A Cognitive Framework for the Analysis of Game Play: 
Tasks, Schemas and Attention Theory

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Abstract

A fully developed nomology for the study of games requires the development of explanatory theoretical constructs associated with validating observational techniques. Drawing from cognition sciences, a framework is proposed based upon the integration of schema theory with attention theory. Cognitive task analysis provides a foundation for preliminary schema descriptions, which can then be elaborated according to more detailed models of cognitive and attentional processes. The resulting theory provides a rich explanatory framework for the cognitive processes underlying game play, as well as detailed hypotheses for the hierarchical structure of pleasures and rewards motivating players. Game engagement is accounted for as a process of schema selection or development, while immersion is explained in terms of schema execution. This framework is being developed not only to explain the substructures of game play, but also to provide schema models that may inform game design processes and provide detailed criteria for the design of patterns of game features for entertainment, pedagogical and therapeutic purposes.

Introduction

This paper refers to examples of computer role-playing games (RPGs) and first-person shooters (FPSs). In reading this, readers familiar with computer games will have expectations about the design features in question and the nature of the experience of playing these genres of games. Game designers similarly have expectations about what kinds of play styles and experiences may be supported by particular game designs, based upon their own experiences as both players and designers. While good game designers can design good games based upon experience, design principles and extensive tuning by play testing, the relationship between the intentions of the designer, the player experience and the mechanisms learned by players to facilitate play have not yet been studied extensively or in depth in an explicit way. A more scientific understanding of the relationship between design features, player cognitive processes and the experience of play can provide clearer guidelines for design and the realisation of design intentions, as well as providing a more rigorous foundation for the application of games in fields where the cognitive changes involved in learning how to play a game are required to have specific effects for purposes such as therapy and education.

The scientific study of gameplay requires the establishment of construct validity for the theoretical frameworks and practical methodologies used. Construct validity can be described as the degree to which inferences can legitimately be made from the operationalizations (i.e., practical experiments) in a study to the theoretical constructs on which those operationalizations are based (Cronbach and Meehl, 1955). Cronbach and Meehl describe how a nomological network provides construct validity, where a nomological network includes “the theoretical framework for what you are trying to measure, an empirical framework for how you are going to measure it, and specification of the linkages among and between these two frameworks”. It is a necessary condition for a construct (i.e., a distinction, concept or theory) to be scientifically admissible that it occur within a nomological (or ‘lawful’) net having at least some laws involving observables.

Gameplay is a cognitively complex activity for which a suitable nomology is needed in order to understand play on a scientific basis. A nomology for game research must provide laws correlating player features, processes and effects with gameplay patterns in relation to game design features\(^2\). In this paper it is proposed that the theories and methods of cognition sciences provide a strong foundation for a game research nomology. This nomology has a high level structure as depicted in Figure 1. Here methods are used to observe a player and their interactions with a specific game design. The interaction patterns, referred to as gameplay gestalts, are compared with previously observed patterns based upon different game stimuli designs. Analysis is conducted using a theoretical framework providing an account of the features of game designs, of player cognition, and of play interaction relating design features to cognitive processes. This comparative analysis is used as a basis for validating or adapting models of hypothetical cognitive schemas underlying gameplay, or to modify the overall theoretical framework if those modifications are found to better account for observed

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\(^2\) A more complete nomology might include theories and methods for investigating factors of designer intention, but once a game is shipped this is lost and the player’s experience is a function of what the player brings to the released artefact of the game software and the unfolding experience of interaction with that artefact.
play patterns. It is also possible to adopt a computational cognitive science methodology, leading to the computational implementation of the hypothetical schemas of players, followed by comparison of the play results with those of human players as a method of refining and validating the schema models.

In this paper it is proposed that the abstract nomology above can be instantiated in a more specific form based upon attention theory and schema theory, together with a methodology of cognitive task analysis, as shown on figure 2. The resulting framework is discussed in some detail. Hierarchical schema structures are then considered that reflect hierarchical time structuring principles designed into games. The paper then goes on to consider how current theories of game enjoyment, immersion and engagement can be mapped onto a schema-based theory of the cognitive processes underlying play in relation to design features. Schema and attention theory provide foundations for a detailed account of the nature of game engagement and immersion, as well as providing explicit models of the cognitive learning outcomes of play. This theory promises a more explicit mapping from designs to cognitive affects and play patterns than current design practice allows for, providing clearer principles for design decision making and the translation of design intentions into patterns of features.

