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Aims & Scope

The International Journal of Neuropsychotherapy (IJNPT) is an open access, online journal that considers manuscripts on all aspects of integrative, biopsychosocial issues related to psychotherapy. IJNPT aims to explore the neurological or other biological underpinnings of mental states and disorders to advance the therapeutic practice of psychotherapy.

Our mission is to provide researchers, educators and clinicians with the best research from around the world to raise awareness of the neuropsychotherapy perspective to mental health interventions.

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EDITORIAL

It gives me a special sense of joy to introduce the second edition of the International Journal of Neuropsychotherapy. There has been a very encouraging interest in the first edition and we hope this interest will continue into our second year. We strongly encourage our readers to introduce the journal to colleagues and to consider submitting papers for our consideration.

Professional Development

Professional development is an important tool to ensure high standards of practice. It is standard practice for all professionals providing services, and is not limited to just the health professions. Professional development also makes sense. New research demonstrates that CPD results in improved professional standards and improved quality of interventions in terms of understanding, approach, strategies and skills. In order to provide a quality service, the professional benefits greatly from having some understanding of the developments in the field and taking steps to upgrade her/his knowledge and skill base.

A couple of years ago the Australian Psychological Society announced that after 31 October 2011, it will cease accepting applications for endorsement of continuing professional development (CPD) activities. In the statement, the APS added the following: "Please note: APS members can accrue Continuing Professional Development (CPD) hours by participating in CPD activities that they determine to be relevant to their individual professional skills, learning plans and goals. These may be self-initiated. CPD activities do not need to be endorsed by the APS."

I am sure every clinician in Australia (as well as clinicians in all other countries) is well aware of these changes to the profession and has by now considered the potential implications for her/his work situation in light of these changes. Of course, there are significant variables at play. Where clinicians practice (whether in a government department, an NGO, private practice, tertiary education or combinations of these – to mention just one of these variables) plays a significant role in terms of the needs for professional development.

From a neuropsychotherapeutic perspective, and in light of research indicators from neurobiological research, we need to consider the implications of these changes for both our clients and ourselves as clinicians. This means considering strategies to best facilitate change and growth for our clients, while being mindful of the need to improve our own psychotherapeutic knowledge base and applied skills within the new CPD framework.

It is encouraging to notice that tertiary institutions and Institutes in Neurobiology research and training are now taking the lead in providing various models of professional development. I encourage researchers and providers in this domain to introduce such initiatives in neuroscience through this platform. The International Journal of Neuropsychotherapy is keen to publish quality research in this area to enhance the footprint of Neuropsychotherapy on global basis.

Pieter Rossouw

Chief Editor

THEORY

A four-stage hierarchical model of image construction and drawing production: Evidence from visual hallucinations, development and pathologic regression in art

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Abstract

A four-stage hierarchical model of image construction is proposed. Stage 1 involves amorphous or scribble fields of light, color, and spots; Stage 2 involves abstract geometric shapes; Stage 3 schematic recognizable objects; and Stage 4 represents three-dimensional realistic images. A similar four-stage model is also proposed for drawing an image. Evidence to support our model of the visual construction of an image is based on phosphenes and various other kinds of visual hallucinations. Evidence to support a similar four-stage model for drawing an image is based on the development of children's drawings and from drawings of adult artists suffering from mental pathologies or Alzheimer's disease. Findings from brain research supporting both models and implying underlying neurological functions and locations are also cited.

Keywords: model, image construction, image drawing, hallucinations, Alzheimer's, mental pathologies

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In this paper we propose that a perceptual image is normally processed—that is, constructed—in the human visual system through what can be considered four qualitatively different hierarchical stages. We also propose that the same four stages are involved in the physical production of an image, such as drawing a picture. After providing evidence for a multi-stage hierarchical construction of visual images, we relate these stages to artistic development in children and to changes in the depictive style of artists suffering from neurological and/or psychiatric pathology. The model involves hierarchical processing from (a) initial sensing of light and color in amorphous or point fields to (b) processing of perceptual representations of geometric shapes to (c) cognitive schematic construction of objects to (d) a normal synthesized 3-dimensional realistic representation. This hierarchical model is consistent with neurophysiological findings that suggest serial processing in ascending the neuraxis (Bar, 2003; Hawkins, 2004; Jackendoff, 1987; Prinz, 2000), yet also assumes a parallel form of processing within each functional level of the hierarchy.

It is important to note that this is not a model of how the perception of color/light, or geometric shapes, or schematic objects—or complete scenes themselves—presumably takes place. Instead, these stages are assumed to take place probably using some kind of parallel processing, but otherwise how they take place is not treated. Thus, this paper outlines a gross structural model of the stages or processes of image construction, and considers the implications of such a hierarchical structure for how an image is constructed in the final perceptual representation. It then relates this to such phenomena as children's drawings, visual hallucination, and regression in drawing by people suffering from serious pathology such as Alzheimer's disease.

One consequence of the model is to show how a patient's art can be directly relevant to medical practice, since the model proposes that for certain patients their art is an intelligible expression of underlying neurophysiology.

The Model: Perceiving or Constructing an Image

Stage 1. The first stage or level, which we term sensory, is characterized by amorphous color fields and scribbles. The visual appearance or phenomenology of Stage 1 consists of a field of light or color; also included are spots or dots of light that occur in a haphazard pattern—that is, the dots are not arranged in such a way as to allow straight lines or other recognizable shapes. Scribbles—that is, patterns made up of many heterogeneous lines without any recognizable shapes or objects—are also representative of Stage 1. Such scribble patterns are interpreted as another form of amorphous or inarticulate visual field. Scribbles are commonly made by children using a relatively sharp-pointed pencil or crayon; however, if instead they were given a relatively wide brush, their scribbles would look much like an amorphous color field. Stage 1 images such as these are produced by children when they first begin to draw. Familiar examples from modern art of images whose visible aspects are also assumed to have been primarily completed in Stage 1 include the typical color-field paintings of Mark Rothko, the familiar drip paintings of Jackson Pollock, and many of the works of Cy Twombly, Franz Klein, and many abstract expressionists.

To describe a painting as at Stage 1 (i.e., sensory: amorphous or color field; or scribble) in no way criticizes the artwork or implicitly equates it with the work of a child: On the contrary, the greater aesthetic and cultural significance of the artist's work based on higher-order processing is assumed. We only illustrate image types, nothing more.[1]

Equally, when we characterize the processing of a visual stimulus as being completed at any given stage—especially in the case of paintings by adult artists—we do not mean to imply that the stimulus is not also processed at higher levels. Rather, we posit that that stimulus is not processed any further in terms of the image properties characteristic of the stage in question. It is well known that network processing that engages the cortex brings lower visual material into a complex framework involving higher-order visual associations, in addition to neural networks that engage memory, recognition, interpretations, meaning, and other contextual information. We also assume (see Zeki, 1998) that each stage represents both a level of completed processing and a level of perception.

Stage 2. The second stage, which we call perceptual, is characterized by geometric lines and patterns (e.g., triangles, ellipses, composites of such shapes, etc.), but without any recognizable objects. These shapes, we assume, involve some prior processing at Stage 1. Examples of such Stage 2 processed images are the typical works of such artists as Victor Vasarely, many by Wassily Kandinsky, Piet Mondrian, Kazimir Malevich, and

1 Note that when we use the expression "Stage 1, 2, 3 or 4 image" we are using shorthand to refer to an image where the visual processing of the stimulus, according to the model, has been essentially completed at the designated Stage.

Josef Albers; and countless more recent artists whose paintings are of simple or complex abstract geometric shapes.

Stage 3. This stage consists of cognitive-schematic (i.e., cartoon-like) objects. Stage 3 is distinguished from Stage 2 by the clear appearance of recognizable objects; however, these objects are schematic and generally flat—such that major cues to depth (e.g., shading, linear perspective) are absent. We believe this level to be legitimate and important, although it has not been given much attention in the experimental literature. Examples of Stage 3 images include many works by Pablo Picasso, Fernand Leger, and other cubists. Marcel Duchamp's *Nude Descending a Staircase* is a well-known representative of this stage, and there are many others. A recent Stage 3 artist would be Keith Haring; and, of course, almost all cartoons and caricatures represent what we are calling Stage 3.

Stage 4. This, the model's final stage of perceptual construction, is characterized by comprehensive and realistic 3-dimensional scenes. Stage 4 consists of the images characteristic of normal visual experience. While there are additional stages and processing beyond Stage 4, we maintain that these involve post- or extravisual neural functions—such as language, for example, or judgments about beauty as identified by Kawabata & Zeki (2004)—but these are beyond the scope of the present discussion. Examples of Stage 4 images include all typical realist portraits, landscapes, and still lifes.

It is important to note that this model proposes that there are only four qualitatively different kinds of visual image—one type at each stage. We assume that most natural, three-dimensional visual experiences involve the earlier constructive use of the three "simpler" stages. A few natural stimuli are presumed to cease being perceptually processed at early stages—for example, perception of the sky and the ocean are normally finished by Stage 1, although the moon and the sun (when present) bring in some of Stage 2. In terms of the model, the perceptual construction of many human artifacts (such as art, buildings, or cartoons) is often completed by Stage 2 or 3.

In addition, we understand that the stages of image processing are mental (i.e., perceptual, experiential, and/or phenomenological) in character (see Zeki, 1998), and most likely reflect complex activity of brain networks that engage hierarchical logic rather than just a specific localization in the visual neuraxis. Nevertheless, we posit that there is plausible neurological evidence for some stage localization as presented below.

Evidence for Stage Localization

Pressure phosphenes. Perhaps the simplest evidence for the first two stages can be observed when gentle pressure is applied to the closed eyes (Oster, 1970; Tyler, 1978). When this occurs, it is common to first observe changes in the brightness of what was an all-black field, followed by points of light (often colored) on a black or almost black field and, finally, grids or gratings or fields of squares, which are often colored. Presumably, pressure applied to the front of the eyes initially color-stimulates retinal elements, then the lateral geniculate, and then areas of the primary visual cortex. Most likely, after this level, visual stimulation achieved by pressure is no longer effective and dissipates.[2] In other words, simple activation of the initial transductive and conductive elements in the visual pathways (without photic input) is sufficient to generate early-stage responses. But the absence of additional stimuli (and differential engagement of amplifying and rectifying elements in the retina) means pressure on the eye is insufficient to elicit higher-stage processing activity.

