

Introduction

The Constraints-Led Approach (CLA) has surfaced in recent decades as a promising new avenue by which pedagogues may better foster motor skill acquisition among prospective learners. Fundamentally, the approach posits that the manipulation of constraints (i.e., features of an organism, their environment, and the task at-hand that together interact to define said individual's opportunities for action) on the part of the practitioner can function to facilitate the emergence of certain movement patterns

(Schmidt & Lee, 2020). Intentional manipulation of said constraints is thus considered (by proponents of the approach) an effective means whereby a practitioner may promote a learner's discovery of appropriate movement solutions (Schmidt & Lee, 2020). Underpinning this approach is a theoretical framework entitled Non-Linear Pedagogy, of which a fundamental tenet is the refutation of prevailing notions that universally

optimal movement solutions do, in fact, exist. This framework is in turn founded upon the propositions of the theoretical rationale of motor behavior entitled Ecological Dynamics.

Purpose:

We sought, in our work, to ascertain the extent to which the implied effectiveness of this approach (for eliciting motor learning) is substantiated by empirical work in the literature; however, also inherent to our mandate was garnering an understanding of the nature of these existing empirical works, in terms of research design, sporting context, sample demographic, metrics utilized, among other features.

The gardener cannot actually “grow” tomatoes, squash, or beans – she can only foster an environment in which the plants do so.

– Stanley McChrystal (as cited in Woods et al., 2020)