A Cognitive Theory of Gameplay: Tasks, Attention and Schemas

Analysis of game play must begin with a consideration of game features that motivate, facilitate and constrain player action. Game design features include built in game tasks, modelled by a process of game task analysis, that ground the in-game meaning of design features. Game tasks include configurational tasks such as trading and inventory management, and teleological and planning tasks such as quest management, found in RPGs, and game challenges (Rollings and Adams, 2003) such as coordination, reflex and reaction time challenges typical of both RPGs and action games. The result of a game task analysis is the representation of a game task model, which is a representation of the goal environment by which play is made meaningful: the primary driver of play is the motivation to achieve goals within the game task environment. Goals may include things like defeat autonomous enemies (‘mobs’), find a key, open a door, finish a level, etc.. The game task environment of an FPS or RPG is likely to be hierarchical, the high level goal being to finish the game, which can be decomposed into subgoals of finishing each level, which in turn may be subdivided into completing significant scenes, areas or quests within each level, which may also be subdivided into significant challenges along the way, etc..

A player plays a game via an interface. During this process, the interface and a pattern of interaction are learned that result in progress being made within the terms of progress designed into the game and measured by factors such as (in the case of FPSs, and RPGs) the defeat of enemies, progressing through the game world settings and locations, gathering wealth and items, increasing in skills, experience points and capabilities. A repetitive pattern of game interaction, observed by an analyst, may be referred to as a game play gestalt (Lindley, 2002), so called because it is a grouping of observed interaction features recognised as a repeating pattern.

A cognitive explanation of game play must provide an account of the underlying structures and processes that result in a player manifesting a game play gestalt. Here it is proposed that such an explanation may be based upon a combination of concepts from attention theory and
Attention theory addresses issues of attentional focus, management of attention (including attentional selection), and the allocation of cognitive resources to cognitive tasks. Ongoing research is addressing the question of the detailed operation of attentional mechanisms, including questions such as the degree to which attentional capacity is specific to specific cognitive resources (or modes) or sharable among resources according to demand, and the stage of processing of perceptual information at which perceptual information is selected for attentional priority.

Figure 2. Proposed framework for the cognitive analysis of game play.

Cognitive Task Analysis (CTA) refers to a variety of methods used to analyse and represent the knowledge and cognitive activities that people utilize to perform complex tasks in a work domain (CTA methods and related techniques are reviewed at http://mentalmodels.mitre.org/cog_eng/ce_methods_l.htm). Different CTA methodologies emphasise different aspects of tasks and their context and use their own particular task definition constructs. For example, Critical Decision Method (CDM) uses probes, which are targeted analysis questions addressing Decision Point Options, Cues, Causal Factors, Goal Shifts, Analogues, Errors, Hypotheticals, Missing Data, Imagery and Task Analysis. Particular probes in this method are cross-referenced to specific forms of knowledge, including Structure, Perceptual, Conceptual, Analogues and Prototypes (see Klein, 1996). Variants of CTA may address issues such as the identification of knowledge resources within organisations and the contextual functions of cognitive decision processes within broader operational systems. These contextual issues are of limited relevance to the cognitive task analysis of entertainment game play, although player subcultures and the contexts of play may have a strong influence on functions, expectations and motivations of play for individual

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players. Furthermore, verbal methods, such as structured interviews and think-aloud protocols, relied upon heavily in many CTA methodologies, are of limited effectiveness for analysing less conscious or heavily automatised aspects of game play, or for observing small scale details of cognitive processes and their interaction with limbic (i.e. emotional) processes. Hence verbal techniques need to be complemented with sociological/ethnographic methods, together with interaction logging, psychophysiological methods, eye-tracking, brain scanning, etc.. GOMS (standing for Goals, Operators, Methods and Selection; see John and Kieras, 1994) is a promising foundation for detailed player cognitive task modelling, with the advantage of having variants that can be computationally executed.