Electrically induced phosphenes. The most systematic investigation of phosphenes has involved the use of mild electric current (Höfer, 1963; Knoll, Höfer, & Kugler, 1966; Knoll, Kugler, Eichmeier, & Höfer, 1962; Knoll & Welpe, 1968; Seidel, Knoll, & Eichmeier, 1968). In these experiments the participant was blindfolded, and low-level electrical stimulation was applied to the lateral orbit. Such electrical stimulation invariably elicited a visual response—electrical phosphenes—in all observers, who were then instructed to draw examples of their visual experiences. Analyses of hundreds of such reports were classified into 15 fundamental types, as shown in Figure 1. We refer to these as the Munich taxonomy of phosphenes (noting that the studies were conducted in Munich, Germany).

With the exception of spots, all of the reported phosphenes induced by electrical stimulation can be categorized as Stage 2 shapes in accordance with the present model. The intensity and frequency of electrical stimulation that elicited a given phosphene shape was not consistent across subjects, although it was consistent within a subject. The similarity of these basic shapes to most children's basic scribbles (see Figure 3) was noted by Kellogg, Knoll and Kugler (1965).

Sensory Deprivation. Some of the earliest descriptions of perceptual experience indicative of the

2 For the history of the study of, and speculation about, such eye deformation-induced phosphenes, see Grosser and Hagner (1990).

underlying visual stages can be found in the sensory deprivation literature. In these studies, male college students spent time in a cubicle in which sensory experience was markedly reduced. The participants wore translucent goggles so that all visual input appeared as a relatively homogeneous field of light. They also wore gloves and cardboard cuffs; the latter extended from the elbow to below the fingertips, in order to reduce tactile stimulation. Auditory stimulation was limited by continuous background noise created by fans and air conditioners and by a U-shaped rubber head pillow that acted as a sound baffle. Participants lay on a bed in a cubicle for 24 hours a day, with interruptions only to eat and for toilet breaks. Most could tolerate sensory deprivation for only two or three days before finding the experience unpleasant and terminating involvement in the experiment.

Of the 29 participants, 25 reported some form of visual hallucination. Heron (1961) observed that hallucinations typically progressed from simple to more complex: The first symptom would be a lightening of the visual field, followed by dots of light or lines; then geometrical figures and patterns, often composed of reduplicated figures, followed by isolated objects against a homogeneous background; and, lastly, full-blown scenes would appear. The reduplicated geometrical figures were sometimes described as wallpaper patterns. Actual figures or objects without a background included images of "a row of little yellow men with black hats on and their mouths open […] a German helmet … [and] … a procession of eyeglasses marching down the street" (Heron, 1961, pp. 6–33). The figures were often described as cartoonish. Complete scenes and landscapes were the least frequently reported hallucinations.

We believe that these reports describe all four stages or levels of visual processing as proposed. The lightening of the visual field and points of light (i.e., earliest experiences) show Stage 1. In pressure phosphenes, these experiences often involve de-saturated colors (although color was not addressed or reported in these experiments). Sensory deprivation-induced hallucinations at Stage 2 are represented by reports of lines and geometrical figures and patterns (e.g., wallpaper patterns); Stage 3 visual phenomena include cartoon-like figures (cf., "rows of little yellow men with black hats and their mouths open"); and Stage 4 is represented by more integrated scenes, especially those described as landscapes. In addition, it should be noted that these perceptions occurred in the predicted order (i.e., from simple to more complex), and that each higher stage was less frequently reported than the previous stage—with the highest stages being reported by only about 20% of participants.[3]

Vernon and McGill (1962) also present a multi-level description of sensory deprivation-induced hallucinations. However, the researchers limit these effects to a 3-level process: Level 1 consisted of flashes of dimly glowing or flickering light without shape; Level 2 hallucinations were more complex and were geometric (e.g., squares, circles, lattice-work); and Level 3 were complex and contained integrated and/or animated scenes that were highly structured and rich in detail. While Levels 1 and 2 are similar to our model's first 2 stages, Vernon and McGill group into a single category (their Level 3) what we distinguish as Stage 3 and Stage 4 processing.

Bonnet Syndrome. A well-known medical phenomenon involving visual hallucinations is the Charles Bonnet Syndrome. This syndrome describes the spontaneous appearance of complex visual hallucinations in adults who are without psychopathology. These hallucinations are experienced primarily by older patients who have visual deficits, especially at the retinal level. Reduction in vision due to vascular pathology in the periphery as well as in visual areas of the brain (e.g., A17–19) is associated with the syndrome. Schultz and Melzack (1991) noted that there is considerable literature indicating that the loss of visual input to the brain as a result of pathology can be a cause of visual hallucinations, and they suggest that these "represent a visual analogue of the phantom limb phenomenon—that is, experience generated by brain activity in the absence of sensory input" (p. 809). Cole (1992) has noted the similarity of sensory deprivation-induced hallucinations to those of Bonnet syndrome: He considers that the absence of visual stimulation in Bonnet's patients is analogous to the absence of external stimuli in sensory deprivation.

Bonnet syndrome hallucinations are "usually colorful, well-formed images that are detailed and sharply in focus even if they appear at a distance" (Schultz & Melzack, 1991, p. 810). The objects seen are quite varied, with images of people and animals being especially common. Examples include, among others, "a brightly colored circus troupe" and "large chickens wearing shoes" (Schultz & Melzack, 1991, p. 811).

A review of the different images, as provided by Schultz, Needham, Taylor, Shindell, and Melzack (1996), reveals that 23% of subjects reported simple light flashes, colored light, and black dots or "bugs". These reports describe what we categorize as Stage 1

3 The results cited here are summarized from the works of Bexton, Heron, and Scott (1954); Heron (1957); and Heron (1961).

images. A further 12% reported formed geometrical shapes or elaborate designs—what we consider to be Stage 2. G. Schultz (personal communication, August 16, 2000) reported that Bonnet's patients frequently described some of their images to be like "cut-outs" and stated that the term "schematic" seemed appropriate for such descriptions. Thus, we conclude that many of the complex hallucinations reported by Bonnet's patients are what we classify as images characteristic of Stage 3: mainly flat, schematic, and cartoon-like.

Further evidence for Stage 3 images can be found among descriptions of Bonnet's Syndrome that appear in the earlier French literature. As discussed by Flournoy (1901), Charles Bonnet's descriptions of hallucinations in his original patient, his grandfather Lullin, were described as being like tapestries or as tableau scenes—terms that suggest rather flat, schematic images. Also reported were fabric patterns, flowers and leaves, a white satin background with black shapes, and circles—all like images on paper. A frequently reported hallucination was of blue handkerchiefs sometimes called squares (or *carreaux*).

In discussing Bonnet's syndrome, de Morsier (1967) describes one 19th century patient who saw "posters on the walls of his room" (p. 681); another 20th century subject reported flat figures of men and animals. De Morsier (1969) also reported patients' descriptions of hallucinations as being like handkerchiefs or black and white images (as in movies), as well as other descriptions equally suggestive of the schematic, flat, cartoon-like qualities proposed for Stage 3 processing in our model.

Schultz et al. (1996) stated that the face of a person or complex scenery was reported by over 70% of Bonnet's patients. It is clear from these reports that the images were often quite realistic, and thus can be considered Stage 4 (i.e., 3-dimensional) according to our model.

It may be somewhat difficult to accept our claim that individuals can have direct phenomenological access to the neurological structures involved in the internal stages of visual processing; however, the aforementioned evidence certainly implies that this is indeed the case. In normal visual experience, the underlying abstract elements at each stage are assumed to be completely captured by the properties of the natural, external visual stimulus, but in the absence of any externally initiated visual stimulation, humans appear to have the ability to consciously experience the internally initiated activity of the underlying visual elements. This accounts for the hallucinations that are expressed at a particular stage.

The Model: Producing the Image

The model as described thus far posits processing of input beginning at a sensory level and progressing to the construction of a phenomenally realistic image at Stage 4. There is, however, another aspect of the model in addition to input processing—namely, that in order for a person to draw, there must also be an output-processing mechanism. After all, when a three-year-old child begins to draw, the child is presumably seeing the world at Stage 4 with all of its 3-dimensional realism. Likewise, many adults with normal 3-dimensional perception are unable to draw or paint at a level as sophisticated as Stage 4. Therefore, although apparently all adults can at least make stick figures (i.e., early Stage 3 images), we consider that the problem—both for children and many adults—is an inadequately developed output or "drawing" module; in particular, they have poor or non-existent Stage 4 output responses.

We propose central nervous system (CNS) mechanisms that entail output strategies that allow a person to draw a picture. Such proposed output mechanisms are presumably linked to the input-processing system but in many ways also remain distinct. Various theorists have proposed that the deficits in children's drawings are not caused by conceptual inadequacies—and certainly not perceptual limitations—but instead are the result of production or drawing-skill deficits (see Cox, 1992, 1993; Freeman, 1980; Freeman & Cox, 1985; Milbrath, 1998).

Perhaps at the highest level of input processing the cortical area devoted to image recognition is roughly similar to the primary speech recognition area (i.e., Wernicke's). If so, we posit that the image drawing module would be analogous to the speech production area (i.e., Broca's). We suggest that this output-processing model is hierarchical, and that it is organized in the same four stages as the input-processing model. There is research to support a distinction between the neural substrates of visual perception and those underlying visual control (Goodale, 1996; Goodale & Milner, 1992). This distinction may involve complex interactions between spatial vision and output responses. If both input- and output-hierarchical models exist, then distinct development of these substrates might be evidenced in both perception and drawing patterns during ontogeny; and, further, CNS insult could differentially affect either or both networks to evoke different patterns of perception or drawing—either separately or possibly at the same time.