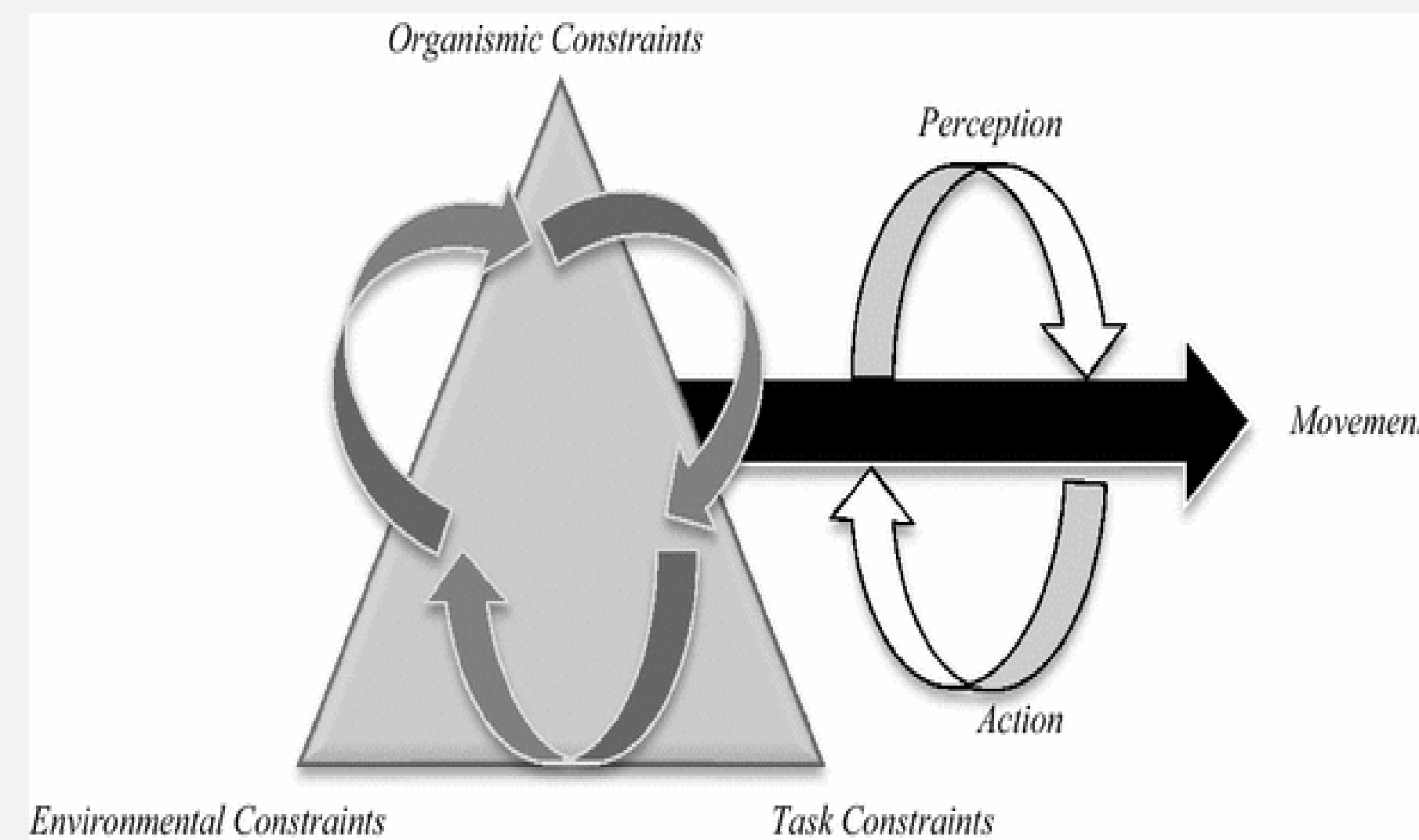


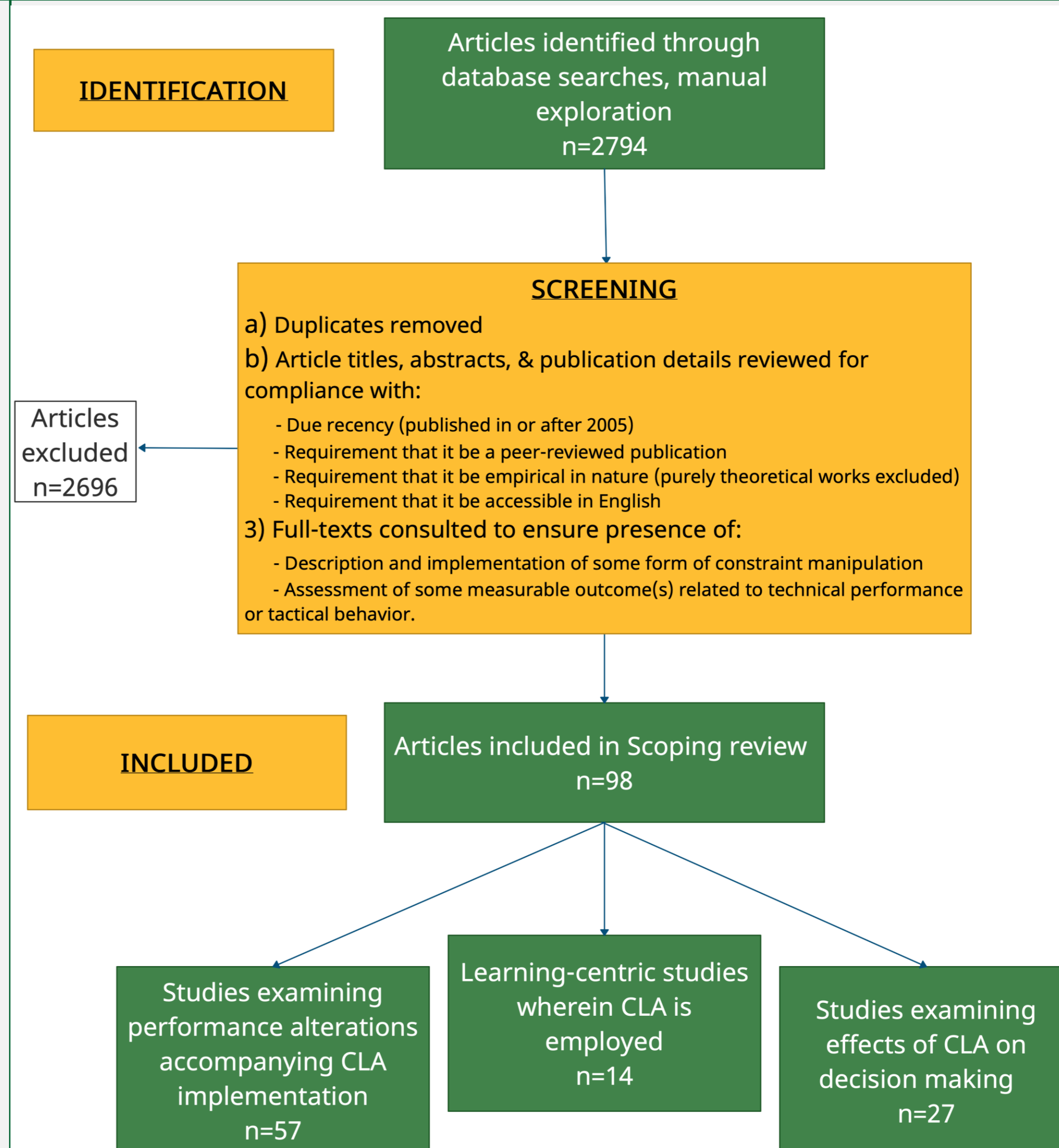
Figure 1. Pictorial representation of the Ecological Dynamics perspective of motor behavior – a theoretical rationale on the basis of which the CLA instructional methodology was conceived (Serra-Oliveres et al., 2016).

