefore, analogy learning is introduced as a method to aid the skill acquisitions of athletes, allowing a more automatic mode of control, than explicit learning which favors conscious control on performing certain movement. Tse, Wong and Masters (2017) describe analogy as a simple form of instruction that enhance the process of learning a new concept by relating it to a fundamentally similar concept to convey motor skill information to learners.

The use of analogy has been acknowledged as a method to invoke implicit processes during the skill acquisition. Implicit motor learning was introduced to reduce the aggregation of declarative knowledge regarding the movement or restrict conscious access to the knowledge. Analogies allow learners to make inferences about concepts with little awareness regarding the

Malaysian Journal of Sport Science and Recreation
Vol.17. No 1, 35 – 49, 2021
DOI: https://doi.org/10.24191/mjssr.v17i1.12723

rules underlying the concepts by minimizing the opportunity for conscious processing which will disrupt the movement action. This was described as "reinvestment" (Masters, 1922).

Liao and Masters (2001) introduced the analogy of the "hypotenuse" in the Pythagoras Theorem to assist them in performing the forehand top spin stroke in table tennis which was then innovated by Poolton (2007) changing it to a more relevant analogy, "mountain". The effectiveness of analogy instructions on skill acquisition has been widely explored in numerous sports since then (Benz et al., 2016; Porter et al., 2015; Tse, Wong, & Masters, 2017).

Choosing the appropriate type of instruction is critical in motor-skill learning and overall performance. This was exemplified by how small differences in the choice of words used in relation to instructions influence performance (Porter, Wu, Crossley, Knopp & Campbell, 2015). A subtle change in the instructions given was proven to significantly improved 20-min sprint performance among low skilled sprinters. The study highlighted the cognitive control of running speed specifically on the mechanics of lower extremities. However, it remained unknown if the combination of three analogies, in means to make adjustment on the mechanics of the whole body parts, would make a greater impact on sprinting performance. Thus, present study sought to find the answer.

METHODOLOGY

Participants

Forty-five Physical Education students who enrolled in a basic athletics course in a university were randomly recruited in this study, age ranging from 19-22 years old. All participants were healthy and free from any injuries. None of them has represented the university, states or clubs in any track and field events. Also, none of the participants had formal sprint training.

PENERBIT PRESS
UNIVERSITI TEKNOLOGI MARA

Instrumentation

In this study, the wireless infrared timing gates (Microgates, Italy) were used to measure the all-out 50 m dash timing. Kinematic variables were assessed from two dimensions video recording which was then analyzed by using Kinovea Software. A video camera (Sony, Japan) was used to record the sprinting task. The trunk angle was relative to horizontal; knee angle, where 180^o corresponds to fully extended knee (Haugen, Danielsen, Alnes, McGhie, Sandbakk & Ettema, 2018); ankle and elbow angles were also measured respectively relative to its fully extension.

Procedures

All participants completed an informed consent before their participation. The task used in this study was a maximum effort of 50-m sprint which was held at the university running track. Each participant was asked to get ready at the start line in three-point-start position and begin the run when they were ready. The timing gates mounted atop tripods were set at a height of 100 cm, approximately the average male torso level.

All participants completed a total of three trials during the pre-test, given the rest interval of not less than 5 minutes for each participant. The 50-m sprint time was recorded and the average (the sum of three trials divide by 3) was used for sample analysis to make sure that all participants were randomly distributed into three groups, Explicit, Analogy and Control group. Intervention was given to them two sessions per week for three weeks separately following the group assigned for them.

In the analogy instruction group, participants were briefed about the mechanics of running. The three analogies were introduced; (1) “run tall”, (2) “swing arms from chin to pocket”, and (3) “claw the track”. On two consecutive days, the explicit instruction group received the extensive instruction; (1) keep the body posture in an upright position and aligned, head and butt not tilting outward, (2) arms should maintain a 90-degree angle at the elbow

PENERBIT PRESS
UNIVERSITI TEKNOLOGI MARA

Malaysian Journal of Sport Science and Recreation
Vol.17. No 1, 35 – 49, 2021
DOI: https://doi.org/10.24191/mjssr.v17i1.12723

throughout the upswing as well as backswing, (3) the landing foot should always be on the balls of the feet.

