Attachment Theory And Affective User Models

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ABSTRACT
It is not immediately obvious that human users either want or need computer systems with affective reactions. Arguments can be made that certain user groups (children) and specific domains (sensitive health information retrieval) may find affectively endowed artifacts as adding value to their interactive experience by either (a) enhancing affordances of the objects, such as toys that 'really' react, or (b) simulating a type of reassuring empathy. To be sure there are other user groups and domains under investigation but by and large arguments supporting affective interface research hinge on making the case that the primary added value is due to increases in a device's empathy. This is a core tenet of the affective research heuristic. Our argument is that affect infusion in computers (or computational artifacts) needs a different base than currently found in cognitive theories of the emotion. In particular, we argue that attachment theory with its triad of attachment categories may produce a useful paradigm shift in emphasis despite the implied long time span to achieve credible results.

Keywords
Attachment theory, autism, affective agents, computational neuroscience.

1. INTRODUCTION
The past ten years have witnessed an escalation in computer technology complexity that would have been previously unimaginable outside of science fiction circles. Phrases that are formed by conjoining 'computing' with *distributed*, *ambient*, *pervasive* and *intelligent* are commonly used in conversation. Global internet pervasiveness is laying down a cradle-to-grave experience with computers that, unlike any other technology since printing, has cut across caste, class and culture. Ever expanding diversity in devices, application domains and user expectations has persistently challenged researchers to explore interaction enhancements along a variety of axes. In recent years, studies of affective qualities of users and how these allegedly impinge on human-computer interactions (and are impinged upon *vice versa*) have inspired a growing research momentum. Implicit in many of these efforts is an *anthropomorphic teleology* wherein the 'character' of the computer is to assume some of the socio-affect motives of human users. This attribution of human purposiveness to artifacts is intriguing and historically a novel departure from the traditional man-machine relation.

In terms of human-computer interaction, the putative goals are both to improve usability and potentially deliver an interaction experience not attainable through non-affectively augmented interfaces. It is the implicit faith in the ability to produce the *latter* that justifies the *socio* affix to the term *socio-affective* interface. The fact that an interface may produce emotional reactions (or even act on measurements of alleged user emotions) does not by itself justify any socio-affective claims. Imagine a robotic taxi driver that insists on exchanging pleasantries with its passengers and making appropriate '*yes, I know*' acknowledgements in a soothing tone before overcharging! There is more to being social than an acknowledgement of interaction guidelines.

It is striking that the focus in affective computing, at least at the human-computer interaction level, is largely on adapting the computer to the user's moods and feelings. Does this imply that, unbeknownst to themselves all these years past, users have been adapting their affective states to 'align' with the computer's mood? We are being slightly polemical here, but there is some measure of truth in the statement nevertheless. Is all this talking about the development of affective interaction styles really another example of language on a metaphorical holiday?

In this paper, we will comment on a number of issues perhaps provocatively, but this will be worthwhile if the debate is broadened. Firstly, it is important to emphasize that we do not hold the view that the computational instantiations of affect must be *either* based on cognitive theories of the emotions *or* based on interpretations of attachment theory. By and large our emotions do not reduce to simple dichotomized variables. Different design scenarios face different sets of problems depending on the specification that must be met. At present, it is not possible to promulgate a one size fits all affective interaction solution. Conceding this much, we argue that for certain classes of artifacts serious attention should be focused on how attachment principles can be extracted and implemented efficiently.

The second issue we wish to pursue is a brief account of attachment theory and its connection with intersubjectivity. The development of intersubjectivity is fundamentally linked to secure attachment and in turn to the management and expression of emotion. More significantly with some shift in thinking in Artificial Intelligence towards embodied intelligence; we argue that the development of affective agency will need foundations in attachment theory, namely, a computational version of it at any rate. Hence if talk of embodied AI is to make sense then the embodiment of attachment mechanisms is essential.

The third area we want to cover in this paper is an account of game we are developing for older children and teenagers with high functioning autism, generally termed Asperger syndrome (AS). The game is designed to mimic the opposite social world of

the person with autism. The game characters interact both autonomously and under the control of the user – depending on the measure of expressed emotion at the time. Characters are brought together (into unions) or teased apart using the three core processes of attachment theory. The purposes are (a) to assess if the user understands what relationships are forming among the characters, (b) to identify strategies the user implements to bring about unions or separations, and (c) to measure the stability of a user's performance and preferences over a period of time.

