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REGULAR ARTICLE

### **Zone of Proximal Development (ZPD) As an Emergent System: A Dynamic Systems Theory Perspective**

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This paper sets out to present a novel construal of one of the notions of Vygotskian cultural-historical theory viz., zone of proximal development (ZPD) drawing upon dynamic systems theory. The principal thesis maintains that ZPD is an emergent and dynamic system which is engendered by a dialectical concatenation of psychogenetic and sociogenetic facets of human development over time. It is reasoned that Vygotskian cultural-historical theory of human development, by invoking dialectical logic, has transcended Cartesian substance dualism and in turn has proffered a monistic and process-anchored ontology for emerging becoming of human consciousness. Likewise, it is contended that dynamic systems theory, having assumed fluent flux of reality with a capital R as its ontological axiom, entails a consilience of cognitive and contextual conceptual schemes to describe, explain, and optimize human development. The paper concludes by drawing some interpretive conclusions in regard to ZPD from dynamic systems theory perspective.

**Keywords** Zone of Proximal Development (ZPD). Vygotskian Cultural-Historical Theory. Dynamic Systems Theory. Emergence. Dialectical Logic.

This article seeks to present a novel interpretation concerning one of the seminal constructs of Vygotskian cultural-historical theory (hereafter CHT) (Vygotsky 1978, 1981, 1986, 1997a), zone of proximal development (ZPD), drawing upon some aspects of dynamic systems theory (hereafter DST) which is current in developmental science. DST 'signifies a multidisciplinary and overarching frame of reference for multiple theoretic persuasions which endeavor to study becoming-in-time dynamics of emergent, complex and non-linear systems' (Karimi-Aghdam 2016b, p. 95). Within disciplinary ambit of developmental science, DST is a unifying metatheory - a paradigmatic and overarching outlook about systems-based approaches and theories- for describing, explaining, and optimizing human development (Lerner 1978, 1996, 2006; Lewis 2000; Lyra 2010; Witherington 2007, 2011; Overton 2010). Further, DST purports to investigate time-dependent developmental trajectories of dynamic, complex, and self-organizing systems (Thelen & Smith 1994; for an accessible genealogy of systems thinking, see Hammond 2002). Consistent with arguments that considers CHT and DST in terms of their ontological presupposition and metatheoretical axioms commensurable (Karimi-Aghdam 2016a; Karimi-Aghdam 2016b; Karimi-Aghdam 2016c; Karimi-Aghdam, Dufva, Lähtenmäki 2016) and in line with Valsiner and van der Veer's (1993, 2014) enlightening reappraisal of the notion of ZPD, the principal thesis, maintains that ZPD is an emergent and dynamic system. It is proposed that ZPD is co-constructed by temporal and indissoluble interpenetration of opposing components of human development - the ongoing and infinite cultural-historical and individual dialectical process (see also Riegel 1976).

After being kept in abeyance for quite a long time, CHT and ZPD were introduced into Western scholarly circles in early seventies (see Van der Veer & Valsiner, 1991,

chapter 12, for a comprehensive history of ZPD). Along with the triumvirate of activity, mediation and internalization, ZPD is appropriated to serve specific purposes of different fields of studies. For example, ZPD has been a common refrain in developmental science and educational sciences embracing Vygotsky's revolutionary conceptualization of human development (Chaiklin 2003; Well 1999). Moreover, it can hardly be doubted that some usages of the cardinal concepts of CHT- and ZPD in particular - for example in educational sciences, applied linguistics, and developmental science literature have resulted in an amorphous conceptualization and operationalization of Vygotsky's original orientation to cultural-historically mediated genesis of human development and consciousness (Leont'ev & Luria 1968; Griffin & Cole 1985; Valsiner 1988; Wertsch 1984). Further, much of the work on ZPD has invoked socioculturally constructed versions of Vygotskian psychology relying mainly on English translation of Vygotskian scholarship (see van der Veer & Yasnitsky 2011) to offer pedagogical implications of relevance for educational purposes.

Besides, in spite of the popularity of Vygotsky's writings worldwide, it seems there is no trade-off, neither theoretically nor empirically, between application and development of his ideas (Valsiner 1988; Yasnitsky 2012, Valsiner & van der Veer 1993, 2014). Finally, ZPD is singled out in this article because it lies at the fulcrum of Vygotskian CHT approach to describe and explain structure, functions and genesis of human consciousness (Simon & Simon 1963; Davydov & Radzikhovski 1985; Bakhurst 1991; Vygotsky 1999a) and higher-level functions that are mediated by ideational and physical artifacts including speeching activities.