Statistical Analysis

All data was analyzed using 'Statistical Package for Science Social' (SPSS) version 20.0. A 3 group x 3 tests mixed design ANOVA was used to analyze the sprinting performance whereas the kinematic data is analyzed by using one way multivariate analysis of variance (MANOVA) test. The significant level for all statistical tests is set at $P \leq .05$.

RESULTS

Sprint Performance Results

Table I: Sprint performance time according to the tests

Test	Pre-Test		Post-Test		Retention Test	
Group	Mean	SD	Mean	SD	Mean	SD
Analogy	6.59s	.41	6.50s	.44	6.53s	.42
Explicit	6.45s	.25	6.49s	.26	6.46s	.24
Control	6.56s	.36	6.52s	.39	6.55s	.37

The mean and standard deviation of sprint time for the three groups during pre, post and retention test were presented in Table 4.2. There was no main effect found for the pre, post and retention tests $F(2, 84) = 2.586$, $p = 0.81$. Also, no main effect was found for all three groups; analogy, explicit and control $F(2, 42) = 0.227$, $p = 0.798$. However, there is an interaction between test and group $F(4, 84) = 2.618$, $p = 0.04$.

PENERBIT PRESS
UNIVERSITI TEKNOLOGI MARA

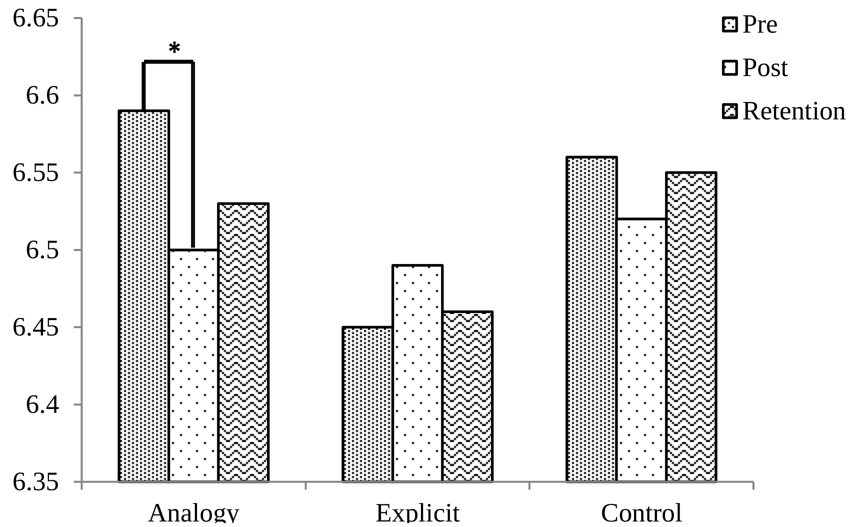

Fig.1: Mean score of 50m sprint time for all three groups in Pre, Post and Retention Tests

Analogy group improve in their sprint performance from pre-test (M = 6.59s, SD = 0.41) to post (M = 6.50s, SD = 0.44) and retention test (M = 6.53s, M = 0.42). Their 50m sprint time was found to be significantly faster in the post test compared to pre-test whereas the retention showed slower sprint performance the post test. No significant differences were found in the explicit and control group in their sprint performance time in all the three tests.

Analysis of Kinematic Angles

The result from MANOVA test showed that there was a significant difference, F (24, 62) = 4.33, Wilks Lambda = 0.139, p < 0.001, ηp2 = 0.627, between the groups and tests. Subsequently, one way ANOVA showed significant difference between groups in the angle of trunk in the post test F (2, 42) = 5.963, p = .05, ηp2 = .221.

Both the analogy group (M = 85.73°, SD = 3.28) and the explicit group (M = 86.47°, SD = 3.96) were significantly larger than the control group (M = 82.20°, SD = 4.27). However, no significant difference was shown between analogy and explicit, noted that both groups

PENERBIT PRESS
UNIVERSITI TEKNOLOGI MARA

Malaysian Journal of Sport Science and Recreation
Vol.17. No 1, 35 – 49, 2021
DOI: https://doi.org/10.24191/mjssr.v17i1.12723

receiving intervention sprinted with more upright trunk posture, leading to a better and safer form (Higashihara et al., 2015).

In the kinematic angle of elbow, a significant difference was found between the groups in the post test F (2, 42) = 11.263, p < .001, ηp2 = .349. Both groups receiving analogy (M = 103.67°, SD = 12.18) and explicit (M = 101.80°, SD = 8.78) instructions achieved a decrease in the angle of elbow flexion of closer to 90 degree, which has been discussed as an ideal angle for a proper running form than the control group (M = 124.47°, SD = 18.85).