Attention theory provides a model of the energetic resources available to cognition, together with an account of principles for the distribution of energy (or attention) to the cognitive resources that use (or manifest) it (see, for example, Johnson and Proctor, 2004). CTA provides a representation of cognitive tasks involved in game play at a level of description that makes sense to an observer and conforms to an observed (set of) gameplay gestalt(s). A cognitive task (CT) model can be used for workload analyses that relate subjective experiences of cognitive workload to contextual demands, psychophysiological indicators, situation awareness and performance (see, for e.g., GARTEUR, 2003). However, the framework proposed here is intended to provide foundations for a detailed account of the cognitive processes and structures involved in play that underlay and explain task performance as addressed by workload analysis. This kind of cognitive account must include the detailed mechanisms by which attention is orchestrated together with cognitive resources, process and skills, in relation to perceptual inputs and in order to generate the motor outputs involved in game play. Hence CTA and workload analysis provide ‘top down’ routes towards understanding the cognitive functions and structures of game play. GOMS is a more detailed CTA method, but further detail is required in order to address learning, fatigue and mapping to neurophysiological mechanisms. Furthermore, task models do not address declarative understandings or structures facilitating comprehension and task performance.

It is proposed here that a sufficiently detailed explanation of game play can be provided by developing an account of the cognitive schemas underlying game play, which can be referred to as game play schemas. Schemas are cognitive structures that link declarative (or factual) and procedural (or performative) knowledge together with other cognitive resources (such as memory, attention, perception, etc.) in patterns that facilitate the manifestation of appropriate actions within a context. While the taxonomical structures of semantic or declarative memory are comprised of object classes together with associated features and arranged in subclass/superclass hierarchies, the elements of schemas are associated by observed contiguity, sequencing and grouping in space and/or time (Mandler, 1984). Schemas can refer to declarative knowledge and taxonomical types with their features and relationships, and integrate these with decision processes. Schemas include scripts for the understanding and enacting of behavioural patterns and routines, a classic example being Shank and Abelson’s (1977) example of the restaurant script that includes a structure of elements for entering a restaurant, sitting down, ordering food, eating, conversing, paying the bill and leaving (etc.). Scripts, as structures used for both comprehension and behaviour generation, represent a structure of cognitive functions that may include cognitive resources, perceptual interpretations and preconditions, decision processes, attention management and responsive motor actions. Story schemas, are patterns representing understandable elements that must occur to make stories comprehensible. The presence of story schemas in the cognitive systems of storytellers, listeners, readers or viewers of stories allow stories to be told and to be comprehended, including the inference of missing information. If a story deviates too far from
a known schema, it will not be perceived as a coherent story. Script and story schemas are concerned with structures of both space and time, while scenes are schemas representing spatial structures, such as the layout of a house, a picture or an area of a city.

While schemas have been interpreted in many different ways, here a game play schema can be understood as a cognitive structure for orchestrating the various cognitive resources required to generate motor outputs of game play in response to the ongoing perception of an unfolding game. A game play schema is therefore the structure and algorithm determining the management of attentional and other cognitive, perceptual and motor resources required to realise the tasks identified by a CTA of game play. A CTA itself provides a first approximation description of a game play schema, but a CTA is also heavily determined by the language and cultural constructs of the observer. The phenomenologically meaningful terms of a CTA may have to be further analysed to account for the ways in which those high level constructs are actually realised by underlying neurophysiological constructs, and this mapping could involve different parsings of functional units at the CTA and neurophysiological levels. Hence a game play schema might be described at different levels of abstraction, some being meaningful in terms of the subjective languages of task performance (e.g. the terms of self-reported task performance) or CTA and others in terms of implementational neurophysiology that may have a very different structure and functional decomposition than that of more linguistically conditioned accounts. Different levels of abstraction in the description of game play schemas are equally valid, neurophysiological descriptions providing an implementational explanation of verbally expressed task-oriented descriptions.