This article following the general line of reasoning carved out by developmental and cultural psychologists concerning DST and CHT (e.g., among others see van Geert

1994, 1998; Cole 1985, 1996; Cole & Wertsch 1996; Lauro-Grotto, Salvatore, Gennaro, & Gelo 2009; Valsiner 1984; Valsiner & van der Veer 1993, 2014, Thelen & Bates 2003; Stetsenko & Arievitch 2010; van der Veer & Yasnitsky, 2010; Karimi-Aghdam, 2016a; Karimi-Aghdam 2016b; Karimi-Aghdam 2016c) seeks, *inter alia*, to vindicate emergent and dynamic nature of ZPD. Reinterpreting ZPD within meta-theoretical constellation of Vygotsky's dialectical thinking and through the lens of DST is conducive to not only pinning down some of unrecognized underpinnings of ZPD but expanding its theoretical interpretations geared towards emerging needs of educational research and classroom practice in particular. In order to set the ground for the main thesis of the article, first some bedrock axioms of DST and CHT are discussed. The main thrust of the article engages with elaboration on ZPD from DST vantage point. The final section carries out the evaluation and draws some conclusions.

### **Dynamic Systems Theory and Vygotskian Cultural-Historical Theory: A Dialectical Perspective**

Dynamic systems theory (Overton 2006, 2007; Overton & Ennis 2006; Witherington 2007, 2011, 2014) or developmental systems perspective (Lerner 2006) is one of the most viable and comprehensive meta-theoretical schemes in developmental science which cogently and coherently caters for concerns of describing, explaining, and optimizing the processual trajectory of human development over time. System philosophy 'reintegrates the concept of enduring universals with transient processes within a *non-bifurcated*, hierarchically differentiated realm of invariant *systems*, as the ultimate actualities of *self-structuring* nature' (Laszlo 1972, italics added). Hence, what-questions about the nature or essence of be(com)ing or existence (ontology of systems)

along with how-questions about the nature and grounds of knowledge (epistemology of systems) are inextricably interwoven in the philosophical position of systems thinking (e.g., Bertalanffy 1968). Similarly, Vygotsky (1978) writes:

The search for method becomes one of the most important problems of the entire enterprise of understanding the uniquely human forms of psychological activity. In this case, the method is simultaneously prerequisite and product, the tool and the result of the study. (p. 65)

It could be argued that common points of departure of CHT and DST share more than a mere superficial resemblance, although origins, objectives and theoretical underpinnings of their attentive philosophical frameworks - systems thinking and dialectical materialism- are conspicuously different (Levins 1998). Differentiating and unifying threads running through dialectical materialism and systems thinking are encapsulated as follows: wholeness and interconnection, selection of variables or parts, purposefulness and goal-seeking, and the outcomes of the process (Levins 1998: 4, passim).

In order to better grasp the relation between CHT and DST, it may be useful to refer to some of the undercurrents of dialectical thinking. The extent to which dialectical triad (thesis, antithesis and synthesis) is invoked to describe 'developments of ideas and theories, or of movements which are based on ideas or theories' is rather adequate (Popper 1940, p.45). A nexus of following philosophical corollaries could be drawn from Hegelian dialectical theory of internal relations:(i) the whole is more than the sum of its parts; (ii) the whole determines the nature of the parts; (iii) the parts cannot be understood if considered in isolation from the whole; and (iv) the parts are dynamically interrelated or interdependent (Phillips 1969: p.7).

I do not maintain that *idealistic* kernel of German dialectical idealism spearheaded by Hegel is the core of DST and Vygotskian CHT. Contrariwise, for both DST and Vygotskian CHT *dialectical materialist monism* (as opposed to physical-material versus psychical-mental substance dualism) is their nucleus whereas the dialectics is their epistemological apparatus for the investigation of the manifold of human developmental process. Ontologically speaking, DST and CHT hold that ultimate reality of human development is material in a fluent process of change and motion, refuting idealistic doctrine which holds that everything real, in essence, is mental or supervenes on the mind. On the other hand, DST and CHT do not see human development to be a *timeless* montage of isolated, self-contained and immutable elements.

It should be noted here that materialist dialectics which CHT is premised on it consists of three laws: (1) the unity and interpenetration of opposites in which the cultural-historical and the natural-biological lines of development are dialectically synthesized, (2) the transformation of quantitative change into qualitative development (i.e., emergence) and (3) the negation of negations which is an ongoing, ascensional, and recursive process of a helical conversion of old to new (Adoratsky, 1934; Wozniak, 1975a, 1975b).

Conceiving and perceiving ultimate reality in terms of dialectics restructures our thinking primarily by dint of substituting notions of ‘alienated thing’, ‘external relation’ and ‘thingified abstractionism’ with notions of ‘synthetic process’, ‘internal relation’ and ‘processual concretism’ (see also Ollman 2003). Moreover, dialectics provides the lens through which we can evince the *essence* of development by revealing its relations and contradictions *in statu nascendi*- in the process of creation, change, and co-

construction - but also to reveal those relations and inner contradictions which are defining and fundamental (Tolman 1981).