The result of knee angle showed a significant difference between the groups in retention test, F (2, 42) = 4.389, p < .019, ηp2 = .173 with the analogy group (M = 152.53°, SD = 5.07) displayed an improvement of a greater knee flexion angle compared to explicit (M = 151.07°, SD = 5.90) and control groups (M =146.40°, SD = 6.71). Unlike trunk and elbow, the angle of knee found significant difference in the post test among the three groups of analogy (M = 152.67°, SD = 5.42), explicit (M = 149.00°, SD = 10.49) and control (M = 146.47°, SD = 6.94).

Scrutinizing the angle of ankle, result showed that there was a significant difference among the groups in the retention test F (2, 42) = 3.235, p < .025, ηp2 = .133. Surprisingly, the explicit group (M = 108.93°, SD = 10.77) displayed a greater mean of angle rather than the analogy group (M = 105.53°, SD = 9.69), and control (M = 99.07°, SD = 8.34). However, there was no significant difference found in the post test between analogy (M = 104.73°, SD = 7.61), explicit (M = 106.13°, SD =7.24) and control (M = 99.38°, SD = 8.37) groups.

Table 2: Kinematic Angles Mean and Standard Deviation

Angle of	**Group**	**Pre-Test**		**Post-Test**		**Retention-Test**	
		Mean	**Std. Dv**	**Mean**	**Std. Dv**	**Mean**	**Std. Dv**
Trunk	Analogy	83.00	4.36	85.73	3.28	85.13	4.10
	Explicit	82.33	6.57	86.47	3.96	85.47	4.24

	Control	81.67	4.87	81.93	4.27	82.20	4.59
Elbow	Analogy	113.67	16.64	103.67	12.18	100.27	10.64
	Explicit	109.73	11.53	101.80	8.78	101.80	8.78
	Control	121.67	21.55	124.47	18.85	123.47	20.13
Knee	Analogy	149.33	5.33	152.67	5.42	152.53	5.07
	Explicit	150.87	6.23	149.00	10.49	151.07	5.90
	Control	145.40	7.58	146.47	6.94	146.40	6.71
Ankle	Analogy	98.93	10.03	104.73	7.61	105.53	9.69
	Explicit	107.33	12.25	106.13	7.24	108.93	10.77
	Control	99.87	8.78	99.33	8.37	99.07	8.33

DISCUSSIONS

The Effects of Analogy on Sprint Performance

Tse, Wong & Masters (2017) suggested that the results from their research may be affected by different number of instructions between the instruction groups. The results could be caused by the number of instructions (1 vs 9 instructions) rather than the nature of the instructions (analogy vs explicit instructions). Therefore, this study has controlled the number of instructions to examine if the advantage of analogy could still hold true when the number of instructions between groups is equal. The present study has found that the effect of analogy instruction was not significant the number of instructions were similar, which was three instructions for both analogy and explicit.

As the previous studies (Poolton et al, 2007; Lee et al., 2019; Tse, Wong & Masters, 2017) found that explicit instructions contain complex rule structures, causing the increase in the cognitive load (Tse, Wong, Whitehill, Ma & Masters, 2016), one possible explanation for the outcome of the present study is that the number of instructions given in this research were not too complicated for them to recall during the execution of the skill. It could be that the equal amount of rules has similar effect on the working memory demand of both analogy and explicit groups. Thus, the benefit of analogy in chunking those complex rules structure is seems to be less stand out, resulting in the insignificant difference in sprint performance among them.

Another possibility behind the insignificant effect of analogy and explicit is the individual differences in interpreting the instructions given to them. The inability to directly access the way these types of instruction affecting their motor skill limits further details underlying this outcome. Similar to the findings of the study by Andy & Masters (2019), the individual interpretation of how the information of analogy and explicit instructions are being processed from neural perspective may have been an issue, calling for further studies to explore the details

The result showed no main effect of groups and tests in the 50m sprint performance. However, in the post hoc test, a significant interaction was found within the analogy group in the post and retention tests. The group receiving analogy instruction performed a faster sprint time in their post-test, compared to the pre-test and therefore, the second null hypothesis was accepted. The analogy group was found to excel significantly whereas the explicit and control groups displayed no significant improvement within the groups.