Hierarchical Time and Schema Structure in Games

Games are designed with time structures that can be considered in terms of a hierarchy of time scales (Lindley 2005a,b). At the smallest scale of time units the game simulates continuous actions and processes, such as character, non-player character (NPC) and mob movements, weapon and projectile behaviour, flowing water, rockfalls, the movement of abstract geometrical objects, doors opening, explosions, etc.. These simulations proceed according to a sequence of discrete simulation time steps, or ticks, that may (but do not necessarily) correspond with the rate of update of graphical display frames. Perhaps with the exception of movement control (e.g. by pressing ‘a’, ‘w’, ‘s’ and ‘d’ keys to move left, forwards, backwards or right over extended simulation ticks) player actions are usually not tracked as extended sequences over ticks at this scale; more typically player actions occur at discrete points within the time sequence, functioning as triggers initiated by a key press or release, a mouse button press or release, etc.. Those player actions may be made meaningful at a scale above that of single simulation ticks, initiating the automated simulation of synthetic actions over an extended number of ticks, such as slashing with a sword or firing a missile. These larger scale units of meaning may be said to belong to the game scale, since they correspond to what may be called game moves in more traditional (non-computational) game forms. In general, the available (legal) types of games moves in a particular game are the types of actions specified in game rules, while events at the simulation scale in a computer game implement game moves.

Game moves are primitive player actions that can be interpreted from several perspectives. The game perspective grounds their significance in the competitive, rule constrained form of a game. However, moves can be regarded from other perspectives, such as socialisation, construction, trading and dramatic performance. As noted in Lindley (2005a, 2005b), game
moves regarded from the perspective of narrative or dramatic performance are equivalent to what Mackay (2001) refers to as *fictive blocks*, basic fragments or units of fictional/narrative significance that may be strung together to form a larger scale narrative. Mackay takes fictive blocks divorced from their original context to be equivalent to Scheckner’s *strips of imaginary behaviour*, patterns that constitute a repertoire of potential behaviours that are performed by an actor in new arrangements in ways that may appear spontaneous and unrehearsed during improvisational performances.

This kind of ‘perspective’ for interpreting and providing significance to game moves is not merely a matter of arbitrary interpretation, but a fundamental condition of making the play experience comprehensible. A computer game typically provides a player with a limited number of commands to perform, including both the initiation or performance of game moves and metagame commands such as saving the game state or quitting the game. Game moves may be moves such as ‘move left’, ‘move forward’, ‘move right’, ‘fire’, ‘toggle run/walk’, ‘cycle weapon’, ‘gesture’, ‘tilt’, etc. Suppose there are a total of 30 such move types to choose from while playing a specific computer RPG (this is an easy figure to reach considering basic movement controls and the possibility of having multiple hotkey assignments to each function key, e.g. for selecting weapons, health boosts and spells). Considering a sequence of 10 moves made by the player, the number of combinations of 10 selections from 30 available moves is $30^{10}$, or $59\,049 \times 10^{10}$ move sequences. Since a typical single player RPG may be played for a hundred hours or so, often with the player selecting several moves per second, the combinatorial space of possible move sequences over the play time required to finish the game is extremely large (in excess of $10^{5319}$).

By far the major part of this vast space of possible move sequences would make no sense at all to play. ‘Making sense’ here is a matter of conforming to the pattern of expectations of a higher level play structure, which is a temporal game play schema, and in particular a script, providing at least an implicit perspective for the interpretation of the meaning of moves. Many kinds of scripts might apply to making sense of a player’s selection of game moves in a play sequence. Some examples of these are:

- a script for the combative engagement of an enemy. This script might begin with the detection of an enemy and then proceed through selecting a configuration of armour, weapons and magic according to the enemy type, deciding upon a tactic for approaching and engaging the enemy, configuring companions if the player controls a party of NPCs, selecting a formation and/or angle of attack, launching the attack, perhaps with a specific sequence for using different weapons upon approach, cycling between attacking, parrying and taking health boosts, deciding to retreat or carrying on to death or victory

- a script for exploring a labyrinth, e.g. the ‘left hand rule’ of following the left wall and occasionally checking to detect traps or secret doors, until the character arrives back at the entrance

- a script for interacting with a trader, including evaluating items, selling unwanted and unnecessary items, upgrading useful items and replenishing diminishable stocks

- a script for negotiating quests, e.g. exploring background information, considering alignment implications, accepting or rejecting a quest, returning to a quest giver when the quest is accomplished, accepting or rejecting rewards or punishments, deciding upon follow on quests, etc..

