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1 **Exploring the use of Think Aloud within Women’s Artistic Gymnastics Judging**  
2 **Education.**

3 **Abstract**

4 Gymnastics is a judgement-based sport whereby the decision-making processes of judges are  
5 expected to lead to valid and reliable outcome scores. The concurrent Think Aloud method has  
6 been used to study decision-making amongst coaches and athletes in previous sport-related  
7 studies but never in judging-based studies. Hence, this project has two aims: 1) to explore  
8 decision-making underpinning the judging process in Women’s Artistic Gymnastic (WAG) by  
9 using a concurrent verbal report, Think Aloud (TA) and: 2) to examine the utilisation of TA as  
10 a means to facilitate judging education with Malaysian WAG judges. 10 qualified judges were  
11 required to verbalise (TA) their thought processes whilst judging a balance beam routine.  
12 Follow-up interviews investigated the prospective utilisation of TA within judging education.  
13 During the judging process participants verbally reported most frequently as to lack of balance,  
14 bending of arms and knees, pointing of feet, confidence, rhythm and tempo, and personal style  
15 as focal points for scoring. Overall TA was reported prospectively as an appropriate tool for  
16 use within judging education, however, some participants reported performance in the primary  
17 task of judging was affected by TA. Study outcomes reported the potential utility of TA to  
18 study the decision-making process amongst judges to enable deduction scores to be applied  
19 objectively. This study will inform future research to investigate the decision-making processes  
20 of both expert and novice judging extending to that of all four WAG apparatus.

21

22 **Key words: Gymnastics, Think Aloud, Judging, Education.**

23

24

## Introduction

Women's Artistic Gymnastics (WAG) judges are expected to evaluate four apparatus of balance beam, floor, vault and uneven bars. They are required to evaluate these apparatus accurately, consistently, quickly, objectively and fairly and understand the intent, purpose, interpretation, and application of each rule for the current cycle. Within each current cycle, a set of rules and regulations governing WAG, the Code of Points (COP), is revised, updated, and approved every four years after an Olympic Games by the Fédération Internationale de Gymnastique (FIG) (Fédération Internationale de Gymnastique, 2016b).

WAG is a sport event combining a series of acrobatic movements with artistry. Gymnasts are expected to perform their routines with 1) maximum elements allowed for a particular apparatus within permitted time, 2) highest element difficulty with connections, 3) minimal execution deductions. Both execution and artistry scores are applied when judging. Execution deductions are applied when there is deviation from the required standards within the COP by E-panel judges. An E panel has four to six judges according to competition requirements. However, each E-panel judge is responsible for their own judgment and discussion is not permitted. The sum of the E-score awarded to a gymnast is the average score provided by E-panel judges excluding the highest and lowest deductions to reduce the 'halo' effect (McFee, 2013). All judges are required to watch the gymnast's performance whilst recording movements as symbols on notation sheets. Extra notes with symbols are also marked on the notation sheets such as a fall from an apparatus alongside execution deduction score markings (see appendix A). Therefore, WAG judges are required to have multi-tasking abilities in order to record the movements in symbol form, whilst also watching the performance and analysing the movements and comparing to the standards provided by COP (Ste-Marie, 2000). Further artistry scores are applied to apparatus such as the Balance Beam. The Balance Beam is an artistic performance whereby the gymnast must demonstrate

50 creativity, confidence of performance, personal style and perfect technique i.e. not “what”  
51 the gymnast performs, but “how” she performs. Composition is based on the movement  
52 vocabulary, both gymnastic and artistic, of the gymnast, as well as the choreography of these  
53 elements in relationship to the Balance Beam, while establishing a strong sense of rhythm  
54 and modulation of pace. Routines must show balance of elements of difficulty with artistic  
55 components in order to create a continuous flow, a cohesive whole; rhythm and tempo  
56 (speed/pace) must be varied, sometimes lively, sometimes slow. However, the routines must  
57 be predominately dynamic and above all uninterrupted and movement transition should be  
58 smooth and fluent, without unnecessary stops or prolonged preparatory movements before  
59 elements. Creative choreography is the originality of the composition of elements and  
60 movements. This means that the exercise has been constructed and is performed using new  
61 ideas, forms, interpretations and originality, thereby avoiding monotony (Fédération  
62 Internationale de Gymnastique (2012). The score calculations of a gymnast for an apparatus  
63 will be completed after the routine has finished and typically within 60 seconds.