Methods

In pursuit of the aims noted above, we conducted a scoping review of the literature pertaining to the CLA for motor skill acquisition, utilizing as the subject of our analysis a comprehensive database composed of empirical studies featuring the approach. A total of 9 databases (and search engines) were explored to obtain relevant and recent articles – with the specific platforms used including PsycINFO, Academic Search Complete, Physical Education Index, CINAHL, Sport Discus, ERIC, CBCA Education, PubMed, and Google Scholar. The keyword search was engineered to retrieve an encompassing yield of relevant work, and was replicated in each database as follows:

“(“non*linear pedagogy” OR “constraints*led (approach* OR method* OR perspective*)” OR “competitive engineer*” OR “ecological dynamic*” OR “representative task design” OR “perceptual*motor landscape”) AND (“skill acquisition” OR “motor learning” OR “sport” OR “perceptual motor learning”)

Preliminary findings revealed that the quantity of studies devoted to ascertaining learning effects was dwarfed by that of studies concerned with alterations in performance or decision making during the acquisition phase; as such, the scope of our review was dilated to include these alternative assessments of the CLA's utility.



Results & Discussion

Of the collection of articles amassed through our exploratory undertakings, the tally of studies found to include a passable assessment of learning in their investigation of the CLA was a disheartening 14 (studies). What we did find there to be an abundance of, however, was studies wherein a constraint manipulation was imposed, but the effects of such only examined within the acquisition phase; that is, any assessments of outcomes were conducted while the constraints-led intervention was still underway. As such, they do not comply with our criteria for a valid assessment of learning, which require that some post-test, retention test, or transfer test be administered subsequent to cessation of the CLA intervention, so as to provide evidence that changes arising from said intervention are stable & enduring. For the purposes of our review though, such studies were still deemed useful, given that any changes observed concurrent with a CLA intervention's implementation suggest that continual adherence to these training practices could bring about long-lasting changes. Conversely, the potential remains for such changes to attenuate in the absence of training, and thus, these studies are not considered to be equitable in value to learning-centric studies (for this review). These studies were thus segregated from learning-centric studies, then assigned either under a “Performance Alteration” or “Decision-Making” grouping, according to whether the dependent variables of concern were related to technical performance or tactical behavior, respectively.

Notable Findings Among the Learning-Centric Studies

- 4 of the 14 featured manipulations of both environmental- and task-constraints; 8 of 14 involved only task-constraint manipulation; only 2 of 14 entailed some form of personal constraints manipulation.
- 3 of the 14 involved skilled participants; remaining 11 (of 14) featured novice participants.
- 9 different sporting or performance contexts were found across the 14 studies; 7 of these represent individual sports or performance contexts, and the other 2, team sport contexts.
- Soccer (European football) was the sport that received the most attention in the respective literature, as it was seen featured in 6 of the 14 studies.