The final lesson we want draw is where we went wrong by firstly, presuming we knew enough about attachment theory to make it 'visible' to the user, and secondly by approaching the implementation as a traditional human computer interaction problem rather than something much more profoundly situated at the intersection between computational neuroscience and control systems theory.

2. SOCIAL INTERFACES AND AFFECT

Much of what is covered here is aimed at interfaces that support avatars and interfaces that *are* avatars to all intents. The thinking that drives avatar interaction is consistent with that driving affective user modeling. Implicit in both is a sense of a digital 'realm' that can help the user *thoughtfully,* at the *right* time and in the *right* tone. A number of cultural traditions are swirling around here. In particular, the interface with the right affective reactions will be empathic (presumably someone has worked out that users are not likely to upgrade to interfaces which with negative or rude affective qualities). There is an understandable argument that directing attention on to empathy is misleading. Affective expression is not exhausted by empathy. In other words, research into affective user interaction modeling does not have to go into suspension pending a definitive account of empathy. Systems that can 'handle' basic emotions such as anger joy, surprise, sadness an so forth are worth while pursuing on the assumption that the emotion component can be sufficiently compartmentalized. It is a compelling engineering practice but we will argue later that despite is short term appeal it is fundamentally misguided. In particular we argue that for affective user modeling to exist it must be in some sense self-sustaining, i.e. only artifacts that can think and learn to think will suffice.

The quest for 'cute' empathic interfaces has not been an unbridled success. Microsoft's social interface, Bob, failed to attract user support despite its metaphorical thoroughness. Its sole legacy was the anthropomorphized CLIPPIT, a much undesired avatar. The hard lesson to be drawn from this anthropomorphizing effort, as Shneiderman points out, is that most users want to control their computer, not form a personal relationship with it [15]. This should not be taken to imply that research with avatars is 'phooey' but that such artifacts may have very specific roles. For example, the use of avatars as experimental media devices for monitoring interactions and testing hypotheses can yield both fruitful new technologies and interesting scientific results [4]. One could argue that it is their very specific remit (as 'workbenches') that imparts their usefulness. Once generalized beyond these domains they may appear either 'quirky 'or as simply a hindrance.

Transmissions between biometric devices (measuring blood pressure, electrical potentials at the brain and skin, and so on) and computers are producing interesting therapeutic artifacts [12]. These may well help users manage stress and even detect dangerous levels of stress. There may be good arguments in favor of using some such devices to monitor video game play and adjusting game content when an arousal threshold is crossed. However many of the artifacts are not sufficiently granular in their analysis to justify affect association with measured device outputs. Associating feelings and thoughts with brain electrophysiology is still hotly disputed [1].

So what is our point? Is this just a case of: everyone else is having fun today, let's wreck the playground? No. Far from it, if the truth were known. It is in fact an appeal to take embodied intelligence and affect very seriously and to revisit developmental issues.

3. ATTACHMENT THEORY

To say that humans and computers are different is trite, but in terms of a world interface humans have several distinct advantages. They appear to come into the world with certain innate components associated with empathy, perspective taking and reciprocity [11]. Decades of research into human-computer interaction have undeniably tried to identify and in cases shore up these gaps [2] [5]. Quite by coincidence, decades of psychological research have identified these same gaps as characteristic of autism [19] [6]. Child development studies show that humans come into the world, typically developing humans, with a set of innate social abilities. This directedness towards others appears to be very much intrinsic to the socio-affective core of humans. Certainly, children with autism either lack this capacity or else exhibit it in very a very impoverished form. Reinforcing the centrality of this capacity and its prominence in child development, studies have also shown that children orient more strongly to people than to things. The very *special nature* of this interaction is critical to human self-definition.

Psychologists and psychiatrists have made considerable progress in understanding the development of interpersonal interactions between humans, especially between infant and mother. The latter relationship is particular significant for a whole range of developmental reasons that one cannot begin to imagine as recreatable within the computer. A tremendous lever for lifting the lid on this area of human life has been attachment theory [16]. It has shed light on the thinking-relationship dyad by classifying forms of attachment between child and mother into ambivalent, avoidant and secure. The latter is the most desirable in terms of overall child development. The secure child grows into a self-confident youth. The other two categories are less desirable producing children with a range of difficulties in relationship formation and emotional expression. Infants, it is argued, use people in different ways to regulate their (the infants') emotions.