Moreover, DST and CHT avoid bifurcating human development into two material and immaterial qualities. Put otherwise, DST and CHT eschew to view human development as an idealized, homogeneous, static, and closed system with inborn genetic design that could be differentiated by contextual particularities and sociocultural contingencies. On the contrary, DST and CHT subscribe to the view that considers human development a socialized, heterogeneous, dynamic, and open system without an intrinsic *telos* (pre-ordained end). Vygotsky (1978, 1987) ensembles the cultural-embedded in immediate physical and mediate cultural-historical spatiotemporal contingencies- and the natural lines - genetic and sequential unfolding of an individual over time-, or in the words of Järvillehto (2009) organism-environment system, on the single-continuum of human consciousness (see Rogoff 1988). Similarly, DST ‘attempts to explain, through the systems’ concept of self-organization and holism, how developmental patterns arise and, in the process, offers a model for development which reconciles the ceaseless flux and variability of real-time action with the orderly, organization flow of development’ (Witherington 2007, p.128).

DST as an intermediate-level theory is argued to be concordant with ‘process-relational’ metatheory which includes ‘process, activity, dialectic change, emergence, and necessary organization as fundamental defining categories, but it does not exclude categories of substance, stability, fixity, additivity, and contingent organization’ (Overton, 2013a, p. 42). It is suggested here that eschewing a priori synthesis of mechanistic materialism and idealism worldviews - a mere tautology devoid of any content, DST (Overton 2006; Overton 2015) holds that dialectic expansionary triad

abductively embodies contextual and cognitive dimensions of human development with a three-pronged stroke (i.e., thesis, antithesis and synthesis). It is beyond the scope of this paper to go into further detail on how ‘process-relational’ metatheory (Overton, 2013b, 2015) substantially invokes the Hegelian dialectical triad to overcome either-or antinomies and integrate them into mutually-defining moments of a unitary process using three fundamental principles: (1) The Identity of Opposites, (2) The Opposites of Identity, and (3) The Synthesis of Wholes.

Time-evolving nature of human activity and speaking activity is other common denominator of CHT and DST (Karimi-Aghdam 2016b; Zaporozhets 2003). It should be noted here that CHT and DST do not view time as *homogeneous*, that is, ‘discrete timescales that are the same quantitatively are also seen as identical in terms of their putative uniformly regimenting effects’ and *spatialized*, that is, ‘the static, objective, quantitative, discrete, abstract, extensive, chronological and mathematical timescales are projected into space’ (Karimi-Aghdam 2016a, p. 60). Against such a view, DST and CHT regard ‘time’ a heterogeneous, continuous, qualitative, indivisible, non-spatialized, lived and irreversible process (see also Valsiner 1998; for a methodological discussion see Molenaar 2004).

Understood thus, CHT and DST valorize a scientifically robust understanding of the processual trajectory of human development over time (history of human development). The notion of ‘history’ in the context of Vygotskian CHT has two interrelated meanings. First, history of human development means an evolutionary trajectory in its processuality over time and is dialectical; second, history denotes human history and is historical materialism (Vygotsky, 1989, pp. 54–55). Karimi-Aghdam (2016b), with Cole and Engeström (1993), argues that conceptualization of the notion of history in



DST accords with ontogenetic (idiographic) and microgenetic (real) timescales whereas from CHT vantage point in addition to these two temporal scales, phylogenetic (evolutionary) and cultural-historical (historical) timescales are considered to be inherent regulating and directing forces upon human development. It is not thus unwarranted to conclude that there is a close affinity between dialectical thinking invoked by Vygotskian CHT (Bidell 1988) and systems thinking drawn upon by DST (Overton 2006; Lerner 1996).

Grossly simplify a far more complex picture, it can be argued that idealism and mechanistic materialism *Weltanschauungen* (i.e. worldviews) underlie long-lived debate between, what Vygotsky (1997b, p. 124) terms, ‘natural scientific, causal, or explanatory psychology’ and ‘teleological, descriptive, or understanding psychology’ schools of thought (see also Karimi-Aghdam 2016c). Vygotsky also (2012) calls these two canonical and panoramic perspectives by other terms: ‘natural scientific, materialistic, and objective psychology’ and ‘metaphysical, idealistic, and subjective psychology’ (p.87). To begin with, those psychological approaches which subscribe to idealistic worldview set out to study human development by interpreting it as an intra-individual (i.e., non-social and intrinsic), an idealized and essentially mental phenomenon, by abstracting it from its attentive material and bodily influences, and by emphasizing subservience of its functioning and processes upon the unity of a self-sufficient whole; hence reducing ontologically all human development to the mental. Generally speaking, psychologists of this kind are not in favor of using objective methods in experimental investigation of human development independently of the subjective consciousness of first-person lived experience as is customary in, and consistent with protocols of, the natural sciences.