Developmental Evidence

Children's drawings. Systematic investigations and theorizing about children's drawings have been carried out by many. One especially comprehensive study was published by Rhoda Kellogg in 1970 in which she described progressive development based upon observation of thousands of drawings made by children from a wide variety of cultural and ethnic backgrounds (Kellogg, 1970). She concluded that, on average, children's drawings move through the four developmental stages as posited by our model. At first there are only scribbles (see Figure 2). The next level involved "basic" scribbles—Kellogg identified twenty of these basic scribbles or, as we call them, basic forms. After the dot, which we place at Stage 1, the first simple forms are straight lines of vertical, horizontal, and diagonal orientation, then a curved line, then multiples of these elements; this is followed by a roving open line; then a zigzag, a loop, a spiral, and circles (as shown in Figure 3). Typically, most of these basic forms are apparent by the time a child is three years old.

A few comments about the basic forms are in order at this point. Although Kellogg claimed that dots and then lines of different orientation were the initial basic elements, one should keep in mind that not every child develops all the basic forms before moving to the next stage or level, and there can be considerable overlap in stages. In Kellogg's description, then, the elements to develop after basic forms are diagrams—examples of which include the cross-shape, square, circle, triangle, an X-shape, and a closed figure that is asymmetric, usually a roving line coming back on itself.

Kellogg strongly emphasized that the level of simple geometric forms develops after scribbles and prior to simple schematic pictorials. Recent scholarship of children's drawings has been critical of the proposed universality of Kellogg's more complex geometric shapes, especially mandalas, radials, and other complex forms. However, the presence of simple forms similar to Kellogg's are accepted as a necessary precursor to even early figure-type drawings, the first pictorials of children (such as Figure 4a). Howard Gardner, for example, a cognitive psychologist with an extensive knowledge of children's drawings, recognized four basic stages of development (Gardner, 1973, 1980). He labeled the four as scribbles, forms, things (simplified objects) and, finally, attempts at realism. More recently, Malchiodi (1998) reviewed much of the published work on children's art and reported stages compatible with the present model, namely: scribbling, basic forms (simple abstract geometric shapes), human forms, and early schemata, followed by more developed schemata and, last, realism. In children's art, the schematic representation of the human form rapidly becomes more detailed and specific, and soon includes hands, arms, and legs (see Figure 4b); other elements are sometimes added, for example clothing to indicate gender differences. This level of representation is often called early pictorialism. At about the same time, the child begins to draw trees, animals, and buildings. As noted, all of these theorists propose that all children go through these stages, arriving at a pictorial level at which drawings are flat and schematic. (See also Milbrath, 1998). Only a small number of children, especially the most talented, move on to our Stage 4, where more realistic, 3-dimensional drawing involving the use of depth cues commonly makes its appearance.

In Figure 5 this hierarchical process in the development of children's drawing is summarized by Kellogg in a way that even she considered oversimplified, but which nevertheless captures the basic idea clearly.

It is important to note that drawing (at least up to early pictorialism) is not the result of the child looking at something and then attempting to draw it; rather, the child seems to be attempting to draw some pattern or schema that exists as an internal mental construct. Much of the time, children's drawings do not appear to be based on some object in their external visual environment that they are trying to reproduce, but instead are determined by a pre-existing schema and by the drawing itself. This process is similar to how an adult constructs a doodle.

Within the framework of our model, therefore, evidence for Stage 1 is found in the early scribble drawings and in the use of dots; Stage 2 is shown in basic diagrams and other more complex geometric shapes and designs; and Stage 3 is represented by early and late pictorialism with its flat, cartoon-like and very schematic representation of objects.

There are a few curious exceptions to this approximate developmental sequence—for example, the well-known case of Nadia, an autistic child who demonstrated extremely advanced depictions of depth and realism almost from her first efforts at drawing at age three or four (Winner, 1982). In this case, however, Nadia's unusual ability was probably closely related to her autism and thus cannot serve as a representative contradiction to the normal progression of stages. Nadia had eidetic imagery combined with a very limited ability to generalize, or form abstractions, or classify objects into categories (Selfe, 1977). Winner (1982) noted that Nadia "could not match pictures of the same objects unless both pictures represented the object in the same orientation" (p. 186). Hence we conclude that her case is more of an outlier, as the bulk of the evidence supports a four-stage model of visual and output processing in children.

Pathological Evidence

Alzheimer's disease. Alzheimer's disease is a slow and progressive degenerative condition involving the hippocampus and cortico-temporal networks that are primarily involved in short-term memory consolidation and cognitive processes. Given the protracted nature of this pathology, it is possible to obtain drawings from the same patient over the course of the disease. Within the premises of our model, as a degenerative condition affects the networks that subtend general perceptual or perceptual-motor function, the patient's drawing should evidence regression through Stages 4 and 3 to Stages 2 and 1 of the model as higher processing function is successively lost. An example of this is presented in Figure 6, which illustrates regression in an Alzheimer's patient who was an artist (Cummings & Zarit, 1987). The first drawing (Figure 6a) is a naturalistic representation and can be described as primarily a Stage 4 image. The second drawing (Figure 6b) shows the schematic Stage 3 exemplified by a clear reduction of depth. The last drawing (Figure 6c) reveals strong geometric Stage 2 properties, although minor aspects of Stage 3 still persist. Another obvious case of stage regression in a female Alzheimer's patient (Wald, 1984) is shown in Figure 7 (a, b, c). We do not assume that every drawing made after another will necessarily be more regressed that the previous drawing, since the disease can stabilize, and can sometimes even appear to improve for short periods of time; but over a period of a year or so regression should be apparent.

In her book on art by Alzheimer's patients, Ruth Abraham (2005) identifies four characteristics of their artwork: simplification, fragmentation, distortion, and perseveration. The first is a term that could be used in a general way to describe regression to our Stage 1; however, we describe simplification more specifically. We do not deal with the second and third descriptors, fragmentation and distortion, although both of these can be understood in our model as the natural consequence of moving from a naturalistic scene through Stages 3 and 2 to Stage 1. The last characteristic, perseveration, seems quite reasonable, but we have nothing to say about this temporal response.

Another recent representation of regression can be seen in the self-portraits of the professional artist William Utermohlen, who was first diagnosed with Alzheimer's disease in 1995. Figure 8a, from 1996, shows considerable realism and depth via shading. By 1997, however, much depth and realism has dropped out and the work shows a primarily schematic, Stage 3 face with a good deal of Stage 2 geometric patterning in the background; and in 1999 the face is now primarily Stage 1. He died of the disease in 2007.

Some final support comes from the late paintings of the prominent abstract expressionist artist Willem de Kooning.[4] In de Kooning's earlier and most representative period, his works typically showed recognizable parts of a woman's body, especially aspects of the face, with the rest of the work being without pictorial content. However, a few of his works during this mature period were also without any imagery or even geometric emphasis. He was diagnosed with probable Alzheimer's disease around 1980, and he also suffered from the effects of alcoholism based on many earlier years of heavy drinking. He continued to paint until mid-1990 and eventually died in 1997. From the perspective of the present model, all of de Kooning's works of the late period are without any Stage 3 schematic imagery and without any systematic geometric patterning (Stage 2). All are either wandering line-like works, usually with strong red, blue, yellow or orange, and occasional green color in the lines or in the shapes created by such relatively thick, wandering lines. A few others are just dark areas of color without any line properties. In short, all of his quite late paintings appear to be at Stage 1. In a modest way, some of his late works were prefigured by aspects of some of his pre-Alzheimer's paintings but they are, in general, quite distinctive. This interpretation is not to deny that they have artistic merit. De Kooning was an extremely talented and innovative artist but he seems to have been driven down to this lowest level, according to the model, by his Alzheimer's condition. Nevertheless, even here he was able to express an intriguing aesthetic. Louis Wain, a much smaller artist who suffered from severe mental pathology, discussed below, produced his most artistically interesting works when he had regressed from Stage 4 to earlier stages. Again, as mentioned earlier, the stage level of a work is not a comment on its aesthetic value.

We also expect that a similar representational regression might be found in some stroke patients or other brain-damaged artists such that the greater the (network hierarchical) effect of the CVA (i.e., cerebrovascular accident), the greater the regression of the patient's ability for visual representation. We posit that progressive recovery from the damage would co-

4 For information on de Kooning's life and late works see Storr and Garrels (1997). Examples of his late paintings made in the late 1980s can be found easily online under his name and "late paintings."

incide with a reversal of such change(s) and advancement to higher stages of processing and representative output. One example supporting this proposal is found in a description of the progressive recovery of a brain-damaged artist provided by Zaidel (2005).[5]

Psychiatric pathology and recovery. Before we address psychiatric pathology and recovery, it is important to summarize the earlier research on psychiatric hallucinations conducted by Horowitz (1964). In this study, subjects reported examples of spots, grids, wavy lines, circles, radiating figures, and similar Stage 2 types of hallucinations, although amorphous specks (Stage 1), schematic shapes of a faucet and animal heads (Stage 3), and realistic animate objects such as a parent or sibling (Stage 4) were also described. When interpreting the reported hallucinations, especially those from anxious and depressed psychiatric patients, Horowitz contends that:

> It was necessary to persist beyond initial verbal descriptions […] and insist that the patient describe and draw what he had seen. Initial descriptions of "vicious snakes" might then be drawn and re-described as wavy lines. In one case the patient's description of "Two armies struggling over my soul" arose from the subjective experience of seeing moving sets of dots. (p. 513)

In short, psychiatric patients (and probably non-psychiatrically disordered individuals) often provide fairly complex narrative interpretations of what are, in fact, much simpler visual percepts.