64 Training and subsequent examination to reaccredit a WAG judge occurs every 4 years  
65 and is aligned to the Olympic cycle. Here, judges are updated with the latest rules and  
66 regulations, to ensure integrity of decisions, competency to apply the COP and FIG rules, and  
67 demonstrate moral and ethical behaviour (Fédération Internationale de Gymnastique, 2016a).  
68 Research has identified seven common biases in gymnastics judging including patriotism  
69 bias, halo bias, memory-influenced bias, reputation bias, order bias, bias emerging from  
70 social comparison processes, and conformity bias (Boen, van Hoye, Auweele, Feys, & Smits,  
71 2008; Leskošek, Čuk, Pajek, Forbes, & Bučar-Pajek, 2012). Further Pajek, Kovač, Pajek, and  
72 Leskošek (2014) reported poor inter-rater reliability and substandard validity in their study  
73 based on 194 gymnasts in the World Championship in Tokyo 2011 and subsequently  
74 suggested further research to improve the reliability and consistency of judging. However, to

75 date, the mechanisms by which score reliability and consistency could be explored are yet to  
76 emerge. It is therefore important to explore decision-making process of judges to inform a  
77 training method appropriate to develop and assess score consistency.

78         Decision-making is defined as the ability to use information from the current situation  
79 and associated knowledge possessed so as to plan, select, and execute an appropriate goal-  
80 directed action or set of actions (Williams & Ford, 2013). MacMahon and Mildenhall (2012)  
81 highlighted the challenge that a sport official faces, given that they have to possess  
82 perceptual-cognitive skills for processing incomplete, intentionally deceptive, and fast-paced  
83 information under time pressure during a competition. WAG judges are required to judge a  
84 series of fast-paced gymnastic movements whilst also under time restriction. There is  
85 presumed sufficient information and processing time for judging a slower moving apparatus,  
86 such as balance beam, hence fewer ‘gaps’ to significantly impact on judgement. In contrast,  
87 fast moving apparatuses, such as vaulting and uneven bars, may be influenced by the within-  
88 event context of previous decisions, time, and score. Within current judging education E-  
89 panel judges are briefed on general deductions applicable for each apparatus followed by  
90 specific deductions for each apparatus, moving from theory into practical judging using  
91 competition videos. Therefore, trainee judges engage in video simulated training prior to the  
92 experience of in competition judging.

93         Verbal reporting has been previously used in other forms of education and training,  
94 specifically that of Think Aloud (a form of verbal reporting), within fields such as nursing  
95 education (McRobert, Mercer, Raw, Goulding, & Williams, 2017), self-regulated reading  
96 (Hua & Gao, 2017), and motor-learning in rehabilitation (Kleynen, Moser, Haarsma,  
97 Beurskens, & Braun, 2017). Think Aloud (TA) requires continuous verbalisation of thoughts  
98 during the performance of a task (Ericsson & Simon, 1983). Ericsson and Simon identified  
99 three levels, whereby Level 1 verbalisation is simply the vocalisation of inner speech and

100 need not to be transformed before being verbalised, whilst Level 2 verbalisation involves the  
101 verbal encoding and vocalisation of an internal representation that is not originally in verbal  
102 code therefore they needed to be transformed before being verbalised. Level 3 verbalisation  
103 involves further explanations of thoughts, ideas, hypotheses, or motives and hence requires  
104 additional cognitive processing beyond that of verbalisation (Boren & Ramey, 2000;  
105 Whitehead, Taylor & Polman, 2016) and therefore may alter concurrent and retrospective  
106 processes. Level 3 has been used to elicit further detail regarding participants decisions in  
107 elite snooker players and therefore explanations were collected within this research (e.g.  
108 Welsh et al., 2018). As snooker is a self-paced activity, Welsh et al, (2018) were able to  
109 determine that snooker players freely verbalised and explained their thoughts ideas and  
110 actions in their own environment. Using Level 3 TA, Welsh et al, (2018) were able to  
111 demonstrate how stress and coping is a transactional process.

112         Within sport ,TA has been used to investigate real-time thought processes of runners  
113 during a long-distance run (Samson, Simpson, Kamphoff, & Langlier, 2015), cognitive focus  
114 in Cyclists (Whitehead et al., 2018), golfers decision-making processes (Whitehead, Taylor,  
115 & Polman, 2015), decision-making and thought processing among poker players with varying  
116 skill-levels (St. Germain & Tenenbaum, 2011), skilled perception processes and skilled  
117 problem solving in chess (Gobet & Charness, 2006) and expert performance in scrabble  
118 (Tuffiash, Roring, & Ericsson, 2007) to explore decision-making processes. Furthermore, TA  
119 has been used to aid self-awareness and reflection-in-action with coaching practice  
120 (Whitehead, Copley, Huntley, Miles, Quayle & Knowles, 2016).