On the other hand, those psychologists who register affinities with mechanistic materialism worldview rivets their focus on explaining human consciousness and development by confining them to the concrete sinuosities, atomized monads, and contextual conditions within which they are situated, constructed, and enacted; hence reducing all developmental aspects of human consciousness and behaviors to the material. To be empirically *scientific*, psychologists of this stripe are more inclined to draw upon experiential and sensual data and facts about inter-individual events in their causal (i.e., linear cause-effect) methodology.

Eschewing to cast human development into mutually exclusive dichotomies aligned with either subjective psychology or objective psychology, DST and CHT do not consider constitutive blocks of human development separate entities, but essentially interpenetrated elements inherent in the organized whole system of human being that subsist together simultaneously. DST and CHT hold that human development and by implication human consciousness is both physical-material and psychical-mental, yet neither (e.g., Zavershneva 2014). DST and CHT subscribe to the view that the dynamic totality of human development for its very existence is dependent on the material while being neither explainable nor describable exclusively in terms of the properties of its material constitutive elements. Human development - borne out of the dialectical contradiction between the material and the mental operating in opposite directions and finally being resolved through a synthesis - is an emergent phenomenon with qualitatively novel character (Ablowitz 1939; Lyra 2012). It should be noted that emergent ensemble of human consciousness and development, either nascently or already emerged, reciprocally effects those constituents parts and properties which have engendered them originally.

Two axioms are implicitly alluded in the holistic outlook of systems thinking: first, systems are non-linear, that is input and output of every single system are not proportional and second, a system is not an additive aggregate of its entities and processes, that is, parts and processes are necessary but are not sufficient condition for existence of a system. Nonadditive interactions between internally relational components and processes of a system which engenders relationally concatenated positive and negative feedback loops confer a system with dynamic and complex set of conditions which are susceptible to give rise to novel properties and processes qua self-organizational emergence (see Campbell 2015). In the words of Thompson (2007: 60) ‘an emergent process belongs to an ensemble or network of elements, arises spontaneously or self-organizes from the locally defined and globally constrained or controlled interactions of those elements, and does not belong to any single element’.

Underpinning this reception is the fact that a whole is a contingent and emergent entity which has objective existence and qualitatively novel properties and is indescribable and inexplicable totally in terms of, and by reference to, corpuscular elements and components shorn of relationally constitutive and reciprocal interactions. These postulations seem paradoxical *prima facie* unless we ascribe them to recursive and synergistic interactions among entities and processes in every single system that enjoys both structural cohesion and functional coherence.

### **Zone of Proximal Development as a Dynamically Emergent System**

Since its inauguration to western academia, ZPD has been one of the fecund notions of Vygotskian CHT and has been widely discussed within educational sciences (e.g., Hedegaard 1996; Kozulin, Gindis, Ageyev, & Miller 2003; Moll 1992) and also within

second language research (e.g., Frawley & Lantolf 1985; Kinginger 2002; Lantolf 2000; Lantolf & Thorne 2006; Lantolf & Poehner 2014). The quantitative burgeoning of the literature on ZPD, however, has led to certain qualitative changes -categorically different interpretations- in some of its usages in current Vygotskian scholarship (Yasnitsky & van der Veer 2016). Further, a practice-only penchant among some educational practitioners has led to theoretical agnosticism and lack of concern about the philosophical underpinnings of the construct.

Bereft of explicit explications subtended by deeper philosophical and theoretical assumptions, ZPD as a theoretical construct now sometimes appears to be in risk of losing its explanatory power (Wertsch 1984; Valsiner & van der Veer 1993). In the mainstream educational literature, it may be argued, ZPD is sometimes reduced to a hackneyed household catchword or as a theoretical embellishment for an experimental study (Wells 1999). For example, providing a cautionary note to educators not to use ZPD as ‘a clever instructional heuristic’, Moll (1992) points out that the concept integrates social-cultural origins of thinking, role of mediation in higher psychological functions, pivotal role of pedagogy in mental development and the seamless connectivity of the individual and the social.

ZPD typifies two core properties of Vygotskian CHT, viz. a genetic (i.e., developmental) explanation- counterposed to a mechanistic explanation- of psychological functions that ‘are organized in accordance with the mediated structure of human activity’ (Cole 1988:140), and scrutinization of the role of situated social practices and interactions on in-time and over-time emergence of higher mental functions (Wertsch 1979). In accord with this stand, Zaretskii (2009) contends that ZPD makes it possible to pinpoint the moment in the temporal stream of consciousness of a

learner when a qualitative saltatory change -a novel and abrupt transformation-which epitomizes development is co-constructed collaboratively and dialogically.