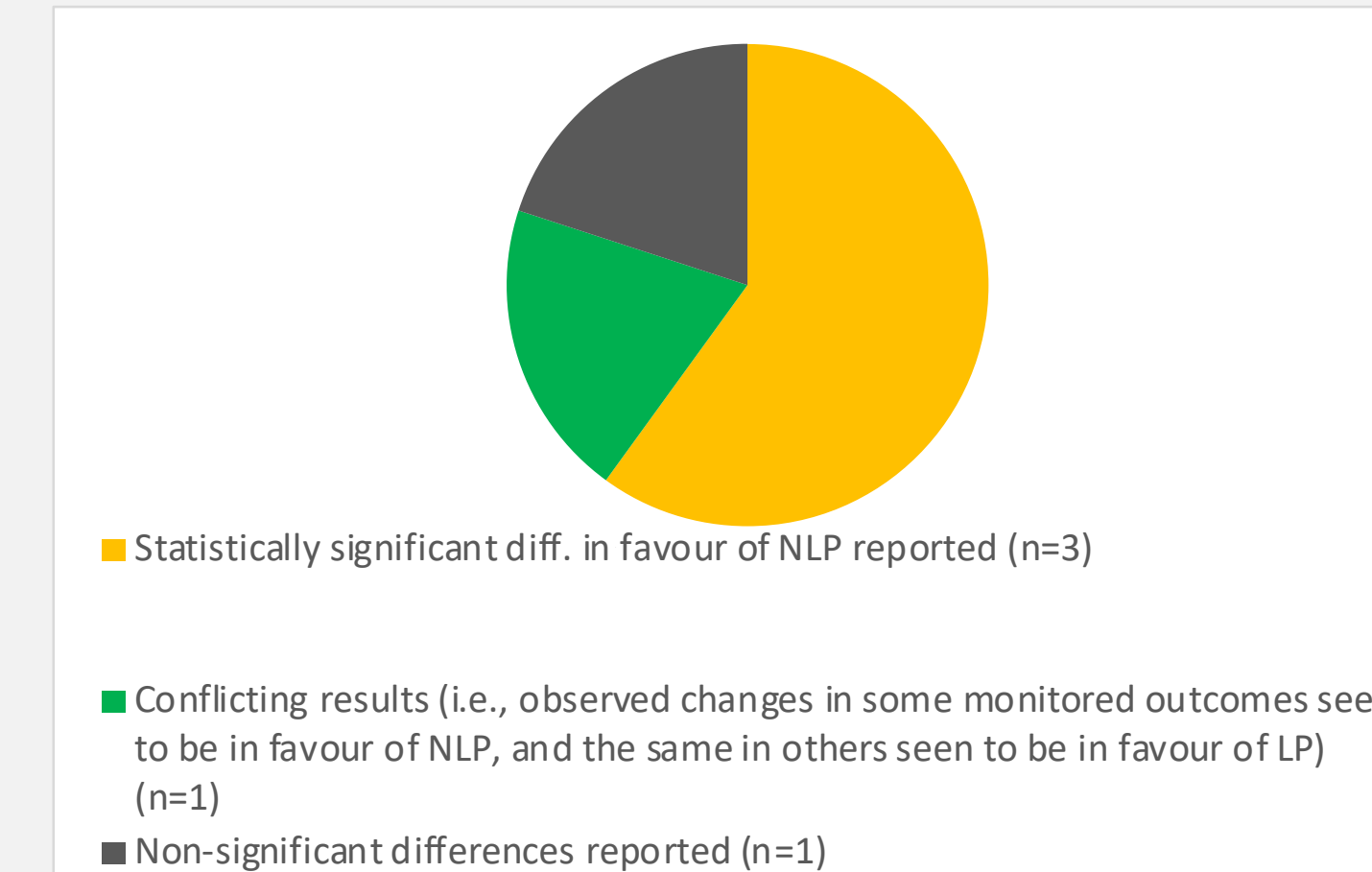


Figure 2. Nature of the findings reported in learning-centric studies wherein the CLA is examined (as an operationalization of Non-Linear Pedagogy) alongside an operationalization of Linear Pedagogy (n=5).

One trend in the literature we found to be quite encouraging was the appreciable uptick that has been seen of late in yearly publications of articles relating to efficacy of the CLA, specifically that of studies incorporating robust learning assessments. For this latter category of articles in particular, enormous acceleration in output has materialized over the last three years (Figure 2).