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Many other schemas are possible, including those for interacting with other players for accomplishing various group tasks or activities in multiplayer games.

The designs of FPS and RPG computer games frequently embed the moves of players within higher level pre-designed time structures, including structures of levels and high level narratives with key structural elements (such as introducing a central conflict, major plot points, and final closure after defeating a game boss) being delivered as non-interactive cut scenes (Lindley, 2005a, 2005b). Schemas for stories (Mandler, 1984) provide structures by which players may anticipate and comprehend high-level story structure within which their game play via game play schemas are embedded. Game structure schemas based upon levels do not need to present any more specific narrative structure, but include expectations of thematic changes and changes in the difficulty of play, increases in player character experience, and increases in the statistics of items such as found weapons and artefacts. Story schemas for computer games can include transitions between story sections that also function as level transitions with their associated expectations and features.

The function of player schemas in making a game play experience comprehensible raises a critical question of how design intentions are translated into game design features with which the player interacts. Design decisions are also made according to schemas, this time in the cognitive systems of designers. These latter schemas amount to the designers’ understanding of how players will make design features meaningful. Once a design is released, however, only the design features remain and it is up to the players to find ways of creating their meaning. Shared schemas among designers and players can facilitate effective game design. Designers’ conceptions of play schemas may take the form of high level ideas about broad styles of play, but are otherwise implicit and learned from the designers’ own playing and design experience. Undesirable consequences may follow from this. For example, players may play a new game according to their established schemas and thereby miss new possibilities of play afforded by the design (which are thereby rendered pointless). To overcome this, specific design techniques may be required to disrupt established player schemas and initiate a fresh game play schema learning process. High level story structures, which have been an ongoing issue of contention in game design, are problematic not only due to problems of requiring cognitive resources to be directed away from game play for full comprehension (Lindley, 2002) or not appealing to taste variations within players (Lindley, 2005), but also due to potential mismatch between schema-driven story construction on the part of players on one hand with pre-designed story elements created according to the story schemas of designers on the other. Since players are active and highly immersed participants in creating the details of the history of the game experience, their own story schemas can be used to create their own retrospective story of the play experience. These schemas may be different from those of the designers, or may cast or conceive of the player character and its experiences in a role suiting the players’ own tastes, needs, motivations and desires. Infrequent pre-defined story elements, which are not immersive in the same way as the interactive play experience, may not figure strongly in these player constructed stories, or may even clash with them, resulting in player distaste for those design elements. This might be avoided by design techniques based upon heavy infiltration of the play experience with pre-designed story content (as in the Final Fantasy series of games), forcing players to ‘play the designers’ story’, or by designing to facilitate player story construction, with little or no pre-designed story content.
The question of differences between player scripts and designers’ expectations of player scripts is not always problematic, and can in fact be highly desired by designers. This amounts to the design of games facilitating emergent game play (discussed, for example, by Salen and Zimmerman, 2004), where complex player behaviours are derived during play in interaction with a game system based upon comparatively simple game rules. Design principles for emergent game play are not yet well developed and a schema-based theory, derived from observation of game play schemas and taking into account schema learning processes, could provide a foundation for developing stronger emergent game play design principles.

Schemas, Immersion and the Pleasures of Play

Game play schemas provide a foundation for analysing and understanding the various motivational factors that keep players engaged and immersed in game play. Holopainen and Meyers (2000) suggest that players are driven to continue in game play due to the desire for both predictive and dramatic closure, where predictive closure is a desire to complete a mental model, while dramatic closure is the resolution of the tension driving a story structure. Holopainen and Meyers suggest that game play consists of the performance of typically repetitive actions, driven by the expectation of closure where in a well-designed game there are multiple hierarchical levels of subclosures. Holopainen and Meyers also suggest an important role for spatial and temporal displacement, which is the tendency of players to project themselves into the representations of the play experience such that rewards defined within the fictional world of a game are experienced as rewards bestowed upon the player. In the terms of the framework described here, temporal closure may be attributed to the operation of schemas having resolutions corresponding with successful executions of the schemas. Hierarchical structures of closures correspond with the kind of hierarchical schema operation evident in game play as described above. Displacement can be regarded as a higher level cognitive process by which the representation of agency achieved by game media, together with interaction within the dynamics of the representation via the feedback loop from perception of game events to motor operations enacting game moves, achieves a level of player identification with the player character (‘I killed the goblin’, rather than ‘my character killed the goblin’). A player’s self-identification with their game character links perceptual events attended according to schema priorities with more general criteria of self value and reward built into the player’s cognitive construction of identity.