For Vygotsky, it could be argued, ZPD is a temporal and transitional interface of inter-psychological and intra-psychological planes of human development in which diachronically incremented quantities have potentiality to be transformed to synchronically emergent qualitative changes in the developmental process over time. The internal contradiction between the constellations of quantitative accretions and qualitative changes and processes within the dynamic purview of ZPD are harmonized and equilibrated in a dialectical unity, engendering helical trajectories across different timescales *ad infinitum*. A reciprocal confluence of the collectivism and historically phyletic human consciousness qua distributive speaking activities is represented in ZPD but also gives rise to the emergence of novel collective experiences and higher level functions such as logical thought, thereby transforming human development in real-time scales and human consciousness across multiple time-scales but also potentiating prospective new changes (see also Bruner 1984; Stetsenko 2005).

Having defined ZPD as ‘the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers’ (p. 86), Vygotsky (1978) maintains that ZPD characterizes the maturing mental developmental dynamics and helical trajectory prospectively. When a child engages in a speaking activity through which s/he is supported in order to extrapolate his/her actual ZPD, the resulting social semiotic and dialogic perturbations exerted on his/ her dynamic system have the potentiality to morph into short-term changes (i.e.,

learning) which eventually may or may not be translated into long-term changes in the structure of the system (i.e., mental development).

Bozhovich (2009) holds to another definition of ZPD by Vygotsky:

The zone of proximal development *defines functions that have not matured yet, but are in a process of maturing*, that will mature tomorrow, that are currently in an *embryonic state*; these functions could be called the *buds* of development, the *flowers* of development, rather than the *fruits* of development, that is, what is only just maturing” (Vygotsky, 1935, p. 42; emphasis added by Bozhovich 2009).

It is my contention continuous with Bozhovich (2009) that in this definition any particular function which is embedded within multiple orders of temporality simultaneously can be characterized by processual latency and essential qualitative properties being co-constructed in the extra-somatic sociocultural dialogic interactions and practical activities. The phenomenon of development DST literature is usually approached from an emergent, interpenetrating and integrated dynamics and process-oriented model of the systems perspective rather than from vantage point of an atomistic, reductionist, object-oriented and elementaristic vantage point (Overton 2006).

Another point here is that from DST perspective when development is viewed as multilayered, unified, and nested system, ZDP, regardless of the specific constitutes and components, could be conceived as a subsystem of the larger synthetically complex and relationally heteronomous cognitive (i.e., intellectual and mental) and affective (i.e., volitional, appetitive and emotional) development system (i.e., human consciousness) (Vygotsky, 1987, p. 50) and simultaneously be conceptualized as a dynamic system (i.e., a time-locked, processual, and organized totality) *sui generis*.

The latter vantage point entails probing a complex and dynamic system such as the integrative cognitive and affective dimensions of human development and

consciousness, *ipso facto*, by investigating hierarchically and analytically dissociated elements and isolated constituents of the system and explaining away the ever-changing causative interactions among its components and elements. It should be emphasized here that development, from DST (Lerner 1996) and CHT (Karimi-Aghdam 2016c; Riegel 1976, 1979) perspectives, is an integrated, nested, and syncretized whole which has different levels of organization. These integrative levels of organization are not ontologically reducible and hence unexplainable exhaustively in terms of components and elements of the preceding levels of organization while they are in dynamic interactionism with other levels across various timescales (for a useful categorization of the concept of level, see Bunge 1960). According to Novikoff's assertion (1945) about levels of organization of a whole totality:

In the continual evolution of matter, new levels of complexity are superimposed on the individual units by the organization and integration of these units into a single system. What were wholes on one level become parts on a higher one. Each level of organization possesses unique properties of structure and behavior which, though dependent on the properties of the constituent elements, appear only when these elements are combined in the new system. Knowledge of the laws of the lower level is necessary for a full understanding of the higher level; yet the unique properties of phenomena at the higher level cannot predicted, a priori, from the laws of the lower level (p. 209).

Nevertheless, from Vygotskian CHT vantage point the emergence of new higher human cognitive traits instantiates two non-autonomous interpenetrating sub-systems of human development namely, the social and the material. To encapsulate this perspective otherwise, ascending dialectical contradiction (relationally united opposites) of the social and the material gives rise to novel higher order functions in human mind. That is, truly novel functions which are neither predictable nor explainable *a priori* by virtue of the properties of the lower-level functions come into existence and have autonomy over and above their constitutive lower-level functions. Vygotsky (1999b) writes:

The history of development of each of the higher mental functions is not the direct continuation and further improvement of the corresponding elementary functions, but

undergoes a radical change in development and a subsequent movement of the process to a completely new plane; each higher mental function is, thus, a specific neoformation [...] ...each higher mental function is, thus, a unit of a higher order determined basically by a unique combination of a series of more elementary functions in the new whole. (pp. 42-43)