Serious psychiatric conditions can also result in a loss of mental capacity that damages adults' ability to draw. Thus, we can expect that the severity of psychiatric disturbance will show up in changes to the stage or level of a person's drawing. Prior to any evidence of mental pathology, a typical adult should be drawing at either Stage 3 or 4 depending on his or her skill. As a mental condition becomes more severe, regression through the stages should become evident—analogous to the effects of Alzheimer's disease. A number of examples support this possibility; perhaps best known is the work of the artist Louis Wain. During his normal adulthood he was well known for his paintings and drawings of cats, which appeared in many illustrated English periodicals (Dale, 1991). These were realistic, and the cats were often shown in humorous situations, implicitly mimicking human interactions. After some years as a successful artist, however, Wain became mentally disturbed and was hospitalized for schizophrenia. The rather well-known series of five drawings that demonstrate the regression in Wain's work can be reliably found under his name on the internet (see Cardoso, n.d.). In the series of his cats presented by Cardoso, the last example is devoid of any recognizable content and from the perspective of the present model is essentially only a Stage 2 image. (Note that Cardoso's use of the word *stage* is different from ours.) It is clear that the early signs of deterioration are present by the changes that can be seen between the first and third drawings: The third "cat" shows considerable loss of depth (via shading), and there is the emergence of much schematic, cartoon-like imagery. Loss of depth is the major cue to movement from Stage 4 down to Stage 3.

There is no reliable evidence that the usual series of Wain's cats was actually made in the order shown, but that seems somewhat irrelevant. Over the years, schizophrenia—like most mental pathologies—can wax and wane for a given patient, even if the general tendency is one of decline over time. In any case, the deterioration in the images is obvious, and Wain's changes are supported by the other examples shown here, where the mental state of the artist at the time of each drawing is known. It is interesting to note that when Wain's images have been shown to students in various university classes by the first author (P. C. V.), it is often remarked by art students that the aesthetic value of Wain's work became greater, and the drawings more interesting, in the early stages of his regression. Another clear example of such representational regression in a mental patient can be found in the *Cunningham Dax Collection: Selected Works of Psychiatric Art* by E. C. Dax (1998), where the artist/patient is listed under schizophrenia. We are informed he suicided not long after the last more stage-regressed drawing.

In contrast to stage regression in psychiatric pathology, recovery from mental disturbance should result in—and reveal—reconstitution of the four-stage hierarchy of representational capacity. An example of this is shown in the works of "Mr. Pauli" (Figure 9). As reported by R. M. Simon (1997), Pauli began painting in a psychiatric group; he subsequently left the group, was discharged from the hospital, and lived on his own. He apparently became progressively "more normal", as evidenced in the sequence of his works that were left at various times at Simon's door. The last picture Pauli brought to her is shown in Figure 9d, a robust representation of a Stage 4 drawing.

A student of the first author who was working in a

5 The artist's portraits are illustrated in Zaidel (2005, pp. 26–28). The paintings move from very schematic, even child-like, in Figure 2.1(a) to flat and cartoon-like in Figure 2.1(b) to real depth in Figure 2.1(g).

hospital observed a patient who showed stage recovery in her drawings, as shown in Figure 10 (a, b, c). The drawings were done while the patient was in a short-term psychiatric ward in New York City. The first day she was admitted she drew 10a; the next day 10b; and on the third day, shortly before being discharged, she drew 10c. Figure 11 (a, b, c) presents the drawings of another patient admitted to the same short-term psychiatric ward and shows, in contrast, systematic stage regression. The drawings were produced on the first, third, and fourth day after his admission (11a, b, and c, respectively); a day later he was transferred to a long-term psychiatric ward. These observations suggest that stage-level evaluations of a person's drawings may be useful for getting a quick measure of the degree of pathology.

Recent papers that provide some support from human regressed drawings for the Model's predicted stage changes in the images produced include the following: Annoni, J. M., Devuyst, G., Carota, A., Bruggimann, L., & Bogousslavsky, J. (2005). Changes in artistic style after minor posterior stroke. *Journal of Neurology, Neurosurgery & Psychiatry, 76*(6), 797-803; Bogousslavsky, J. (2005). Artistic creativity, style and brain disorders. *European Neurology, 54*,(2), 103-111; Chatterjee, A., Bromberger, B., Smith II, W. B., Sternschein, R., & Widick, P. (2011). Artistic production following brain damage: A study of three artists. *Leonardo, 44*(5), 405-410; Kleiner-Fisman, G., & Lang, A. E. (2004). Insights into brain function through the examination of art: the influence of neurodegenerative diseases. *Neuroreport, 15*(6), 933-937.

Discussion

Visual system location. There is a modest but relevant literature on the anatomical localization of processing of phosphenes and related visual images in humans. Chapanis, Uematsu, Konigsmark, and Walker (1973), and Brindley and Lewin (1968) report the sensations induced by stimulation of the visual cortex of a recently blinded woman. It was shown that stimulation using a simple cortical electrode usually led to the sensation of a single spot of light at a constant location in the visual field. It was also reported that simultaneous stimulation by several electrodes caused the patient to perceive predictable simple patterns. (These findings support our model and proposed mechanisms of Stages 1 and 2). Chapanis et al. (1973) studied three patients implanted with thalamic electrodes via the occipital lobe. Electrical stimulation of the electrodes led to the perception of phosphenes described as round, square, triangular, or rectangular. (This is evidence for Stage 2). Lance (1976) reported that Foerster (1931) had claimed that unformed visual hallucinations (such as flashes of light) originated in the retina or primary receptive area for vision in the occipital cortex (Brodmann's areas 17 and 18); he also reported that organized images were obtained by stimulation of area 19. Lance summarized reports by his patients who had parieto-occipital lesions and concluded that their perceptions consisted primarily of objects, people, and animals, and that those were presumably "the common building blocks of visual memory, a matrix for the channeling of visual memory rather than the visual memory itself" (p. 732). He stated that these images were more complex than the "flashes, zigzags and wholes of light and color obtained from the primary visual cortex" (p. 732). These reports provide evidence for Stages 1, 2, and 3 of visual processing, consistent with hierarchical mechanisms progressing from lower to higher levels. Finally, a review by ffytche and Howard (1999) summarized the hallucinations of 50 patients with degenerative ocular disease in which they reported that the patients' hallucinations were rather stereotypical, and that the visions were likely due to de-stimulatory, indirect neuropathological changes of the visual cortex rather than pathology of the eye, directly. The ocular diseases were senile macular degeneration (58%), glaucoma (18%), and a variety of other pathologies (24%). Given the different pathological etiologies of blindness and the absence of any focal cerebral pathology, one should not expect a simple connection between the type of hallucination and the CNS-dependent stages described by our model. Yet all of the reported images are representative of one of the four Stages of the model, although the effects (e.g., of movement, size change, etc.) appear to be unrelated. Reports of visual phenomena (see ffytche & Howard, 1999, p. 1250) included "fireworks exploding in vivid color" (Stage 1), "nets in sharp geometric shapes" and other patterns (Stage 2), multiple copies of objects, for example, rows of mugs, faces distorted, or cut-up like an early Picasso (Stage 3), and a number of naturalistic images (Stage 4).

Is this merely serendipitous, or do these perceptions support distinct CNS effects of differing visual activity? To propose an answer, we address where the model's stages *might* engage local network activities in the brain. Stage 1, we propose, takes place in the retina, the lateral geniculate nucleus (LGN), and the primary visual cortex (A17), and is probably completed at the color center found at V4 (Zeki, 1990). Hence this stage is presumed to reflect relatively low-level neuro-cortical events. It is well known that color, brightness, and spot- or point-shaped receptive fields are found in the retina and lateral geniculate nucleus (LGN), and that V4 is a kind of final-stage color center. We posit that these structures constitute the primary neurological substrates for Stage 1 processing. Studies by Grüsser, Grüsser-Cornehls, Kusel, and Przybyszewski (1989) seem to support this contention.

We believe that Stage 2 mostly engages the primary or initial areas of the visual cortex, where orientation, straight lines, and angles are detected—that is, V1–V3 and probably somewhat higher visual areas, and possibly also a final center, analogous to the Zeki color center, which organizes abstract geometric shapes.

Stage 3 processing is assumed to take place and be completed in as yet unidentified higher levels of the cortex, although various studies implicate the lateral-occipital complex (see below). More specifically, Stage 3 can be interpreted as engaging an object recognition area. This means that objects are first recognized in schematic, simplified form, and that this takes place after Stage 2 processing, and before Stage 4.

Research on object recognition supports the idea that the proposed Stage 3 engages higher, and perhaps multiple, cortical and extra-cortical networks—see, for example, Malach et al. (1995). In general, there is reliable evidence that there are two visual processing systems, one for recognizing forms/object ("what" is seen), and the other for locating the object in the visual space ("where" it is seen) (Ungerleider, Courtney, & Haxby, 1998). Object recognition is processed in the ventral visual network, probably involving the lateral-occipital complex (Haxby et al., 1999; Kanwisher, Woods, Iacoboni, & Mazziotta, 1997). Doniger, Silipo, Rabinowitz, Snodgrass, and Javitt (2001) used schematic representations (e.g., simple cartoon-like representations of an elephant), and noted that this type and level of recognition takes place in the lateral-occipital complex, secondary to early cortical visual processing (i.e., V1–V3) where we presume most of Stage 2 occurs.

It is important to note that in this model, the actual location for object recognition need not be specified, but only that the process involves hierarchical networked activations. There is an extensive body of research on object recognition that has used schematic or cartoon-like drawings of objects, which implicitly supports the presence of Stage 3. For example, the line drawings of Snodgrass and Vanderwart (1980) support this hypothesis. There is also evidence that the human visual system can recognize objects from partial information (Snodgrass & Feenan, 1990). This capacity, called "perceptual closure", implies that simple object schemas are present in the visual system and can be activated by incomplete (object) information. We hold that this strengthens our concept of Stage 3 processing.

Our model of Stage 3 and (possibly) Stage 4 processing, as noted, receives further support from studies that have shown object recognition and spatial vision to be subtended by separate cortical loci/networks. Presumably 3-D spatial representation and localization of an object occurs at Stage 4, after earlier schematic or simplified object recognition. (See Kohler, Kapur, Moscovitch, Winocur, Houle, 1995; Moscovitch, Kapur, Kohler, Houle, 1995 for discussion.) The present model, in its simplest form, implies that the perceptual construction at Stage 3 does not include the functional or associative meaning of an object. Presumably these properties are processed at higher levels of the networked hierarchy that are different from, and probably subsequent to, the perceptual construction of the object per se.