121         TA, has however, received some criticism based on its reliability for participants to  
122 verbalise accurate thought processes. More specifically, participants may report additional  
123 descriptions or explanations that are not part of their actual thought process at the current  
124 time of TA (Eccles, 2012) and verbal overshadowing (Chin & Schooler, 2008; Ericsson,



149 breadth of knowledge than traditional quantitative approaches reduce to simplistic  
150 representations but also new knowledge that maybe tacit in nature.

151 To explore the depth of participants' experiences, requires the researcher to make explicit the  
152 'biases' (e.g. values, beliefs and experiences) that are inherent within the decision-making  
153 processes throughout the study. As such, the first author was an accredited Women's Artistic  
154 Gymnastics (WAG) in Malaysia (7 years of experience) and hence had an intimate  
155 knowledge of the Malaysian gymnastic sporting context. Thus, the adopted insider  
156 epistemology, together with the researcher's values and beliefs in relation to improving the  
157 quality of training for WAG judges positively influenced the design of the research and help  
158 build rapport with the participants. As the first author has prior knowledge and experience of  
159 WAG judging, both a deductive and inductive approach was used. Where a deductive  
160 approach was used (testing of theories and hypothesis), this was based on the first authors  
161 prior knowledge and rules governing the judging decision making process. In addition, where  
162 an inductive approach was used, this allowed new ideas to be identified.

### 163 **Participants**

164 The participants were 10 female Malaysian Women Artistic Gymnastics judges with  
165 international (n=4) and national (n=6) accreditation for Cycle 13th (2012-2016). Participants  
166 had a range of years of experience, from 1-9 years (M = 6.60, SD = 2.31). Participants were  
167 recruited through email forwarded by the gatekeeper (Malaysia Gymnastics Federation) with  
168 participant information sheet and a demonstration clip attached. This was followed by  
169 convenience sampling and word-of-mouth methods used to recruit the judges who were  
170 attending the 18th Malaysian Games in Sarawak, Malaysia. University Ethics Committee  
171 approval was gained and within the consent of the Malaysian Gymnastics Federation (MGF)  
172 as gatekeeper.

173 **Data Collection**

174 To ensure quality of the video clips, both demonstration video clip and TA on balance beam  
175 routine video clip were sent to three non-potential participants as a pilot study for social  
176 validation. Participants confirmed that the video clips were sufficient and provided them with  
177 an overall understanding of how to use TA when observing the balance beam routines. They  
178 had also responded both entry and exit countdown timer were helpful to prepare for TA and  
179 to sum the total deductions.

180 **General ‘Think Aloud’ (TA) training.** Prior to data collection all participants were  
181 sent, via email, the video clips of general TA training, TA demonstration  
182 (<https://www.youtube.com/watch?v=t1-Uobhvx0M&t=1s>), and TA on Balance Beam. A  
183 video clip previously used by McRobert, Williams, Ward, and Eccles (2009) was adapted and  
184 used to train participants to use TA specifically Level 2 TA. The training video required the  
185 participant to say out loud what is the next alphabet after “A” and calculating how many dots  
186 appeared on screen followed by further gymnastics specific examples, which involved  
187 balance beam clips. The clips asked participants to solve generic tasks and they were  
188 provided with the instructions to verbalise using Level 2. Therefore participants were  
189 instructed to ‘please Think Aloud anything that comes to your mind, but do not try to explain  
190 this’, (Ericsson & Simon, 1993). Level 2 TA was employed rather than Level 3, as previous  
191 research has established that instructing participant to verbalise their thoughts using Level 2  
192 does not alter performance, whereas directing participants to provide explanations for their  
193 thoughts (Level 3) may alter performance (Fox, Ericsson and Best, 2011). Asking  
194 participants to explain their thoughts whilst judging during a fast-paced activity may disrupt  
195 the judge’s ability to provide reliable or ‘real life’ verbalisations.

196           **Pre data collection training.** During face-to-face data collection, study participants  
197 were re-oriented with the TA process whereby the general training exercises were replayed  
198 (McRobert et al., 2009; Ericsson & Simon, 1993). Participants were oriented with the TA  
199 video format including the entry and exit countdown timer provided with the latter post  
200 routine to complete the E-score calculation within the 60-second time allocated. Participants  
201 were briefed to be ready for prompts by the researcher such as “please think aloud” to  
202 verbalise all execution deductions and artistry deductions whilst judging balance beam  
203 routines and in particular if they remained silence for more than 10 seconds. Van Someren,  
204 Barnard and Sanberg (1994) recommend that the training task is similar to the target task, or  
205 as they state “in general it is wise to look for a task which is not too different from the target  
206 task” (p. 43). Therefore, participants were given the opportunity to practice TA on practice  
207 videos provided previously. Sony Dictaphones (model ICD-PX240) were used to record all  
208 audio responses verbalised by participants during the TA sessions and interviews. Olympus  
209 AS-2400 transcription kit was use to process verbatim transcription.