Klimmt (2003) offers an account of the enjoyment of game play based upon three factors, the experience of effectance, cyclic feelings of suspense and relief, and the fascination of a temporary escape to an alternative reality provided by the fictional world represented by a game. Effectance on the most basic level, corresponding to the atomic level of initiating and experiencing the consequences of game moves as described above, is realised as a series of single loops of player input followed by game system response and output. Effectance provides inherent pleasure in the form of immediate feedback to the player as a causal agent influencing the game world, a satisfying experience in comparison with the often ambiguous or limited influence of actions or intentions in the everyday world. The pleasures of effectance in computer game play may be greatly enhanced, since a small scale action like clicking a mouse button can have large scale in-game consequences, such as mass destruction, landscape alteration or transfers of large amounts of money.

Klimmt describes the next level of organisation in game play in terms of episodes consisting of sequences of input/output loops structured by possibilities or a necessity to act followed by action and a result (e.g. overcoming a game challenge) leading to the next episode. Hence an
episode corresponds with what Lindley (2005a, 2005b) refers to as a game bout, actually constituting a complete mini-game as a self-contained competitive experience, this corresponding to an action sequence executed according to a game play schema as described in this paper. Enjoyment within episodes may include the excitement of possible action, the pleasures of curiosity and discovery, the pleasures of experiencing the negative emotions of suspense followed by the transference of arousal to an ecstatic experience when the challenge creating the anxiety of suspense is overcome, and enhanced self-esteem. Due to the interactive nature of games and the strong ego involvement via identification of players with their game character (i.e the displacement phenomenon described by Holopainen and Meyers, 2000), the pleasures of relief at the resolution of episodes are greatly enhanced in comparison with non-interactive media since they function to boost player self-esteem. Since games offer long sequences of such short episodes, they uniquely offer an ongoing opportunity for the pleasures involved in the transference of arousal from suspense to joyful resolution, driven according to underlying game play schemas.

Finally, Klimmt describes the whole session of playing that includes the sequence of episodes and provides the player with the experience of participating in a narrative. As active participants in the events of the narrative, players have the pleasure of being able to experience new objects, actions, social interactions and experiences at no risk. These vicarious experiences can help players to cope with felt frustrations and deficiencies in their everyday lives, a process both of catharsis and of perception of increased competence and relevance.

Klimmt’s model provides a basis for explaining reward during the detailed execution of game play schemas during which each mapping from perception through a decision process to an action is rewarded as the experience of effectance. Schemas as described in this paper offer greater discrimination at the level of episodes by allowing different forms of episodes to be modelled as the result of different schema patterns (e.g. different scripts for combat, exploration, trading and quest negotiation). All of these script types can be rewarded upon completion by the intrinsic rewards of completion described by Holopainen and Meyers (2000), while different types of scripts may have their own specific rewards, such as curiosity and discovery for exploration scripts, the overcoming of suspense for combat scripts, and enhanced self-esteem for trading and questing scripts. Schemas for stories include rewards not just via displacement facilitating vicarious experience, but also through the gratifications of expectations created by the story schema structure being met, a large scale manifestation of the rewards of completion.