Recent papers that provide support for the Model's claim that in the case of hallucinations the hierarchical four stages or kinds of image involve the firing of specific visual receptors in the known visual system include: Baker, T. I. & Cowan, J. D. (2009). Spontaneous pattern formation and pinning in the primary visual cortex. *Journal of Physiology-Paris, 103*(1), 52-68; Billock, V. A., & Tsou, B. H. (2012). Elementary visual hallucinations and their relationships to neural-pattern forming mechanisms. *Psychological Bulletin 138*(4), 744-774; Bressloff, P.C., Cowan, J. D., Golubitsky, M. Thomas, P. J. & Wiener, M. C. (2002). What geometric visual hallucinations tell us about the visual cortex? *Neural Computation, 14*(3), 473- 491; Poggel, D. A., Muller-Oehring, E. M., Gothe, J., Kenkel, S. , Kasten, E. & Sabel, B. A. (2007). Visual hallucinations during spontaneous and trained-induced visual field recovery. *Neuropsychologia, 45*, 2598-2607.

Our input-processing model predicts that mental pathology—schizophrenia, for example, or neurological deterioration (e.g., Alzheimer's disease)—could insult and affect the input processing at one or more stages, not just the systems that are involved in output or drawing. That is, if the drawing ability of a patient suffering from mental pathology regresses to Stage 3 or 2, then this deterioration in output might be accompanied by and reflect deterioration of the related perceptual processing. Support for this interpretation is provided by Doniger et al. (2001) who report that schizophrenics have object recognition deficits that are likely due to impaired sensory/perceptual processing.

Some four decades ago, Klüver (1966, as cited by ffytche and Howard, 1999, p. 1255) observed commonalities in abnormal visual experience that suggested “some fundamental mechanisms involving various levels of the nervous system.” The present model, while focusing on artistic perception and output (i.e., drawing), reinforces and extends these findings.

Parallel and serial processing. It is well established that parallel processing underlies much visual perception. Certainly, within a stage (of our model), parallel processing can, and (we presume) commonly does occur. For example, if we consider Stage 1 to be primarily subtended at retinal and LGN levels, then the parallel processing of these substrates—as contributory to Stage 1 perception—is well known. The actual relationships of neural networks involved in higher levels of the model, as far as we are aware, remain unknown, although the connection of Stages 1 and 2 can be considered a function of the visual radiations engaging (the highest) Level 1 processing onto Stage 2.

It is important to note, however, that serial processing also operates within this model: The four qualitative stages of our model are explicitly predicted to occur in a hierarchical sequence—that is, the gross structure of the model involves hierarchically qualitative stages that are, at the macro level, serial. The qualitative stages in the model are consistent with the known fact that cortical areas have an identifiable hierarchy based on laminar patterns of inputs and outputs. There is strong evidence for certain types of serial processing in the cortex—see, for example, Doeringer and Hogan (1998); Hubel and Wiesel (1965, 1977); Inui, Wang, Tamura, Kaneoke, and Kakigi (2004); and Pons, Garraghty, Friedman, and Mishkin (1987). Nevertheless, as noted, the model is assumed to predominantly involve parallel processing, especially within a given stage. Still, it is reasonable to presume that parallel and serial processing occur synergistically both within and between levels of the hierarchy. This is consistent with hierarchical cognitive function as proposed by Jackendoff (1987) and extended by Prinz (2000).

Bottom-up and top-down processing networks. As presented, the model could be seen as a bottom-up processing model; however, we accept the recently proposed interpretations that cortical processing commonly involves bi-directional networked hierarchies, such that prominent bottom-up and top-down effects are reciprocal (Bar, 2003; Hawkins, 2004; Prinz, 2000). The present model allows this bi-directionality within and between stages. For example, at Stage 2, ascending and descending networks are presumed to be involved in the perception/construction (and production) of lines and geometrical patterns initiated by the stimulus; the descending projections may involve maintenance of the accuracy of stimulus input so as to strengthen, focus, and perhaps contextualize it to other dimensions of cognition and/or emotion. This is consistent with the cited models and would reflect complex dynamical systems activation and integration in the CNS.

The model and primitive art. Animals do not draw, unless artificially encouraged to do so by humans—and even then they show no reliable evidence for drawing recognizable objects. Therefore, we (like others) assume that making designs and drawings constitute distinctly human activity. It is also likely that drawing is closely connected to human language. Indeed, the existence of designs, much less drawings, have been commonly used as evidence for “identifying” the first humans—that is, the first primates capable of human consciousness and capable of symbolic thought and expression. There is much debate over when and where this occurred. Some have argued for a relatively recent date of around 32,000 BCE (Pfeifer, 1982), and others for around 75,000 BCE (Hogan, 2003). A few claim that very simple marks are examples of even earlier human art. The very earliest claims are for “cupules” (Bednarik, 1993), which are small hemispherical indentations pounded into flat, sloping, or vertical rock surfaces. Cupules are very analogous to the present model’s understanding of the simplest and earliest element, the dot. However, when cupules are found without other more complex markings, the claim that they represent early art seems to stretch the concept of art to a breaking point. Regardless, for present purposes, it is a common observation that in the case of primitive art, very simple elements appear first, then geometric patterns, then more complex designs, and finally stick drawings and schematic objects. More complex realism comes still later, if at all. (See also Zaidel, 2005).

In concluding we summarize: The present model is a four-stage hierarchical description both of how an image is processed or constructed to visual completion and also of how it is produced when the image is drawn. Supporting evidence is drawn from the following: more than a century of published reports of visual hallucinations; the extensive literature on the development of children’s drawings; and artistic regression in persons suffering from mental or medical pathology. In addition, much recent research in cognitive neuroscience has been cited to connect the model, at least in a general way, to brain functions. The model may also bear on historical development or changes in art, such as interpretations of the origin of art in early human societies.

Finally, this paper by focusing on the relevance of a patient's art interprets the patient as a whole person, not just a collection of parts, thus emphasizing medicine as an integration of both the sciences and the humanities.

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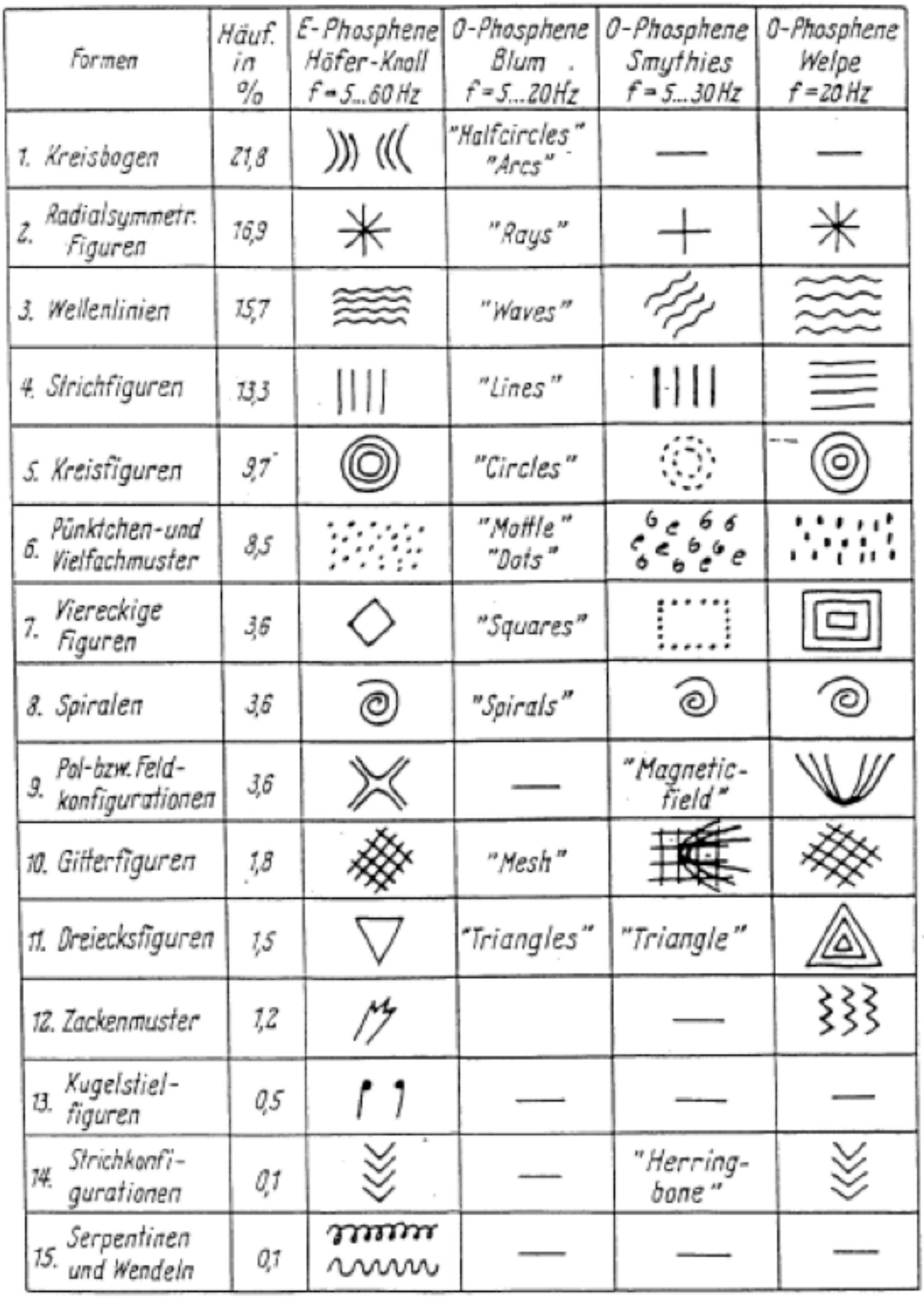
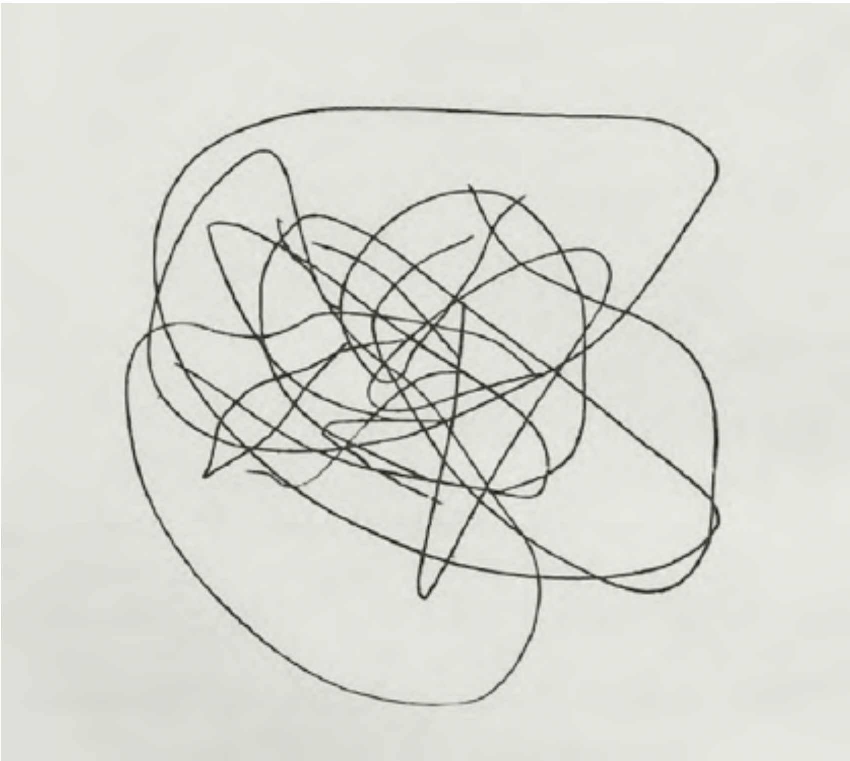