When qualitatively novel properties come into being within ZPD system, the processes of constituting and reconstituting are amplified by infinite feedforward and feedback loops between the social and the material. This self-organizational process, in turn, leads to identity-transformed and spontaneously emergent functions of human mind. This argument comes into closer alignment with Valsiner and Van der Veer (1993, pp.41-42) contention: ‘The actual dialectical synthesis at crisis periods leads to the reorganization of the structure of central and adjunct psychological functions in ways that give rise to novel functions on the basis of loss and reorganization of the previous ones’. On this view, ZPD as a dynamic, complex and emergent system may be divisible to its isolated elements descriptively but structural analysis is not *sine qua non* for its functional explanation nor for accounting for its emerging and organized complexification over time.

The open-systemic totality of ZPD, *a fortiori* human consciousness, cannot be explained by atomizing its structural organizations to simpler constituents and functions since as a contingent whole they have some emergent functional qualities and properties which are distinct and indeducible from those of fragmentary experiential idiosyncrasies. Taking this further, organized complexity of ZPD is irreducible to its constitutive lower-level functions. ZPD development is not an abstract and reified construct that exists without activities of an agentive human. Rather, ZPD is a person-centered notion (Valsiner & van der Veer 1993, 2014) that emerges from the unique activities and lived experiences of a person which are mainly mediated through



sociohistorically-fashioned activities and semiotic artifacts including speaking activities. ZPD exerts causal influences on, and reciprocally is recalibrated in and by, contextual constraints, conditioned actual and unconditioned possible uniquely human functions. Spelled out in this way, ZPD exists and persists because of the experiential and mediational engagements of a human being over multiple heterochronic timescales having being enmeshed with and distributed across malleable cultural, social, historical and situational *umwelt*. Internal relationality of the past, the present, and the future are epitomized in experiential flux and fluidity of ZPD which ranges back and forth across a flowing temporal continuum. ZPD *re-presents* and dialectically synthesizes present and creative (re)actualization of the past (no-longer present) and the future (not-yet present) (Pepper 1942; Karimi-Aghdam 2016a). Hence, Valsiner and Van der Veer (1993) argue, ZPD ‘was used by Vygotsky to emphasize the process of construction of the future structure of the functions on the basis of the present experience by the child’ (p.44).

Vygotsky (1981) holds that ‘all higher functions are not developed in biology and not in the history of pure phylogenesis. Rather, the very mechanism underlying higher mental functions is a copy from social interaction; all higher mental functions are internalized social relationships’ (p.164). In fact, however, not all emergent higher-level functions in human mind are identically duplicated functions which are present in human interactions via historical-cultural signs and artifacts, especially collectively sedimented speaking activities (i.e., language), in the social and cultural milieu. The novel functions discontinuously emerge through internally mediated interdigitations among and across both lower and higher functions and adaptations to externally mediated perturbations in the structural and functional architecture of mind. For

example, Vygotsky (1978) suggests that ‘...child development is a complex dialectical process characterized by periodicity, unevenness in the development of different functions, metamorphosis or qualitative transformation of one form into another, intertwining of external and internal factors and adaptive processes which overcome impediments...’ (p.73, italics added). Therefore, explaining human consciousness and, by implication, ZPD from Vygotskian CHT standpoint by decomposing it to be aggregative and fetishized summation of quantitative effects of the exogenous determinants shorn of orienting power of a human agent seems untenable.

One possible principal reason for this is that only some quantitative changes acquire novel properties and are converted into qualitative transformations at different levels (Shirokov1937). Perhaps another viable reason is that coming into being of any emergent function with new qualitative features in human mind ends up in restructuring the far-from equilibrium and time-dependent system of human mind. Cole and Engeström (1993) subscribe implicitly to this view when they maintain that activity systems as basic unit of analysis in cultural historical approach ‘ are best viewed as complex formations in which equilibrium is an exception and tensions, disturbances, and local innovations are the rule and the engine of change’ (p.8). Vygotsky (1978, p.46), to instate the significance of emergence, stresses that

*... sign-using activity in children is neither simply invented nor passed down by adults; rather it arises from something that is originally not a sign operation and becomes one only after a series of qualitative transformations. Each of these transformations provides the conditions for the next stage and is itself conditioned by the preceding one; thus, transformations are linked like stages of a single process, and are historical in nature.... [the higher psychological functions] are subject to the fundamental laws of development...as the outcome of the same dialectical process, not as something introduced from without or from within. (Italics in the original)*

Consistent with van Geert (1994) and Valsiner (1984) I argue that reciprocal co-determination or mutual causality is the linking element between the individual and the social that accounts partly for explanation of the human development as contingent whole over time. Double determination (i.e., circular causality) also demonstrates *vertical* causal influence between lower-level functions and higher-level functions of human consciousness in which microscopic parts and macroscopic wholes exert causal power on one another reciprocally but asymmetrically. Similarly, the same-level functions *horizontally* influence one another too. That is, every higher-level function influences other high-level functions, and similarly, every lower-level function exercises causal influence on other lower-level functions. Apart from this kind of co-conditioning and reciprocal influence that obtain among components and functions, development-facilitating variability and variability-limiting development both exert obvious influence on various aspects of human consciousness and development. Hence, any explanation of human mental functions from Vygotskian CHT perspective should entail accommodating circular causality and eschew measuring ZPD with ‘variables’ and correlational research designs (Valsiner & van der Veer 2014) .