210           **Data collection of TA on balance beam.** Participants were instructed to TA and  
211 verbalise their thoughts that were relevant to all execution deductions applied onto each  
212 element performed on balance beam routines played in a 26 minute TA balance beam video  
213 montage (<https://www.youtube.com/watch?v=nzWgjxmC4RQ>). This footage comprised of  
214 10 balance beam routines from publicly available sources with gymnasts from several nations  
215 globally and across several competitions and was created using Window Movie Maker and  
216 uploaded to a privately accessed YouTube account created by the researcher. A balance beam  
217 routine is set as less than 90 seconds as coded in COP (Fédération Internationale de  
218 Gymnastique, 2015) while a 5-second entry countdown timer was added on screen before the  
219 routine began to serve as preparation time with a green light flashing during actual  
220 competition. A 60-second exit countdown timer was added at the end of each routine for

221 participants to calculate execution scores and to TA on artistry deductions. All routine video  
222 clips were muted to exclude background noise whilst the footage angle was set from an angle  
223 akin to the judges perspective during actual competition. Participants were instructed to use  
224 Level 2 verbalisation whilst writing down usual notations and/or symbols on the judging  
225 sheets provided as in the COP (see appendix 1 for an example). Participants were prompted  
226 by researcher to TA at the beginning of routine after the second element performed by the  
227 gymnast in a routine if they remained silent. At the end of each balance beam routine,  
228 respondents were prompted to TA on artistry deductions if they remained silence for 10  
229 seconds after they had completed calculating the execution deduction scores and were  
230 waiting for next routine. Verbalisation during the TA session was recorded whilst all written  
231 judging notation sheets were collected at the end of session (see appendix 1 for an example).

232 **Interview questions.** Immediately following the completion of TA on balance beam  
233 session, participants (n=10) took part in an interview exploring the use of TA into current  
234 WAG judging education. A post TA data collection semi-structured interview was developed  
235 to gain an understanding of participants' individual experiences of engaging in the TA  
236 process. The interview (available on request) consisted of questions aimed to explore  
237 participant reflection on phases before, during, and after the TA data collection session and  
238 assessed the appropriateness to adapt TA into current WAG judging education. In addition,  
239 participants were asked to comment on the potential for TA outcomes and how it may inform  
240 coaches and gymnasts understandings of judging process/decision-making.

## 241 **Data Analysis**

242 A total of 227 minutes of TA audio clips were collected and were transcribed  
243 verbatim to make up a total of 38 pages of font Arial size 12 with double line spacing text.  
244 All transcripts underwent translation checks from the multiple languages used, including

245 Malay, Chinese, and Cantonese to English. Data was analysed using both deductive and  
246 inductive approaches. Firstly, the first author's knowledge and experience of gymnastics  
247 judging together with the judging Code of Points were employed deductively to create a list  
248 of commonly used 'judging terms'. A content analysis approach aligned to the 'judging  
249 terms' was subsequently used to identify the number of matching terms expressed by the  
250 judges using TA. Exploring the experiences of judges using TA beyond the deductive  
251 framework also allowed inductive themes to be identified and in doing so presented  
252 gymnastics judging as a socially constructed reality. In order to make sense of this reality the  
253 first author – who is immersed in the field of gymnastics judging – identified themes that  
254 were consistent across the participant data. Following this, authors 2 and 3 acted as critical  
255 friends in order to provide an 'opportunity for dialogue and the reflexive acknowledgement  
256 of multiple truths, perspectives and results in the research process (Smith & McGannon,  
257 2017, p17). The combination of these approaches facilitated a process of 'meaning making'  
258 between the judges shared cognitive expressions relating to decision making and the  
259 researchers interpretations of these meanings (Lofland & Lofland, 1996). In doing so we  
260 acknowledge that whilst each participant judges according to personal interpretations  
261 informed by experience, this approach to data analysis was done not to promote individual  
262 differences, but to highlight the shared meaning across the group.

