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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)**

The me	Sub-Theme	Raw Data Extracts
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)

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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 <i>Must be performed in this order</i>	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.)		2 different Grips (No cast, MT, DMT)	Acro Series Bonus (DMT min. C)	B + B + C D + B + C	D + D	Turn (Gp. 3)	Acro Direct A + D C + C	A + E C + D	Salto Direction (F/S & B)	Salto with LA turn (min. 360°)
C/D with Turn or Flight		Non-flight with 360° LA turn (no MT)	Dance / Mixed Salto + Dance / Scale (this order) Turns	C + C D + A A + C		Acro Series (2 ele. 1 salto)	Mixed D (salto) + B (dance) E (salto) + A (dance)		Salto with Double BA	DMT
Jump from LB to HB	0.5	DMT	Confidence Personal style Rhythm & tempo in movements (no DV) Exercise as a series of disconnected elements & movements Lack of variety and/or creativity of movements & transitions Lack of side movements (no DV) Insufficient use of entire length of beam Missing combination of movements/elements close to beam Mount not from the table of elements +1 ½ turn on 2 feet with straight legs (throughout exercise)	0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	DMT	Expressiveness Confidence Personal style Inability to play a role or a character throughout Exercise as a series of disconnected ele./movements Poor editing - no structure to the music Incorrect selection of movements for particular music Lack of variety and/or creativity of movements & transitions Insuff. use of straight lines, curves & changes of direction	0.1 0.1 0.1 0.1 0.1 0.1/0.3 0.1 0.1 0.1	0.1 0.3 0.1 ea 0.1/0.3 0.5 0.1	
1							EXE	ART	0.3	
2							EXE	ART	1.9	1
3							EXE	ART	1.2	1

FIG WTC January 2014