It can be concluded that analogy, used as biomechanical metaphors promotes implicit learning by describing the higher –order relationships underlying a motor task without presenting individual rules (Liao & Masters, 2001), invoking an automatic mode of control over their action (Kal et al., 2018).

The Effects of Analogy on Sprint Kinematics

Results from MANOVA test showed that there is a significant difference among the group of instructions. In the trunk flexion angle, result indicated that both analogy and explicit groups different significantly in the post test compared to the control group. Both groups attain changes of angle from forward lean to a more upright posture, meaning that they have attained a better and safer form of running as to prevent injuries especially the most common type of injury in sprinting, which is hamstring strain (Higashihara et al., 2015).

Elbow angle in the post test also displayed similar results where both instructions groups attained better posture. The explicit group possessed the same effect as analogy most probably due the nature of the instruction, highlighting the specific angle to be achieved in which "the arms should maintain a 90-degree angle at the elbow throughout the upswing as well as backswing", whereas the analogy group receiving the "chin to pocket" cue. Even though the optimum positions are yet to be established (Macadam, Cronin, Uthoff, Johnston & Knicker, 2018), a discussion regarding an ideal sprinting mechanics has suggested that keeping the elbow flexed at 90° helps in driving the arms aggressively to match the stride pattern (Cappadona, 2013).

Although the result of knee flexion angle in the post tests showed no significant difference among the three groups, the result in retention test showed otherwise. No statistically difference between analogy and explicit group, the analogy group showed a better performance than the control group. Cappadona (2013) showed that the most efficient sprinters may have the longest stride length corresponding to a higher degree of extension and thus, results in greater force production. Anderson (2019) has also discussed that greater knee flexion in the swing phase is ideal for a good form.

The angle of the ankle for post-test showed a significant difference between the groups. The explicit, instead of analogy group, performed a greater flexion in the post test indicates that the explicit group performed better than the other two, analogy and control groups. For the kinematic of the ankle flexion, "claw the track with your shoe" is used for the analogy group and "foot landing must always be on the ball of your feet" is used for the explicit group as a tool to correct the foot-strike pattern among novices' sprinters.

PENERBIT PRESS
UNIVERSITI TEKNOLOGI MARA

The finding was conceptually similar to the study by Porter et al (2015) which found that the use of "claw the floor" instruction as to adopt the external focus of attention was proven to enhance 20-m sprinting performance. However, the previous study did not provide kinematic data of the ankle flexion and therefore, it limits better understanding on how the mechanism of the analogy used actually affecting the running mechanics as present study also found significant improvement of sprint time in the post test.

CONCLUSION

Based on the findings of present study, analogy instruction was shown to not only improve sprinting techniques but also performance. Analogy, as it focuses on the movement effect, allows for the utilization of unconscious, fast and reflexive control processes (Hodges & Williams, 2012), making their significant improvement in sprint performance as the desired outcome is achieved almost as a by-product. Although the explicit group has also resulted in better sprint mechanics, no significant improvement was noted in their performance as the explicit instructions were mainly adopting internal focus of attention, inducing a conscious type of control that tend to constraint their motor system. Therefore, this finding has validated the constrained action hypothesis as widely elaborated in past studies (Wulf, McNevin, & Shea, 2001; Shucker et al., 2009; Makaruk et al., 2012; Ille et al., 2013; Porter et al., 2015).

RECOMMENDATION

Present study has found significant kinematic changes among the analogy and explicit groups and validated the effectiveness of analogy instruction on sprint performance. Another study can be done to further examine the effect of different types of instructions on running mechanics through the insight of a more detailed level in kinematic including the stride length and stride frequency, as to attain a better understanding on the underlying mechanism of the analogy on sprint performance. A similar study can also be done by manipulating the methodology of the intervention. As all three analogies used in this research were given one shot or simultaneously in the intervention period, another inquiry derived if there should be any significant differences if the analogy were given separately in a given period of time throughout the intervention. Further studies should fill in the gaps.

REFERENCES

Anderson, O. (2018). *Running Form: How to Run Faster and Prevent Injury*. Human Kinetics.

Andy, C. Y., & Masters, R. S. (2019). Improving motor skill acquisition through analogy in children with autism spectrum disorders. *Psychology of Sport and Exercise*, 41, 63-69.