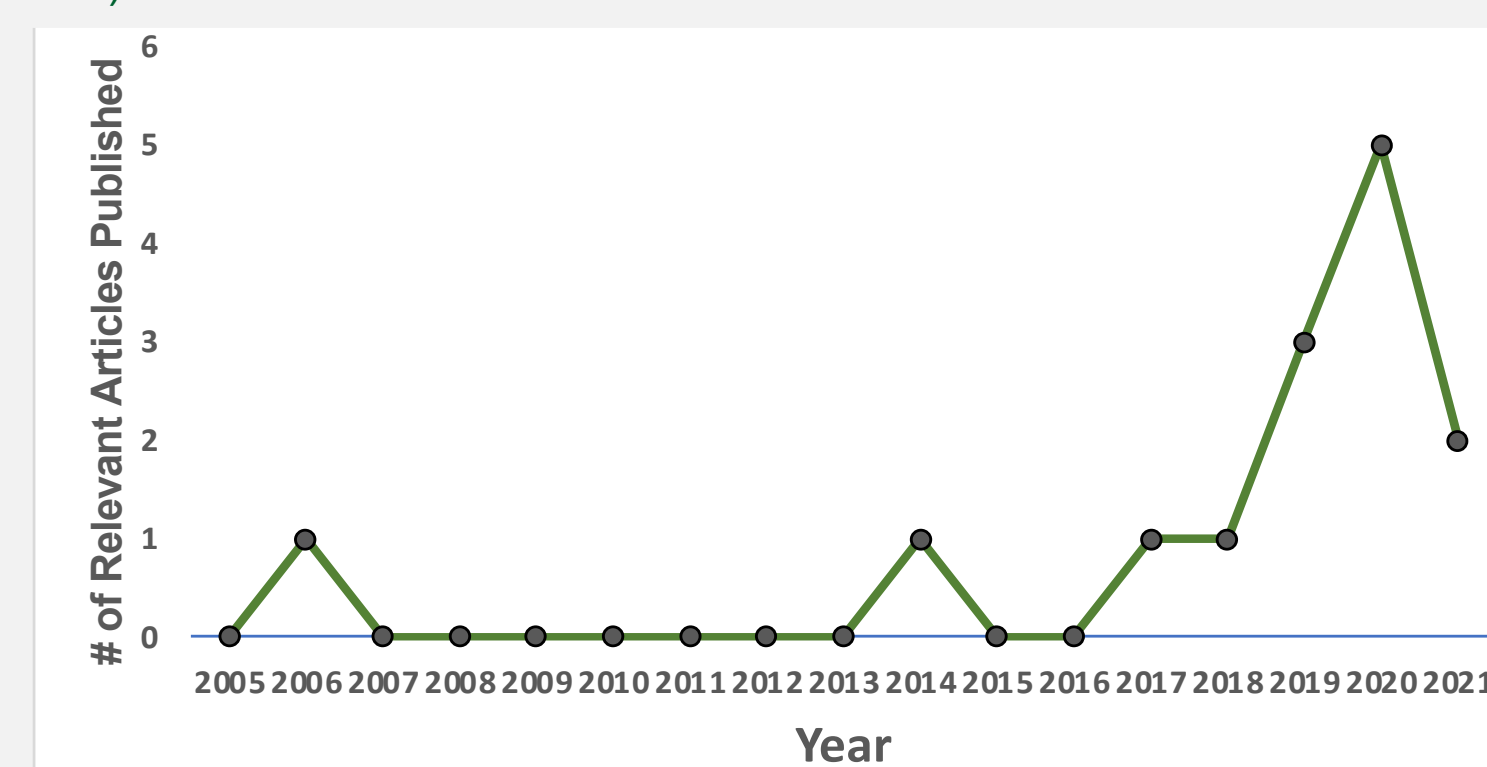


Figure 3. Trend of yearly publications of articles investigating the efficacy of the CLA with respect to learning.

The “Performance Alteration” and “Decision-Making” article categories are still under analysis. Initial impressions suggest that they both mirror the “Learning-Centric” grouping in numerous ways – most notably in the heterogeneity exhibited across their constituent articles.