3.1 Is Computational Empathy possible?

When we attempt to move some of these results and theory into the area of human-computer interaction, we encounter a number of interesting problems. Firstly, computers have no childhood, unlike their users. Secondly, we are still a very long way from computers that exhibit even a fraction of the developmental tendencies of an infant. Thirdly, the pattern of dependent interactions between mother and child is infinitely richer and more varied than that between computer and computer user.

However, despite these gaps, there is an argument for extending attachment theory's insights as heuristics in developing adaptive affective artifacts. The categorization system of attachment provides a better purchase on several issues. Rather than wonder about the replication, detection or engendering of specific emotions, attachment theory provides a system for organizing exploration of macro affective qualities in terms of patterns of influence. Simply put attachment theory is primary; the derivation of emotions is secondary.

Moreover, the theory provides a rationale (as if any was needed) that the computer is essentially an item with a personality disorder derived from an absence of attachment. This is not a negative counsel of despair but an attempt to develop thinking about affect in terms that are not completely discordant with human development. It is absolutely essential to accept one unalterable fact of human life. We often make ourselves feel better (or worse) by having an affect on other people. This is a key insight that we have attempted to harness in our computational work.

Why is empathy so important? Could an artifact get by without it and still fulfill its affective user modeling role? As mentioned earlier they are domains and specific problems where discrete emotion responses are probably sufficient. For instance if a user was operating a piece of equipment that was gradually putting the user or other users in danger, one might reasonably expect a the feedback loop to berate the user for his/he careless or lack of awareness of the consequences of their actions. This is probably the lowest and least sophisticated level of affective interaction. However, it the feedback loop here is not based on empathy – at least it has no more grasp of empathy that ELIZA had. The reasons why empathy driven responses are different kinds of 'stuff' is because empathy is entwined with perspective taking and reciprocity. Therefore it is difficult to conceptualize how appropriate modeling of affective interaction is achievable without some form of embodiment of these processes. Furthermore, and we do not want to pursue this point too far as it would us well beyond the remit of this paper, there is a connection between consciousness, intentionality and the processes that control emotion expression and interpretation. The types of artifacts that will eventually implement robust affective interaction modeling will therefore have answered several fundamental philosophical and psychological questions about the mechanisms underlying interpersonal relationships.

Whether a computational theory of empathy is possible, in the sense that an implementation would be recognized as empathetic for a reasonable sample of users over a reasonable period of time, is a moot point – a polemical point perhaps. If we could sensibly ask the question: how does that computer make sense of emotional issues? We would be on edge of answering the questions what is the nature of that computer's relationship with people? It is with this former question, that we believe attachment theory can provide sustainable guidance over time

3.2 A Brief Note on Autism

Autism has a spectral presentation both in terms of severity and heterogeneity. We can imagine autism coming in range of colors, each distinct but with overlapping hues at the boundaries. At one end of the spectrum lie those described as severely autistic with little to no communication skills and minimal capacity for independent living. At the other lie those with Asperger syndrome (roughly understood as high functioning autism or autism with normal to above average intelligence) many of whom lead very successful lives. Recent 'post mortem' research has argued that a wide range of prominent Western scientists, composers, mathematicians and philosophers may have had Asperger syndrome. Coincidentally, Wittgenstein has been singled out as the modern philosophical exemplar of Asperger syndrome [7]. For over thirty years now, a triad of impairments has been accepted as defining the central autistic deficits [20]:

1. Impairments in imagination (e.g. inflexible cognitive orientations and processing)
2. Impairments in communication (e.g. failure to initiate conversation, inappropriate language, terse responses)
3. Impairments in social interaction (e.g. ignorance of nonverbal cues, abrupt or stiff body language)

Current theories have drawn heavily from various banks in the philosophy of mind and language. Others have focused on putative and emerging neuroscientific explanations – or more accurately the search for neuroscientific conceptual primitives for the condition. Each theory is focused on explaining a broad range of deficits associated with autism for convenience we have summarized these below:

(a) Theory of mind – situates the explanation of autism in deficits in perspective taking, emotional recognition, capacity to perceive intentions of others, *mentalising* capacity (ability to attribute mental states)
(b) Central coherence – largely hinges on observations that autistic thinking often emphasizes the primacy of detail above overview, parts above whole. Manifestation in language is through relevance failures, i.e. inability to remain on topic
(c) Executive function – identifies incapacity to sequence a response, organize thoughts, inattentiveness and erratic planning stemming from presumed frontal lobe dysfunction in the brain
(d) Intersubjectivity – focuses on understanding the autistic lack of interest in others, the incomprehension over the sharing of experiences with others and the inability to listen to others and respond reciprocally. *A deficit interpersonal affect processing*

Most notable about these theories, which are embedded one way or another in medical scientific practice, is the deference they show to age old philosophical concepts about minds, selves and knowledge of others. The main reason for outlining their central theses is to provide a canvas for sketching our work with attachment theory in a computer game aimed to 'help' adjust the social interactions of autistic adolescents – our user group. The focus on developing intersubjectivity is deliberate. While several characteristics separate the autistic person form his or her peers, the lack of interest in sharing experiences is perhaps the most striking over time.

Introducing autistic users into the equation is problematical. One is tempted to marginalize any experimental results on the grounds that the group is pathological by nature. It is difficult to derive general insights. We have chosen to invert this lens, partly for therapeutic reasons, but also because what wee often regard as 'normal' has its roots in filtering out 'abnormal behavioral and thought patterns.

4. THE GAME MODEL

The game we have been developing is based around an adolescent whose progress through the world is based on his social interaction successes. The central character is called Shem. His behavior and interaction style are designed to replicate the Gillberg diagnostic criteria for AS [8].

The non player characters (NPC) are adolescents with the exception of three 'adult' NPCs. The adults NPCs are a teacher, a policeman and a mentor (in this case the mentor is actually the philosopher Ludwig Wittgenstein). The game is intended as a voyage of social discovery – perhaps best understood as a blending of the Wind in Willows and the Wizard of Oz. As it exists at present there are 12 NPCs in total and three levels. The design has been constrained by (a) the requirement to test our hypotheses, (b) the allowance for design refinement and (c) the financial constraints associated with prototyping. The affective qualities of the NPCs (their personalities) are scripted. For example, some male NPC are scripted to fight under certain conditions, which others (including females) are scripted to remain in proximity to one another.

Each NPC has preset attachment scale values. For example a strongly secure NPC will tolerate another NPC friend leaving the room, and welcome them back. An insecure NPC will try for proximity to any other group of NPCs irrespective of their behavior and consequently ignores or avoids a returned friendly NPC. An NPC with a high ambivalence rating will express unease at being proximate to other NPCs. When a friendly NPC leaves the proximity of an ambivalent NPC, to return later, the latter will respond in confused and contradictory patterns, both wanting the company of the other NPC and being equally willing the push him or her away.

On a technical note, much of the interpretation of behavior is based on both the character script and the division of the 3D game space into a series of 'cubes'. The occupation of a cube by a character alters a cube's attachment properties – up to a point characters can be treated as cubes themselves [14].

The first exposure of the game to the user involves a series of cutaway scenes all set in the one level (which has been variously described as either a prison courtyard or an outside gymnasium). NPCs do not talk but text boxes can be provided. The only audio is some faint music and environmental noises (e.g. footfalls, doors closing, sounds of punches, running noises, and so forth). The purpose of the cutaway scenes is to show the users that they are marked differences in the way in which one NPC will use another NPC to regulates his/her behavior, i.e. his or her emotions. The secure NPC settles down quickly with which other NOC he has an attachment with.

The insecure avoidant NPC keep his distance from the NPC that he as once attached to, and possibly other NPCS, The insecure ambivalent NPC will have a conflict filled relationship with other NPCs to whom he is attracted.

Why not let the NPCs talk? The primary reasons for suppressing NPC speech is to minimize priming of affective interpretation by he users. Many autistic people have fondness for sameness and there was a concern that if specific dialogues were given to NPCs it might hinder the evolution of feedback between NPC and user. Hence, the user would 'work' to ensure that a character would not change. The behavior of the central character Shem can be rotated through all three categories of attachment during the cutaway sequences. Once the users have studied the cutaway sequences they are asked to complete a questionnaire on the strengths and difficulties they noticed in various characters. They are also asked to attribute social qualities to the various characters. This is another reason why NPC speech is suppressed – to prevent answer priming.