263 Interviews lasted between 13-17 minutes and provided a total of 73 pages of font  
264 Arial size 12 with double line spacing text were transcribed for the follow-up interviews.  
265 Both a deductive and inductive approach was taken when analysing the interview data  
266 (Scanlan, Stein & Ravizza, 1989). The first author's previous knowledge and experience of  
267 being a WAG judge and implementing TA within this study was used to analyse the data  
268 from a deductive perspective. Given that, this study is the first to consider participants  
269 perceptions of TA during gymnastics judging, inductive reasoning was also employed with a

270 view of allowing themes to be generated from the raw data, through a process of thematic  
271 analysis (Braun and Clarke, 2006). Thematic analysis offered a “theoretically flexible  
272 approach” (Braun & Clarke, 2014, p.1), and involved the following stages; 1) familiarising  
273 ourselves with the data, reading and re-reading transcripts and noting initial themes, 2)  
274 generating initial codes and collecting data relevant to each code, 3) searching for themes by  
275 collating codes into potential themes, 4) reviewing the themes and 5) defining and naming  
276 themes, where clear definitions and names for themes were generated. To ensure for rigour,  
277 a double hermeneutic was undertaken, where the researchers tried to make sense of the  
278 participants own sense making, regarding their experiences of using TA. As with the TA  
279 data, a critical friend was used in the same manner (Smith & McGannon, 2017).

## 280 **Results**

### 281 **Content of TA Verbalisations**

282 Table 1 shows the thematic structure of major deductions on both general execution  
283 and artistry focused by judges during the TA session. Data revealed that all judges were able  
284 to take note of the major deductions such as a “fall” which penalised the gymnast a whole  
285 point (1.0) deduction. All participants also focused on “insufficient height of elements”  
286 executed by gymnasts with a total of 144 quotes were found across the study. These were  
287 followed by 126 quotes of “lack of balance”, which also known colloquially as “wobble”, and  
288 76 quotes of “bend arms or bend knees” quotes verbalised by 90% of the participants. A total  
289 of 64 quotes of “relaxed feet” or “feet not pointed” were verbalised by participants (n=8)  
290 while 60 quotes of “confidence” been mentioned by 90% of the participants showing judges  
291 were concerned with the artistry executed by gymnast’s despite of general execution  
292 deductions. 90% of participant’s verbalisations linked to a gymnast’s rhythm and tempo in

293 movement while 80% of verbalisations link to a gymnast's personal style whilst performing  
 294 the routine showed that artistry deductions were of highly priority.

295 **Table 1. Themes verbalised during execution deductions during the TA session**  
 296 **(P refers to participant number)**

<b>The me</b>	<b>Sub-Theme</b>	<b>Raw Data Extracts</b>
General Deduction	Fall ( <i>n</i> =10)	"fall down, deduct 1.0 point" (P1)
	Insufficient height of elements ( <i>n</i> =10)	" split leg back leg not high enough, .1" (P4)
	Bend arms/knees ( <i>n</i> =9)	"front pike with the bend knees, but she managed to catch up" (P10)
	Turn ( <i>n</i> =9)	"a bit slack, short of the turn, she didn't complete the full turn" (P5)
	Landing ( <i>n</i> =9)	"deep squat landing...let me give her a maximum .5 towards landing" (P5)
	Leg/knee separation ( <i>n</i> =9)	"double twist, legs apart" (P6)
	Pause ( <i>n</i> =9)	"she pause again before she do a skill" (P10)
	Wobble/lack of balance ( <i>n</i> =9)	" ouu wow, big wobble, .3 deducted..." (P2)
	Extra steps ( <i>n</i> =8)	"round-off two and a half... with a large step, so .3..." (P7)
	Feet not pointed/relaxed ( <i>n</i> =8)	"...combine with switch leg side aerial, didn't point toes, .1" (P7)
Insufficient split in dance ( <i>n</i> =7)	"there was not a good split leap, there was a deduction for both leg a little bit below horizontal" (P5)	
Artistry Deduction	Confidence ( <i>n</i> =9)	"overall I think she needs to boost up her confidence, especially for her dance elements, she pause like 3-5 seconds before she really did on the beam" (P10)
	Rhythm and tempo in movements ( <i>n</i> =9)	"she had confidence, personal style, not really tempo and rhythm" (P5)
	Personal style ( <i>n</i> =8)	"in terms of artistry, no confidence, no personal style..." (P8)
	Lack of side movements ( <i>n</i> =6)	"lack of side movement, 0.1..." (P10)
	Missing combination of movements/ elements close to beam( <i>n</i> =3)	"missing combination (of movements/elements close to beam) 0.1" (P1)