It can be seen, then, that schema models may provide a detailed description of the processes underlying game play that can accommodate a variety of different forms of player reward. In addition to this, schema theory can provide detailed hypotheses regarding the nature of game engagement and immersion. Douglas and Hargadon (2001) note that it is highly normative schemas that enable readers of narrative texts to ‘lose’ themselves in the text in what they refer to as an immersive affective experience. Douglas and Hargadon contrast this with engaged affective experience where contradictory schemas or elements defying conventional schemas tend to disrupt reader immersion in the text “obliging them to assume an extra-textual perspective on the text itself, as well as on the schemas that have shaped it and the scripts operating within it”. Disruption of expectations requires engagement with an unfamiliar narrative structure.
While Douglas and Hargadon use schemas to explain immersion in and engagement with hypertexts, the same concepts apply to game play schemas. As noted above, when a game play schema has been learned, a player may attempt to apply it within games that appear to resemble those within which the schema has previously been successful. Hence players may repeat game play patterns without exploring new interaction possibilities afforded by new games, as long as the established patterns support progress within the game. A new kind of game in which previously established game play schemas do not work might in these terms be said to require players to become involved in the engaged affective experience required for developing new game play schemas (or indeed to initially determine which already available schemas apply within a specific game). Once a successful schema is matched or formed, the player shifts from engaged affective experience to immersed affective experience in the performance of the schema.

Extrapolating from Douglas and Hargadon’s (2001) suggestion for the case of interactive hypertexts, and as previously observed by Turkle (1984) in the case of games, game play often reaches states of timeless loss of self-consciousness, involving the state of consciousness that Csikszentmihalyi (1991) calls **flow**, a state at the boundaries between engagement and immersion, of being totally absorbed in meeting a constantly unfolding challenge. Contrary to Douglas and Hargadon’s view, however, this need not have anything to do with narrative. For games it is generally a state of pure game play, in the present terms, a state of selecting and performing game play schemas to provide an *immersion in performance* within the internal world of a game, but not (necessarily) in the internal world of a narrative. The performance is itself a process requiring attention, and for successful flow the attentional demands of performing an integrated cognitive and instrumental pattern must fall above thresholds of boredom and within the bounds of what is achievable and sustainable for the player in a flowing state of concentration. Csikszentmihalyi characterizes flow, an experience that is simultaneously challenging and rewarding, as one of the most enjoyable and valuable experiences that a person can have. Careful study of the structure of game play schemas, together with an exploration of the attentional mechanisms orchestrated by schema structure, may provide a cognitive explanation of this experience of flow.

It may be asked whether a schema-based explanation is sufficient to explain all forms of immersion in game play. Based upon observations of children playing games, Ermi and Mäyrä (2005) have proposed the SCI model in which immersion in gameplay can take three forms. **Sensory** immersion involves an immersion in the audiovisual perceptual qualities of a game. **Challenge-based** immersion involves immersion in the cognitive and motor tasks performed in order to meet the challenges designed into a game. **Imaginative** immersion involves immersion within the represented imaginary world and fantasy of a game. In terms of the framework presented here, imaginative immersion can be regarded as immersion facilitated by the execution of story schemas. Challenge-based immersion can be regarded as immersion facilitated by the execution of game play schemas. It is not clear, however, that sensory immersion can be accounted for by a schema theory. Some forms of sensory immersion may be accounted for by schema models, such as immersion in the musical experience of a game, or in visual completions within the visual representational functions of a game (e.g. perceiving an environment, involving scene schemas, or in the rewards of gestalt completion for recognising objects in the game world by cognitively grouping a set of perceptual components). However, immersion in more freely structured perceptual phenomena, involving sounds, colours, lines, textures, movement and forms beyond what they represent, may involve different neural processes, perhaps similar to the kind of selective activation of neural centres to which Ramachandran and Hirstein (1999) attribute the general
appreciation of aesthetic value. In this sense sensory immersion may be *extra-schematic*, an immersion in lower level perceptual cognition while perception is not attached to decision processes.

**Conclusion**

This paper has presented a cognitive framework for analysing game play based upon game specific schemas and story schemas. This framework supports numerous hypotheses regarding the cognitive processes underlying play, integrating and accounting for the pleasures of play experienced by players. Ongoing research is addressing the development and validation of more detailed schema models derived from observations of players during play. This work requires the validation of cognitive task models, including determination of appropriate levels of abstraction within those models and eventually leading via schemas to a mapping of their terms to models of underlying neurophysiological models. Current experimental methods include the use of questionnaires and speak aloud protocols together with interaction logging and eyetracking studies during game play, using both off the shelf and modified commercial games as experimental stimuli.

**References**