Figure 1 Cutaway of two adolescent boys

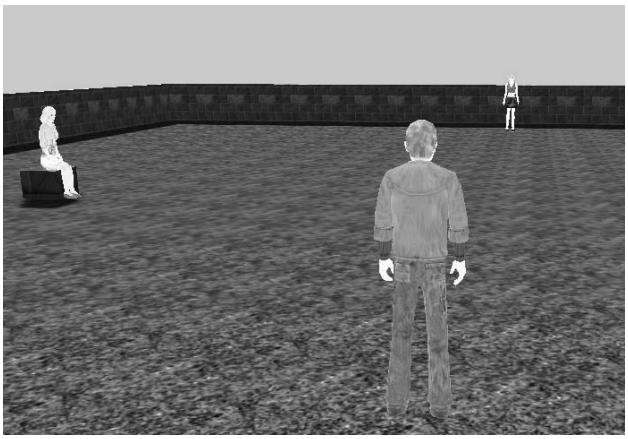

Figure 2 Cutaway of Shem and two girls

However, a much more persuasive argument for leaving our NPCs speechless, given our user group, comes from a study of AS individuals' interpretations of cartoons involving kinetic activity by geometrical shapes [13]. The Heider and Himmel cartoons are animated line drawings largely centered on a 'room' in which one geometrical shape is attempting to leave but is being blocked (harassed) by another shape. In the study in question two samples of typically developed individuals and those with AS were asked to describe what they saw – what was happening. The descriptions were part of a general test for social attribution skills. The most striking outcome was that whereas almost all the typical individuals used socio-affective verbs and adjectives to describe

the behaviors (*the big guy is bullying the little guy*, *the little one is afraid*.) hardly any of the AS groups used similar terms. The AS group provided pure physical descriptions of the movements. T*he black block is above the small triangle. The small triangle and black block are touching*. What these results appear to demonstrate is an inability to attribute affective properties to the objects, i.e. an inability to anthropomorphize objects and their behaviors.

Could it be the case therefore that the same might occur if the as group examined a series of NPC exhibiting various degrees of attachment? What would this tell us about how best to affectively condition interaction for this user group? Were there general lessons to be learnt?

In the scene above Shem meets two girls who react differently to him – the characters can take on random attachment patterns to extend the range of tests if necessary.

5. Game Play: The lessons

Our sample consisted of 9 adolescents with AS. Al had normal to above full scale IQ. None were visually impaired. Three had mild dyspraxia. A measure of the social functioning relative to their peers was obtained from the Vineland Adaptive Behavior Scale [17]. This questionnaire is administered to parents. Without discussing the results in detail it useful to sum up their ratings as placing the group between three and six years behind their peers across abroad range of adaptive social functioning. Separate Strengths and Difficulties questionnaires were administered to both parents and adolescents. Again the precise details are not significant here, but the noticeably converged on 'peer relation's being the greatest weakness.

The first set of experiments was based on the use of cutaway scenes to test the users' affective attribution properties. The research question was whether there would be any practical benefit in building interactive affective agents for these groups. In other words could they recognize affective interactions without being primed, and of not what type of priming was required [10].

The main results of this phase of the work showed that the users had great difficulty working out what type of emotion might be at play between characters and how to rate the behaviors (in attachment terms). Interestingly the more physically animated the characters became (fighting) the easier the attribution of affect became. However, avoidant behavior where a character might move position because of the near proximity of another character confused the users.

Once the users had experienced the cutaway scenes, they each had the opportunity to 'play' the scene again by controlling the character Shem. They were told tat Shem had (a) to make friends with some of the other characters and (b) they had to devise strategies for Shem. Since the game environment can be panned from any angled I was possible to determine the reaction of an NPC to Shem form both Shem's perspective and that of any other NPC.

The significant issue for discussion is the use or non-use the user group made of other NPCs behaviors. Even when they had complete control over Shem's movements it was not all evident that the group in general distinguished between the two types of insecure attachment behavior. Moreover, in the case of secure NPCs, their behavior was mysterious. Consequently, the NPCs were provided with speech boxes which gave an additional clue to their motivations.