CLA Exemplar

Excellent example of an operationalization of the constraints-led approach, wherein a task constraint (i.e., visual occlusion goggles) is introduced to the performer so as to direct their attention, by means of constraining their visual field, towards salient sources of information in the performance setting (i.e., the motion of the intended pass recipient as opposed to that of the ball) (Dunton et al., 2020). This guides them in their exploration of the field of opportunities for action (governed by interacting constraints), and enables them to perceive, with greater acuity, the most effective actional opportunities; by virtue, this promotes efficiency in **realizing** situationally optimal movement solutions. Participants were randomly assigned to one of three groups: Occlusion (OCC), Practice (PRA) and Control (CON). Participants in the PRA groups completed the same intervention as the OCC groups, only without the spatial occlusion goggles and those in the CON group completed testing protocols only.

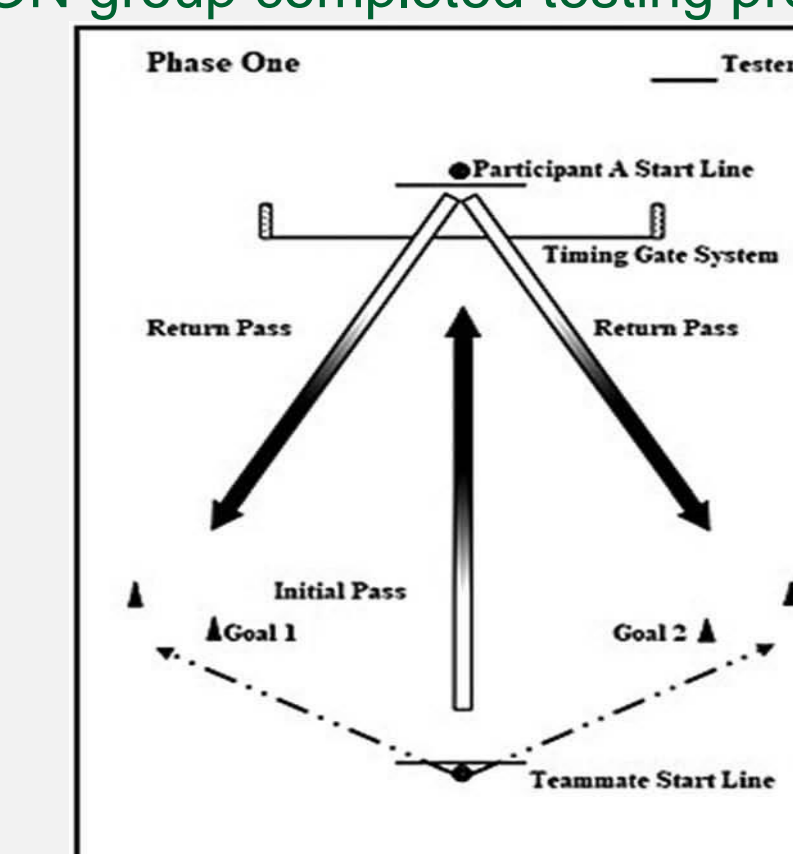


Figure 5. Visual occlusion goggles (Dunton et al., 2020).

Figure 4. Experimental and training protocol; participant A (subject under analysis) receives a pass from, and must return a pass to, a teammate darting from a central position to Goal 1 or Goal 2 – as determined by coach at random (Dunton et al., 2020).