Figure 1. Various types of phosphenes ("Munich taxonomy"): Stage 1 images (sensory: amorphous, #6), and the rest Stage 2 (perceptual: geometric). From "Vergleich von Anregungsbedingungen, For-Klassen und Bewegungsgarten optischer und elektrischer Phosphene" [Comparison of excitation conditions, shapes, and movement of optic and electric phosphenes], by M. Knoll and E. Welpe, 1968, *Elektro Medizin. Biomedizin und Technik, 13,* 128–134.

a.



b.

Figure 2. Children’s scribble drawings: (a) scribbles in curved, diagonal lines, by a boy, aged 16 months and (b) round scribbles by a boy, aged 20 months. From Children’s Human Figure Drawings (Vol. 2) by K. V. Mortensen, 1984, p. 444. Copyright 1984 by Dansk Psykologisk Forlag.

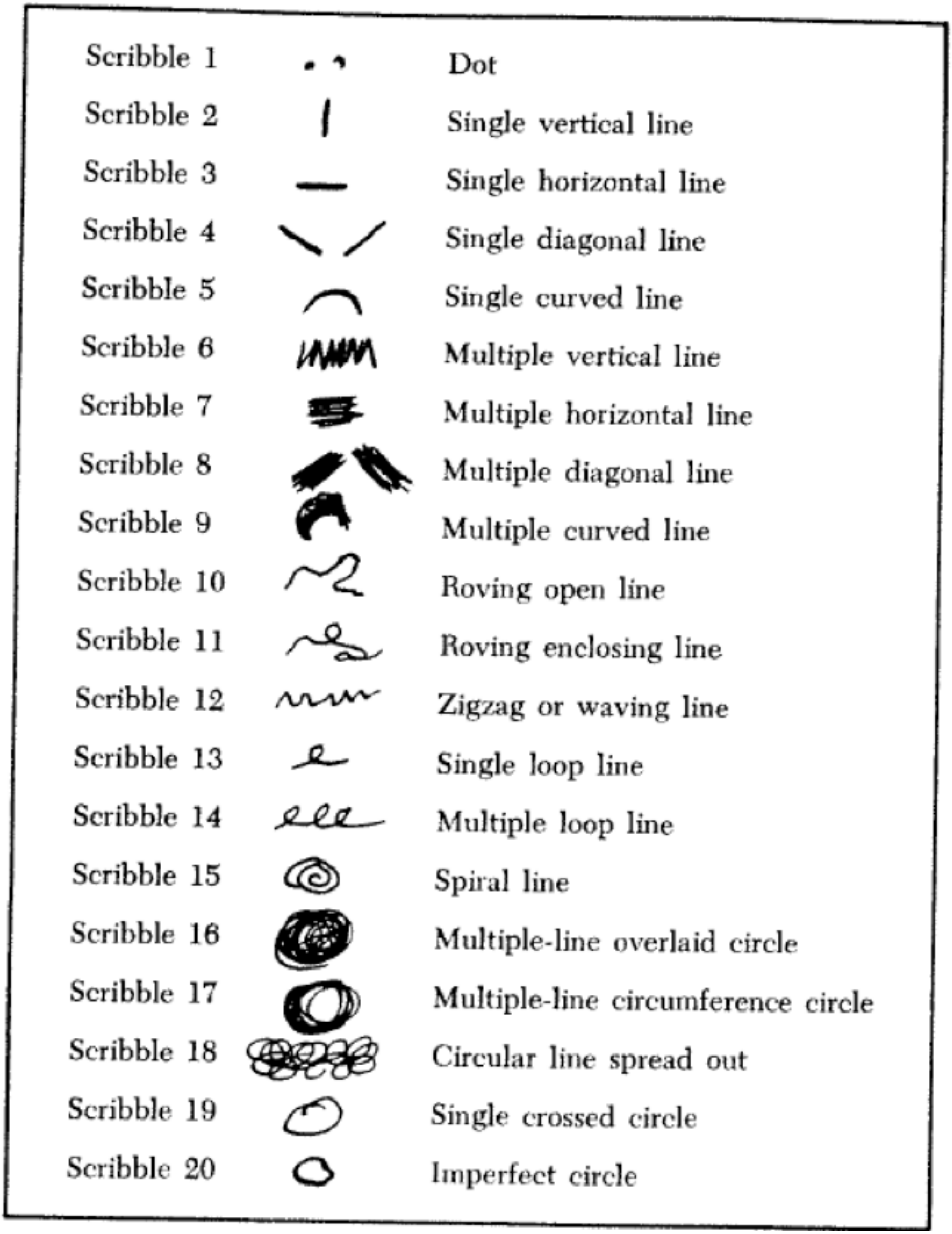
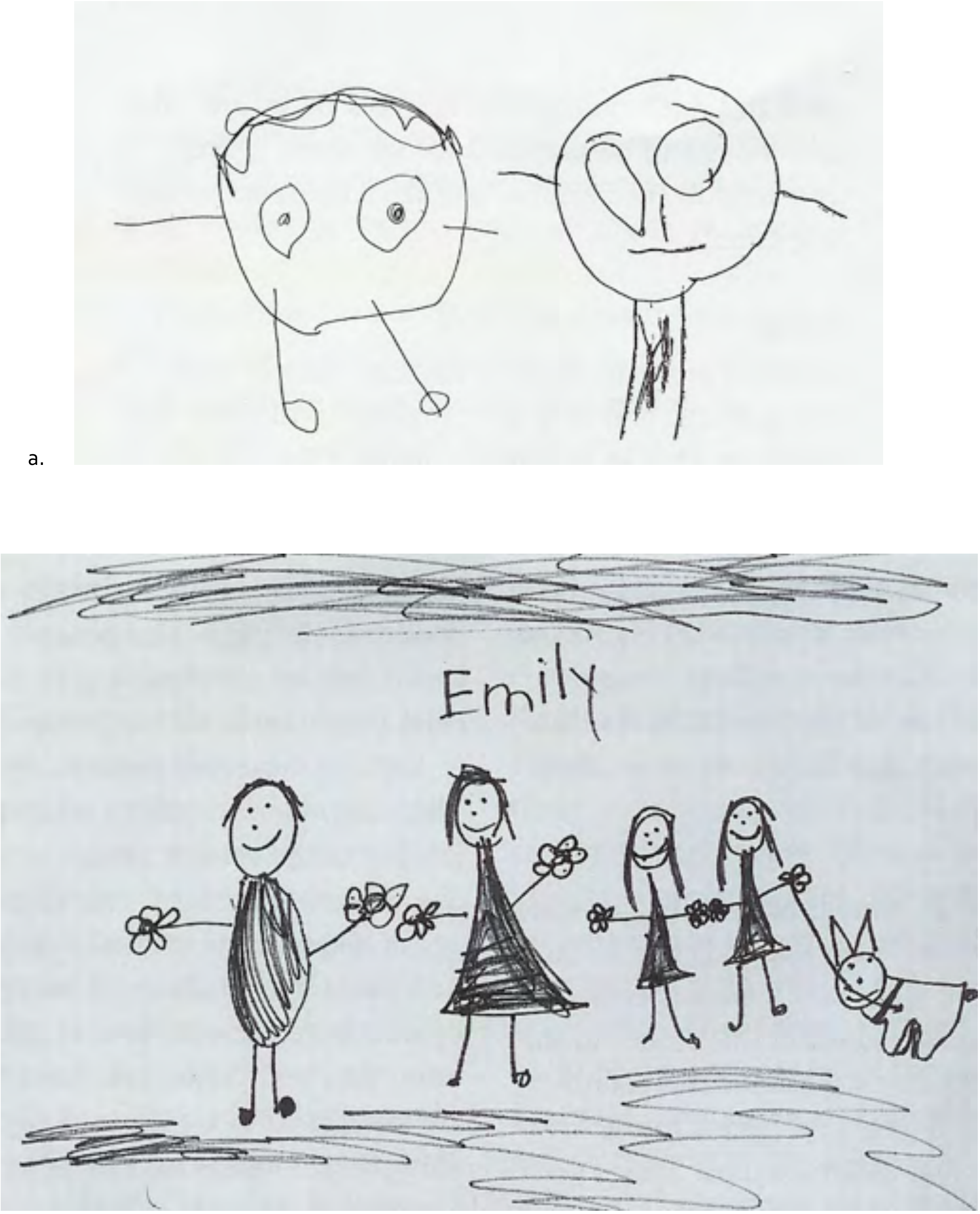


Figure 3. Children's drawings: the basic scribbles. Except for the dot and roving lines (Stage 1), all these are Stage 2 images (perceptual: geometric). From Analyzing Children's Art by R Kellogg, 1970. Copyright 1970 by National Press Books, Palo Alto, Ca.



a.

b.