An additional feature was to introduction of gangs (groups of three) of more characters that 'hung out' together. The users had to judge which gangs wee safest for Shem to meet. Again observation of the behavior of each group was crucial to the completion of the task. The more rejection Shem received, the less secure he felt – leading to him having conflicts with previous friendly NPCs. If the user became too frustrated with Shem being constantly excluded, he or she could summon up either a policeman or a teacher to patrol the environment and escort Shem around for a set time.

As we mentioned the purpose of this experiment was to help Shem make friends and identify traits in the behaviors of others that would aid in making the right choice. Unfortunately time after time the user made the same mistakes. In the first place, their capacity to distinguish between the proximity that Shem should have with male NPCs and female NPCs was poor. Even when a female NPC would 'move off', Shem was usually directed to follow them. The addition of dialogue boxes did little to improve their judgment. If a female NPC said 'There's a friend o mine over here. I must go', the users would usually direct Shem to follow here. Secondly, even when Shem is attacked by certain groups, and called names (dialogue boxes again), the user group insisted on remaining proximate to the ambivalent social group.

Figure 3 Avoidant behavior

Thirdly, even when other NPCs stopped to 'talk' with Shem the users generally wanted Shem to 'do something' even if that meant driving way the other NPC. The control of interaction was also centered of Shem, rather than allowing another NPC to hover around and engage in greetings. Admittedly Shem's own greeting range was restricted to limit irrelevance. The final lesson both the users and researchers learnt is that is very hard to capture intersubjectivity in a computer game without a very rich layer of AI and character memories being created.

6. DISCUSSION

What out results reveal to date is that for certain user groups with a proclivity for impaired affect recognition, the interaction focused on improving their recognition of affect has a role but given the size of our sample and the relative lengths of the

experiments we are not in a position to make definitive claims about affective agents being effective for this user group at least. Most of the group had impaired abilities to attribute emotion terms accurately compared to peers [9].

There is no doubt that attachment theory shines an interesting light on how computer games can be made interesting without necessary being violent, but extracting general lesson for affective interaction requires more work. It became clear from out studies that allowing the user to control the 'action' was unsatisfactory since love of sameness often meant that the full range on interactions with NPCs was not explored. As a result we decided to build an autonomous community of affective characters that would express and reach some type of accommodation based on attachment theory. This work is divided into three section which wee briefly call brain, lungs and heart.

At present we are tackling the generation of affect and the response to user affect influenced interaction by altering the intelligence of the main Shem character. Shem-II has a 'brain' based on Taylor's CODAM model. The CODAM model regards consciousness and thinking as top-level processes tuned, as it were to attention catching stimuli in the environment. Its simplest statement is probably found in [18]. Given the computational overhead on implementing CODAM it is only possible to restrict the work to basic motion and attention processes, with 'memory' being scripted for each character. Also the number of characters has been reduced. From attachment and affect perspectives CODAM is significant because of its emphasis on paying attention to the environment – either selective or sustained attention is always active.

However while CODAM provides elements of a 'conscious' affective character and through manipulating its selective/sustained attention focus one can more spontaneously mimic the three modes of attachment, it still needs social motion equations to inspire the characters to move. The lungs of the system are provided by work on behavioral game theory, particularly the Falk and Fishbacher equations governing kindness and reciprocity. An overview can be found in [3]. The advantage of using game theory is that it provides a handle on social preferences and in turn on self-preferences. Consequently, both group an individual interactions can be explained and elaborated by the adjustment of relatively few variables.

The heart of the system still comes from the use of attachment scales excerpt the scales can now respond more spontaneously to changes in the system. It must be admitted that more progress could have been made on refining the interactions if the problem had been tackled as largely one residing at the boundary went computational neuroscience and control system theory, rather than an augmented human-computer interface design model.

Our current task is to let the game system run autonomously for periods of days running into weeks and record the states o equilibriums being produced. In many ways this takes us right back to the development of intersubjectivity between infant and career. It is a gradual process and perhaps, if building artifacts with affect they too will need a gradual nurturing.

7. ACKNOWLEDGMENTS

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