Benz, A., Winkelman, N., Porter, J., & Nimphius, S. (2016). Coaching instructions and cues for enhancing sprint performance. *Strength & Conditioning Journal*, 38(1), 1-11.

Cappadona, J. (2013). *Kinematic and spatiotemporal analysis between sprint drills and maximal sprinting.*

Haugen, T., Danielsen, J., Alnes, L. O., McGhie, D., Sandbakk, Ø., & Ettema, G. (2018). On the importance of "front-side mechanics" in athletics sprinting. *International journal of sports physiology and performance*, 13(4), 420-427.

Higashihara, A., Nagano, Y., Takahashi, K., & Fukubayashi, T. (2015). Effects of forward trunk lean on hamstring muscle kinematics during sprinting. *Journal of sports sciences*, 33(13), 1366-1375.

Hodges, N., & Williams, A. M. (Eds.). (2012). *Skill acquisition in sport Research, theory and practice*. Routledge.

Ille, A., Selin, I., Do, M. C., & Thon, B. (2013). Attentional focus effects on sprint start performance as a function of skill level. *Journal of Sports Sciences*, 31(15), 1705-1712.

Kal, E., Prosée, R., Winters, M., & Van Der Kamp, J. (2018). Does implicit motor learning lead to greater automatization of motor skills compared to explicit motor learning? A systematic review. *PloS one*, 13(9), e0203591.

Lee, R. W., Tse, A. C., & Wong, T. W. (2019). *Application of Analogy in Learning Badminton Among Older Adults: Implications for Rehabilitation*. Motor control, (00), 1-14.

Liao, C. M., & Masters, R. S. (2001). *Analogy learning: A means to implicit motor learning. Journal of sports sciences*, 19(5), 307-319.

Macadam, P., Cronin, J. B., Uthoff, A. M., Johnston, M., & Knicker, A. J. (2018). Role of Arm Mechanics During Sprint Running: A Review of the Literature and Practical Applications. *Strength & Conditioning Journal*, 40(5), 14-23.

Magill, R. A., & Anderson, D. I. (2017). *Motor learning and control.* Concepts and applications (11th ed.). New York: McGraw-Hill.

Makaruk, H., Porter, J., Czaplicki, A., Sadowski, J., Sacewicz, T. (2012). The role of attentional focus in plyometric training. *The Journal of Sports Medicine and Physical Fitness*, 52(3), 319-327.

Masters, R.S.W. (1992). Knowledge, knerves and know-how: The role of explicit versus implicit knowledge in the break- down of a complex motor skill under pressure. *British Journal of Psychology*, 83, 343-358.

Poolton, J. M., Masters, R. S., & Maxwell, J. P. (2007). The development of a culturally appropriate analogy for implicit motor learning in a Chinese population. *The Sport Psychologist*, 21(4), 375-382.

Porter, J. M., Anton, P. M., Wikoff, N. M., & Ostrowski, J. B. (2013). Instructing skilled athletes to focus their attention externally at greater distances enhances jumping performance. *The Journal of Strength & Conditioning Research*, 27(8), 2073-2078.

Porter, J. M., Wu, W. F., Crossley, R. M., Knopp, S. W., & Campbell, O. C. (2015). Adopting an external focus of attention improves sprinting performance in low-skilled sprinters. *The Journal of Strength & Conditioning Research*, 29(4), 947-953.

Schücker, L., Hagemann, N., Strauss, B., Volker, K. (2009). The effect of attentional focus on running economy. *Journal of Sports Sciences,* 27(12), 1241-1248.

Tse, A. C., Wong, T. W., & Masters, R. S. (2017). Examining motor learning in older adults using analogy instruction. *Psychology of Sport and Exercise*, 28, 78-84.

Tse, C. Y. A., Wong, A., Whitehill, T., Ma, E., & Masters, R. (2016). Examining the cognitive demands of analogy instructions compared to explicit instructions. *International journal of speech-language pathology*, 18(5), 465-472.

Wulf, G., McNevin, N., & Shea, C. H. (2001). The automaticity of complex motor skill learning as a function of attentional focus. *The Quarterly Journal of Experimental Psychology Section A*, 54(4), 1143-1154.

Wulf, G., Shea, C., & Lewthwaite, R. (2010). Motor skill learning and performance: a review of influential factors. *Medical education*, 44(1), 75-84.