297

298

## 299 **Post TA Session Interview**

300 Table 2 provides an overview of the main themes that emerged through participant  
301 interviews after using TA whilst judging balance beam videos. Within this, 60% of  
302 participants expressed positive perceptions of TA in applying TA within WAG judging  
303 education. Participants (40%) reported tangible benefits from TA, for example participant 2  
304 noted: “it (TA) helps you to speak out what’s inside your mind”. Moreover, 40% of  
305 participants reported that the TA could assist WAG judging course instructors to access to  
306 thoughts/decision-making of novice judges in particular to correct errors such as invalid  
307 execution deductions. For example, participant 5 said course instructors could understand the  
308 *reason for deductions* through TA thus corrections could be made immediately while  
309 participant G noted: “I feel that this [TA] is very good for judging purposes, especially for  
310 training the new judges because a lot of the time they do not actually know *how* they arrive at  
311 the deductions”.

312 Participants commented on the utility of TA within judging and suggested that by  
313 sharing thoughts/views between expert judges and novice judges as well as between novice  
314 judges themselves may help to improve application of correct execution deductions for a  
315 particular movement by way of appreciation of views from other judges. Participant 3 stated  
316 “it will be more useful if there is a pair or more than one person looking into the video and  
317 TA together so that all of the judges can share their thoughts on the gymnasts performance  
318 and from this, one can learn from each other on the deductions and also the execution.” while  
319 participant 7 said “It’s always easier if there is someone more qualified to sit with them  
320 [novice judges] because sometimes they do not understand where the deductions come from,  
321 that’s why actually I think doing this [TA session] is very good to train new judges.”  
322 However, participant 10 shared her experience in previous judging whereby novice judges  
323 who served in execution panel might be correct sometimes as compared to expert judges who

324 used to judge both difficulties and execution at the same time which might distract them:  
325 “We also need to reflect on ourselves [experienced judges] because we can’t see because we  
326 are the experience judge that means we are always right, there could be a possibility that  
327 actually we have overlook certain things...”.

328 Findings showed that 40% of participants expressed that they experienced restrictions  
329 to using TA whilst judging the balance beam routine video clips. Participant F noted “the  
330 mind is faster than the mouth...” while participant 7 said “we [judges] can’t multi-task so  
331 much by talking and writing and recording whatever we need to do. If we are doing it all  
332 together, most of the time actually we might miss out one or two of the deductions”. In  
333 addition, the participants noted that the TA using video clips could be further applied within  
334 ‘live’ training sessions to provide feedback to coaches and gymnasts in situ. Participant A,  
335 both a coach and a national judge, suggested gymnasts themselves via the judges TA data  
336 could understand faults such as ‘wobble’, ‘lack of height’ of elements and under rotation  
337 with turns better when they, as is typical, are simply shown the video replays recorded during  
338 training. Indeed, seven out of ten participants offered support to the use of TA whilst  
339 coaching and its potential influence therefore on coaching. Participant 7, an international  
340 judge and also a coach expressed that holding a ‘dual role’ as a coach and judge could  
341 influence decision-making process:

342 ‘...As judges actually, we only focus on looking at how well they (gymnasts) can  
343 perform the skills, how they execute the skills and what are the deductions that we  
344 should actually...like... look at. But as a coach, they [coaches] are more into  
345 technique where they sometimes... you know they actually didn’t look at how judges  
346 *judge* the routine. By working together, the gymnast actually if they work together  
347 with the judges, they can do better and they will score higher....’ (Participant 7)

349 **Table 2. Perceptions of TA by WAG officials (P refers to participant number).**

Theme	Sub-Theme	Example Raw Data Extracts
Perception of TA use	TA in judge training programme	"If this [TA] is applied in the judging training courses I think it's quite good so that it can help judges to understand at which point... exactly at that point of time where [the deductions are ] happening." (P6)
	Speak out	"I feel that I learnt that somehow we [judges] need to speak out loud more instead of you just keep in inside in your heart and then when you speak it out, you can share more your judging experience with others because maybe our judging experience and other people's judging experience is different." (P9)
	Accessing thoughts of novice judges	"For new judges I would think it's good for them to speak out about their own deductions and from there actually they will know whether what they are deducted is actually correct or it's actually they need maybe more training." (P7)
	Accessing thoughts of expert judges	"It [TA] will be more useful if there is a more experienced judge to TA together with you so you can know what did other judges (did) looked at the gymnasts, what their deductions on their elements." (P3)
	To correct judging errors	"A lot of time the new judges do not actually know what to deduct... or maybe it's a wrong deduction instead of a wobble 0.1 they might take a 0.3 or 0.5 (deduction) so that is a big difference if you actually take a wrong deduction." (P7)
	Training new judges	"I feel that this [TA] is very good for judging purposes, especially training the new judges because a lot of the time they do not actually know how to arrive with all these deductions." (P7)
	Helpful to gymnast	"When we record then show our gymnasts, then only they understand where is their mistake, ... if you never show them the video they don't understand. Like for wobble, if you record down (and) show them then they only know... okay, okay... leg not high enough, never jumped, never turned properly... the details can (be) seen very clear from the video. Only (by) talk, they [gymnast]... sometimes they don't understand because they never see, they don't know." (P1)
Limitation of TA	Multi-tasking	"You want to speak out what you see then you want to write down, so you can't do a lot of things at one time." (P4)
Experiences in TA	Previous TA experience	"We [judges] didn't speak aloud like that... like we just go through ...I mean like not whole routine, maybe like a certain skill only. We didn't like speak aloud like... play the whole routine" (P4)