Figure 4. Children's drawings, human figure: (a) tadpole figures by boys aged 3 ½ and 4 ½ years and (b) human-figure drawing by a 6-year-old girl. From Child Art in Context: A Cultural and Comparative Perspective by C. Golomb, 2002, pp. 20, 30. Copyright 2002 by the American Psychological Association.

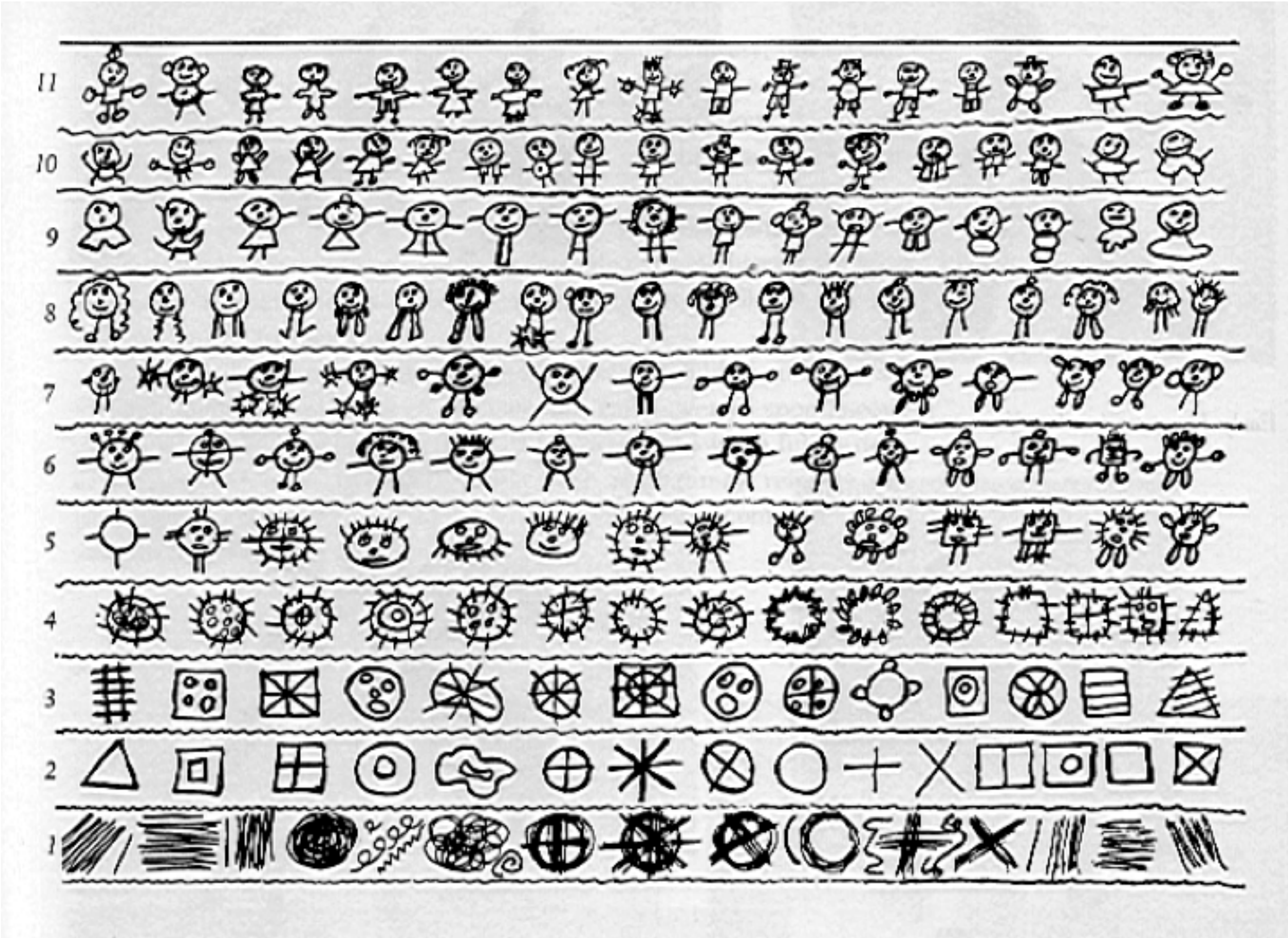
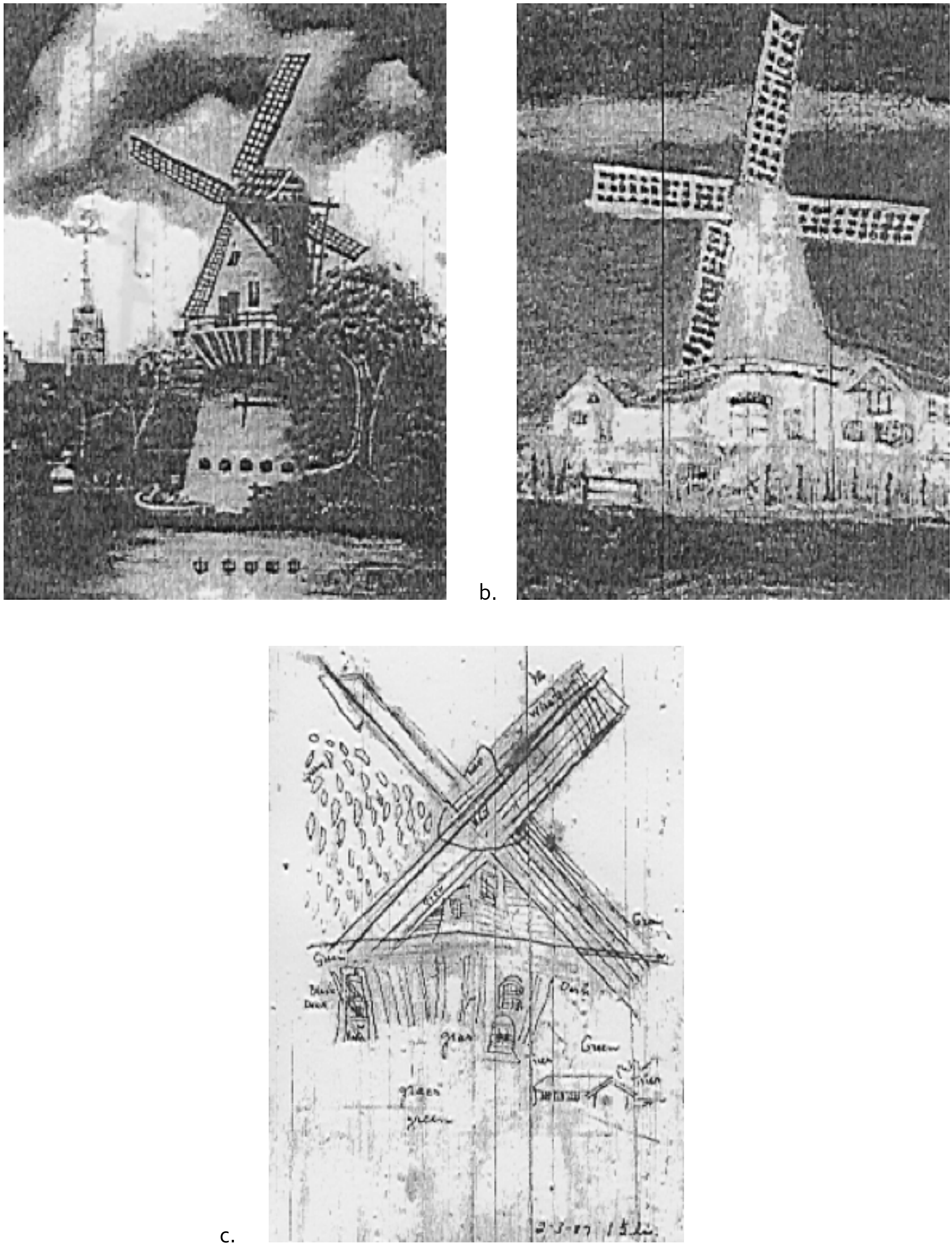


Figure 5. Stages of children's drawings: Stage 1 (sensory-amorphous: scribble); Stage 2 (perceptual: geometric); Stage 3 (cognitive: schematic). From Analyzing Children's Art by R Kellogg, 1970. Copyright 1970 by National Press Books, Palo Alto, Ca.



a. b. c.

Figure 6. Regression in an Alzheimer's patient who was an artist: The first image (a) is a mill painted near time of onset of symptoms suggestive of Alzheimer's disease; the second (b) was painted seven years after onset of Alzheimer's disease, when language and memory abnormalities were well established; and the third (c) is a sketch of the mill completed nine years after onset of the disease, where loss of perspective, perseveration, and intrusion of irrelevant details are clearly evident. Figure 6a is a Stage 4 image (comprehensive: realistic); by 6c the image is a schematic Stage 3 with some geometric Stage 2. From "Probable Alzheimer's Disease in an Artist" by J. L. Cummings and J. M. Zarit, 1987, The Journal of the American Medical Association, 258, pp. 2731–2734. Copyright 1987 by the American Medical Association.

a. 

b. 