It is easy to see, at first sight, that for Vygotsky (1978, 1998) not all changes in human mind are to be regarded as ‘development’. Nor can we consider developmental trajectory of emergent higher mental functions during the process of self-organization at multiple levels and over different timescales, unlike core postulation of reductionist approaches, to be traceable exclusively to either the world (social-cultural-historical structures) or the brain (biophysiological structures) neglecting the effect of their inexorable interactions over time. This line of reasoning not only is not incompatible with the genetic explanation of higher mental functions contended by Vygotsky (1981)

but also is indispensable for an adequate and coherent explanation of qualitative and novel changes that emerge over time mainly because of speaking-induced mediations.

Therefore, it may be safe to claim that Vygotskian CHT does not vindicate the view that human development could be explained by aggregating quantitative changes in a linear fashion nor does it lend support to standpoint that properties of emergent higher mental functions are possessed consummately and *a priori* by lower-level functions. In other words, since human development and by implication higher mental functions are emergent phenomena with novel properties and qualitative characteristics, therefore, their discrete and disparate constituents or their mere summations do not give an adequate and holistic picture of the emergence and integrated totality of human development over time. That is why the genetic or developmental method which was introduced by Vygotsky (1978) and subsequently taken up by his followers (e.g., see Wertsch 1985) to scrutinize dynamics and underlying mechanisms that govern and are productive of regular transitions.

For Vygotsky ZPD is a two-layer system in which *learning* and (mental) *development* are regarded as two separate but interdependent levels over different timescales (Vygotsky 1978, 1987). Conversely, as discussed above bidirectional and circular conditioning of these sub-systems (quantitative learning and qualitative development dialectic) both account for incessant developmental process and emergence of human consciousness.

As briefly highlighted above, Vygotsky (1978) maintains that language is a social-cultural-historical semiotic sign system through which a child is capable of self-regulating his/her thinking. This being so, it follows that the emergence of some higher-level functions in developmental trajectory of human mind is, in principle, possible

without corresponding efficient causal influence exerted by externally-initiated learning practices. In other words, learning is a causally sufficient condition for mental development but is not a necessary condition for the emergence of mental development. That reconfiguration and synthesis of lower-level functions and higher-level functions may engender new qualitative functions is documented in the literature (Valsiner and van der Veer 2014, p. 158). Moreover, Vygotsky [1998] himself further buttresses this claim by suggesting that

In the process of development, all of these functions [attention, memory, perception, will, and thinking] form *a complex hierarchic system* where the central or leading function is the *development of thinking*, the function of forming concepts. All the other functions enter into *the complex synthesis* with this new formation; they are *intellectualized* and *restructured* on the basis of thinking in concepts. (p. 85; Italics added)

It should be mentioned here that to assume a direct causal antecedence of learning to development does amount to neither wholesale epiphenomenalism nor equifinalism. To put the point another way, development is not a prefigured by-product of learning. Also, variational piecewise changes (i.e., learning) do not necessarily end up in the same transformational changes (i.e., development) and end-states over prolonged time scales. And this agrees entirely with the idea that ‘instruction moves ahead of and leads development because it only occurs or is only necessary for the development of functions that are not yet mature’ (Miller 2011, p. 121).

Based on CHT conceptualization of human development epiphenomenalism is untenable; otherwise, it was possible to explain human development by reducing it to only accumulation of changes of lower-level functions which appear and are fostered in social interactions between a child and others. Another reason which may be adduced is that Vygotskian CHT, unlike behaviorism, holds that only human beings are able to

enrich and expand their mental and intellectual development by drawing upon cultural and historical artefacts including language as mediatory tools between the subjective and objective contexts (Lektorsky 1977).

Furthermore, according to Vygotsky (1978) children end up in different developmental level based on the learning trajectory which they have passed through. One cannot help accepting that individual differences in children in terms of their mental development is partly attributable to socio-historically constructed artefacts and interactional practices with which they have been engaged. In substance, the presumption of subscribing to multifinality rather than equifinality is also evident in Vygotsky's predilection to foreground the material world in shaping and constructing human development. A further argument for rejecting equifinality of human development on the basis of Vygotsky's scholarship is that assuming similar end state for all children irrespective of their trajectory dehistoricizes CHT and the notion of 'development' across different timescales becomes otiose.