Current TA experience "It's a good experience to [TA] actually to talk and write and record down everything... I think it's interesting. We should try [TA] again... I think if we just talk about the deductions I think it's even better." (P5)

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## Discussion

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The primary aim of the research was to design, implement, and examine the utility of TA for use within women's artistic gymnastic judging education. Following design and implementation, participants expressed their acceptance towards the use of TA in WAG judging education with advantages such as sharing of thoughts to apply correct execution deductions through TA verbalisation. Participants also expressed the potential to apply TA within judging education courses and training for thought access and to ensure the objectivity of judging scores.

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The TA video clip compilation of non-stop 10 balance beam routines according to the interview data may have overburdened the non-international respondent. Previous TA research has acknowledged that there is no guidance as to the length of time that a participant should TA for (Eccles & Aarsal, 2017). Nicholls and Polman (2008), did consider the length of TA within their study noting that using TA for a prolonged period of time may become challenging for the participant. There was no scheduled break during the TA session and whilst suitable for training within judging education courses/post course development, it was deemed unrealistic as that of a typical competition setting may consist of only four to six gymnasts in a rotation. Therefore, the length of TA session for a single apparatus should be shortened in further research to mimic that of a real competition. Therefore, five routines for balance beam and floor exercise respectively was suggested for the TA session in future studies.

372 Study participants reported having to multi-task during judging (Ste-Marie, 2000) and  
373 therefore adding a 'speaking' element (TA) into the judging task may have adversely  
374 affected the judging process. This may be attributed to verbal overshadowing (Chin &  
375 Schooler, 2008). Schooler and Engdler-Schooler (1990) provided evidence for verbal  
376 overshadowing and found that a disruptive effect occurs through verbally reporting as verbal-  
377 overshadowing occurs as the formation of a verbally biased memory representation that  
378 overshadows original visual memory. It is argued that by asking participants to TA may  
379 result in reactive effects on task process and can influence the performance of a task. Further,  
380 future research aiming to employ TA within WAG judging may consider removing, as part of  
381 a developmental process, the notation from the task in order to reduce potential verbal  
382 overshadowing and improve attentional focus.

383 Interestingly the content of TA verbalisations varied across judges, with deduction  
384 themes being reported by some judges and not others. For example, *Fall* and *insufficient*  
385 *height* were verbalised by all participants, however some themes were only verbalised by 7  
386 (insufficient split - in dance element), 6 (lack of side movement - in routine construction) and  
387 3 (missing combination of movements) participants. Although, not something that was  
388 investigated within this study, however, future research could seek to investigate the  
389 decision-making differences between different levels such as international-non-international  
390 during judging (Catteeuw, Gilis, Jaspers, Wagemans, & Helsen, 2010; MacMahon & Ste-  
391 Marie, 2002; Ste-Marie, 1999). Although some time ago, Ste-Marie (1999) found that expert  
392 judges with more than 10 years of judging experiences were better at predicting the upcoming  
393 gymnastic elements and judged more correctly on those elements. Indeed, since 1999 the  
394 COP has moved through several revised versions due to the increasing complexity of routines  
395 and skills now seen in competition. In WAG, only categories 1 and 2 international judges, are  
396 eligible to judge at World Championships (Fédération Internationale de Gymnastique, 2016a)

397 thus, by virtue, have more judging experience when compared to those holding lower levels  
398 of judging awards. As such, it could be said that they might be more able to verbalise their  
399 decision-making using TA during judging tasks by providing more objective and reliable  
400 judging scores than novice judges as a consequence of accumulated judging experiences.  
401 Further, such judges may be able to retrieve information in their memory more efficiently and  
402 cope with the multiple attentional demands. This insight may well inform further study to  
403 explore verbal overshadowing (Chin & Schooler, 2008) and the multi-tasking of judges (Ste-  
404 Marie, 2000) whereby adding another “speaking” element into existing judging task in the  
405 TA session may affect the subsequent reliability and objectivity of judging scores.