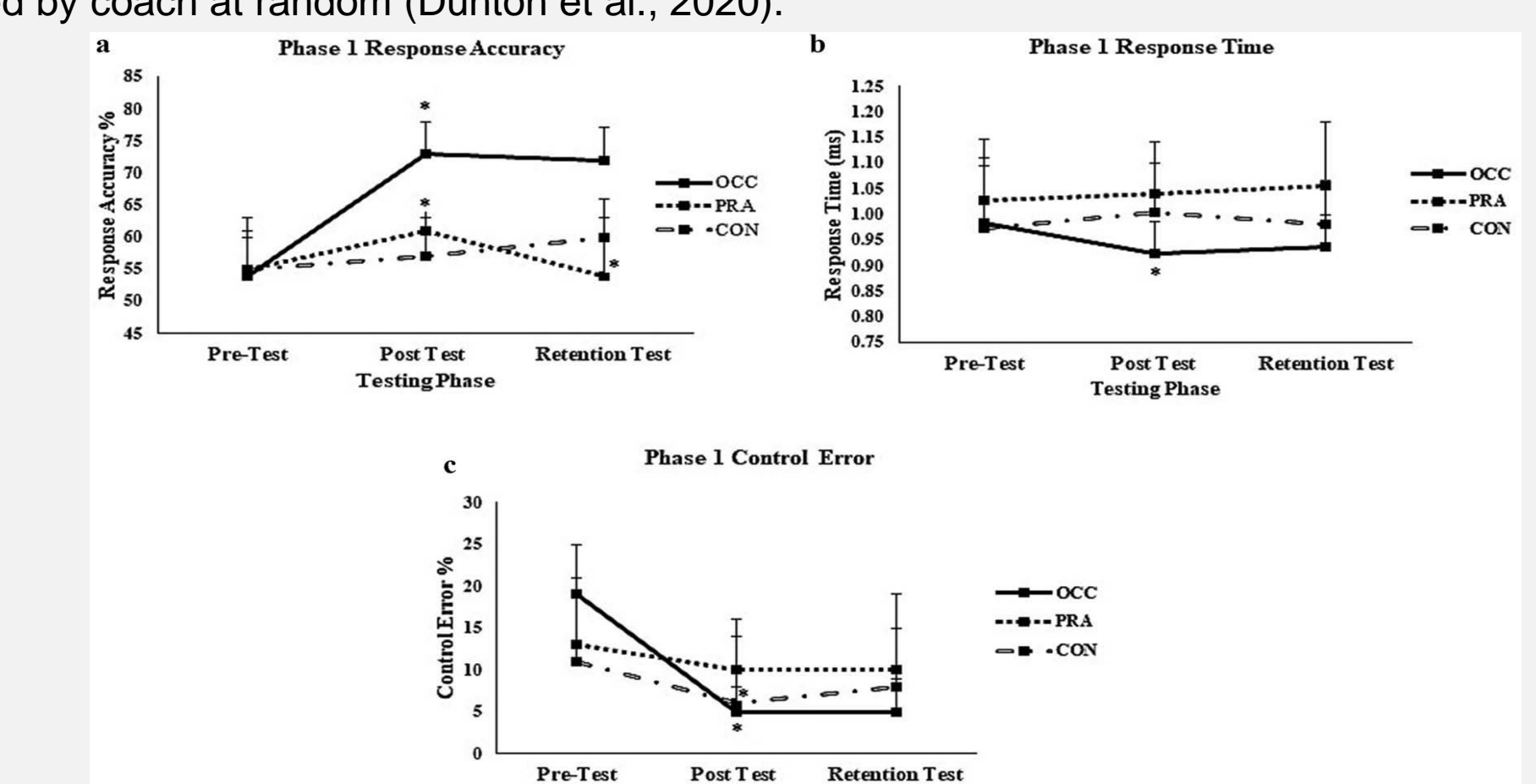


Figure 6. (a) Mean scores for response accuracy for each group, (b) Mean scores for response time for each group, (c) Mean scores for control error for each group, error bars indicate standard deviation with '*' used to identify significant changes. Significant improvements evident in OCC group from pre- to post-test (with such improvements maintained in retention tests) for each performance variable (Dunton et al., 2020).

Conclusions & Directives

Although the evidence unearthed thus far appears to partially support the purported promise of the CLA, the scarcity of relevant empirical works wherein a passable assessment of learning is incorporated, coupled with the significant heterogeneity characterising the existing collection of studies, do not endear one to great confidence (as yet) in this as the most effective means for inducing motor learning.

Forthcoming investigations into the utility of the CLA should aspire to pair constraints-led interventions with robust assessments of learning; further, researchers should seek to situate such investigations in contexts thus far neglected in the literature.

Notably, some are calling for greater efforts to be made by researchers to demystify for practitioners the challenging, and at times confronting, language inherent to the CLA – the intent of such being to foster greater uptake of the approach among pedagogues (Renshaw & Chow, 2019). It is reasonable to suspect that increased interest in the CLA among practitioners would translate to greater attention being devoted to the approach (and to identifying its true merit) among researchers – accordingly, we echo such a directive.