As argued so far, for Vygotskian CHT the issue of child development is bound up with the hypothetical fact that learning is not directly translatable into development. That is, relation between real-time learning and developmental-time emergents is not one-way antecedent cause. Put simple, the causal arrow does not always start from learning and end in development. Contrariwise, the relation between development and learning is a two-way road and they reciprocally impact one another. Development may facilitate and/or constrain learning and *vice versa*.

So much so that causal nexus between these two is not the upward causality (i.e., synchronic bottom-up determination) from lower-level learning practices to high-level developmental emergents. Rather, higher level emergent patterns and structures

themselves along with the totality of the system as a whole exert downward causal influence (i.e., diachronic top-down causation) (Campbell 1974) on the lower level interactions and constitutive components. On this count, dialectical and causal relationship between learning and development mutually facilitate and/or constrains one another, and by extension, both learning and development are cause and effect *pari passu*.

Drawing on above arguments, I venture a new definition that ZPD could be redefined as a hypothetical emergent, dynamic and temporal buffer zone between actually matured quantitative micro-changes (i.e., learning) and ex-ante emerging qualitative developmental macro-changes in which mediational transitions of cultural-historical semiotic systems, artifacts and speaking activities in particular set their constant time-bound multidirectional and helical interpenetration in motion.

## **Conclusion**

The main thesis of this article was to reinterpret Vygotsky's (1978, 1986, 1998) ZPD through the lens of dynamic systems theory perspective. It was suggested that both DST and CHT are predicated on a relational topology in which both contextual and cognitive facets of human development are primordially intertwined. DST and CHT, to draw another broad conclusion, endeavor to bridge the ontological schism between mechanistic materialism and idealism in developmental science research. It was argued that DST and CHT invoke the dialectical logic to synthesize the social and the individual into an embracive and harmonized whole. Inconsistent with some Vygotskian CHT scholars' stance that warrant atemporal activity *per se* as unit of analysis, I reasoned that emerging higher-level functions within purview of ZPD that are first co-

constructed and entified in speaking and interactional activities between human beings comply more adequately with Vygotsky's discussions concerning human development and consciousness.

Additionally, it was discussed that DST and CHT dialectically synthesize underlying assumptions of contextual and cognitive facets whereby fluid, dynamic, emergent and process-based nature of human development is espoused. A subsidiary drift of this article was toward cross-fertilizing CHT and DST by arguing that emergence is a common construct in both research programmes even though presently in CHT literature there exists a dearth of research on emergence. The bulk of the article was allocated to substantiating the argument that Vygotskian CHT mainly by invoking Marxian, and by proxy, Hegelian dialectic, like a well-received version of DST, embraces a monistic and relational ontology, and by extension, colligates mutually distinctive yet constitutive nature of cognitive and cultural-historical facets of human consciousness that simultaneously undergird and undermine one another.

Moreover, it was discussed that CHT, viewed through systems thinking spectacles, takes the view that relations among the components and the processes of the human developmental system change ceaselessly at multiple levels and over different timescales as human mind is engaged simultaneously with dynamic cultural, social, historical and situational context, seamlessly albeit mediational. Furthermore, it was contended that confluence of psychophysical attributes of consciousness in verbal and non-verbal activity in Vygotskian CHT is equivalent to the recognition that finite and fragmentary experiences are external manifestations of consciousness and are bounded in time and space while consciousness and activity are dialectically united.



It was also maintained that the causal nexus between development and learning is circular. Invariable succession of learning and development in ZPD involves both temporal contiguity and antecedence so much so that their relations may be posited to be causal. It was suggested that, viewed from DST paradigmatic standpoint, Vygotskian CHT may be reconstrued as holding that development-facilitating variability-upward causation from joint activity in the sociohistorical environment- and variability-limiting development- downward causation from internalized higher-order functions - reciprocally exercise causal power on various aspects of human consciousness over time. One may thus conclude that one reason that CHT is predicated upon dialectical logic is to come to better grips with human development.

Finally, based on preceding discussions ZPD was considered as an emergent dynamic system the boundary of which is demarcated by a dialectical interaction of quantitative learning and qualitative development that is germinated and mediated mainly via speaking activity – a central semiotic medium - and practical activity. More to the point, ZPD was argued to be a dynamic emergent system that may be investigated atomistically (i.e., by structural atomization) but to reduce it wholesale to properties and characteristics of elementary and lower-order functions circumscribe the possibility of capturing the functionality of ZPD - unless the confluent interaction among elements and functions is taken into consideration.

### **Compliance with Ethical Standards**

**Conflict of Interest** The author declares that he has no conflict of interest.

**Ethical Approval** This article does not contain any studies with human participants or animals performed by the author.

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