406 Data provided through TA from the WAG judges could be used to inform coaching  
407 practice as it allows the coach to understand the decision-making with regard to deductions  
408 and provide illustration beyond that gained from video replay for the gymnast themselves.  
409 Although not within judging, similar suggestions have also been provided in previous  
410 research, which relates to the coach and athlete, where TA could be used to inform coach and  
411 practitioner interventions and practice (Nichols and Polman, 2008; Samson et al, 2015;  
412 Whitehead et al., 2015; Whitehead et al., 2018). More specifically, through understanding  
413 athlete cognition coaches and practitioners may be able to provide more informed  
414 interventions when working with their athlete. In a similar fashion, the coach could learn  
415 from the WAG judge’s decision-making process through the use of TA.

416 An important limitation to acknowledge could be due to the researcher collecting this  
417 data having a significant level of expertise in the area of gymnastics judging. This level of  
418 expertise could have created some sort of ‘Hawthorne Effect’ (Haessler, 2014), where the  
419 subjects awareness of being observed during their TA trial, may have affected their  
420 responses. In addition, due to the researcher having a high level of expertise within WAG

421 judging, this could also have had an impact on what is being reported. Future research may  
422 want to take this into consideration.

423           In conclusion, results suggest that TA could be an appropriate tool to include within  
424 current Women's Artistic Gymnastics judging education to explore the decision-making of  
425 judges when making general execution and artistry deductions. TA may support, in  
426 particular, the development process of novice judges by improving the cognitive processes  
427 and awareness of the execution deductions during routine performance. It is recommended  
428 that future research develops the use of TA as a training method to facilitate the development  
429 of WAG judges and to investigate the TA differences between experienced and less  
430 experienced judges to inform future practice. Further the utility of TA across apparatus could  
431 be explored beyond that of the balance beam exercise and thus becomes fully representative  
432 of the judging requirements within a competition

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Appendix 1: Example of a judging symbol notation sheet

CV 0.1	0.2	CR	CV	0.1	0.2	CR	CV	0.1	0.2	CR
D + D or more	D (flight → or ↗) + C, or more on HB Must be performed in this order	HB → LB Flight →	Acro Flight (no DMT) All connections must be rob except when staked	C/D + D (non reb fwd) C + C B + E	C/D + D B + D (fwd dir) B + F	2 different Dance - 1 with 180° split / straddle	Acro Indirect B/C + D A + A + D	C + E D + D A + A + E	2 different Dance - 1 with 180° split / straddle	2 different Dance - 1 with 180° split / straddle
D + E (both flight ele.)			Acro Series Bonus (DMT min. C)	B + B + C D + B + C		Turn (Gp. 3)	Acro Direct A + D C + C	A + E C + D	Salto Direction (F/S & B)	
C/D with Turn or Flight			Dance / Mixed (No cast, MT, DMT)	C + C D + A A + C	D + D	Acro Series (2 ele. 1 salto)	Mixed D (salto) + B (dance) E (salto) + A (dance)		Salto with LA turn (min. 360°)	
Jump from LB to HB	0.5		Confidence		0.1	Acro Direction (F/S & B)	Turns B + B (no step)	D + B	Salto with Double BA	
Hang on HB, feet on LB, grasp LB	0.5		Personal style		0.1	DMT	Expressiveness		DMT	
+2 of same element into DMT	0.1		Rhythm & tempo in movements (no DV)		0.1		Confidence			
			Exercise as a series of disconnected elements & movements		0.1		Personal style			
			Lack of variety and/or creativity of movements & transitions		0.1		Inability to play a role or a character throughout			0.1 Missing movement touching floor
			Lack of side movements (no DV)		0.1		Exercise as a series of disconnected ele./movements			0.1 Missing min. 360° turn on one foot
			Insufficient use of entire length of beam		0.1		Poor editing - no structure to the music			0.1 +1 ele to prone position
			Missing combination of movements/elements close to beam		0.1		Incorrect selection of movements for particular music	0.1/0.3		0.1/0.3 Musical beats, rhythm, tempo
			Mount not from the table of elements		0.1		Lack of variety and/or creativity of movements & transitions			0.1 Background music
			+1 1/2 turn on 2 feet with straight legs (throughout exercise)		0.1		Inisuff. use of straight lines, curves & changes of direction			0.1 Synchronization at end of exercise
①										
②										
③										

FIG WTC January 2014