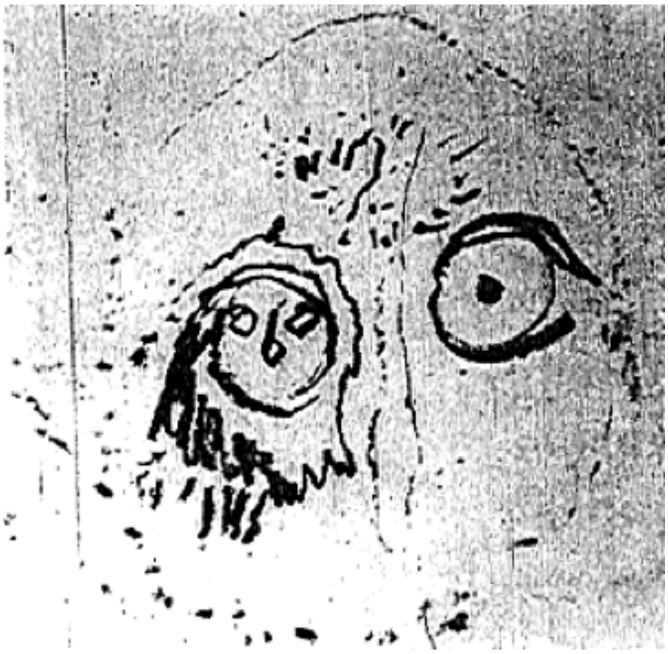
c. 

Figure 7. Images illustrating regression in an Alzheimer's patient: the image in (a) is Stage 3 (cognitive: schematic), which by (c) is showing strong Stage 2 components (geometric). From "The Graphic Representation of Regression in an Alzheimer's Disease Patient," by J. Wald, 1984, The Arts in Psychotherapy, 11, pp. 165–175. Copyright 1984 by Elsevier Ltd.

a. 1996

b. 1997

c. 1999

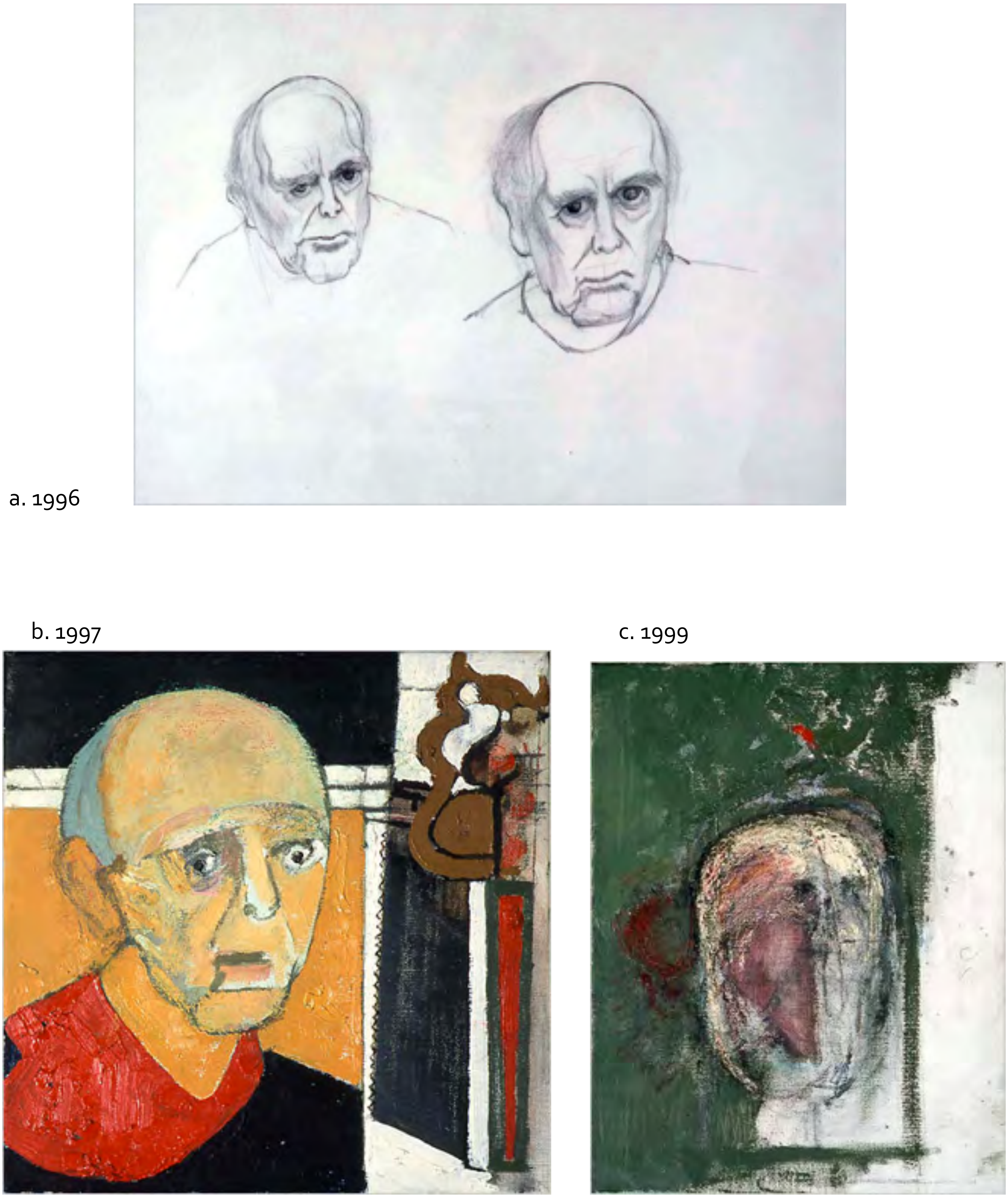
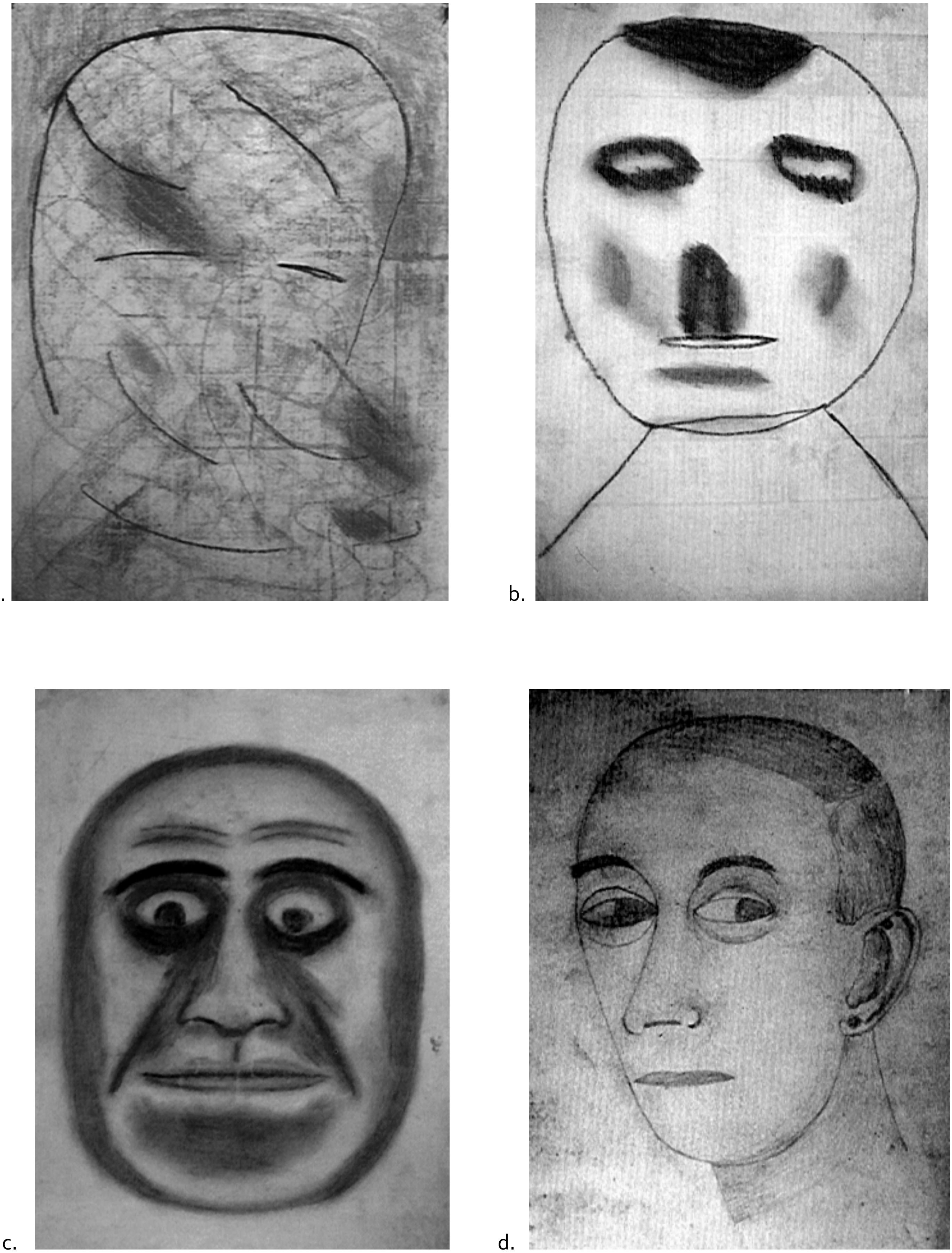


Figure 8. Regression through the model's stages in the art of William Utermohlen. Galerie Beckel Odille Boïcos, Paris, France.



a. b. c. d.

Figure 9. An example of psychiatric recovery (progression) in drawing levels: drawings in chronological order by "Mr. Pauli," from (a), mostly Stage 1 to (d), with strong Stage 4 characteristics. From Symbolic Images in Art as Therapy by R. M. Simon, 1997. Copyright 1997 by Routledge.

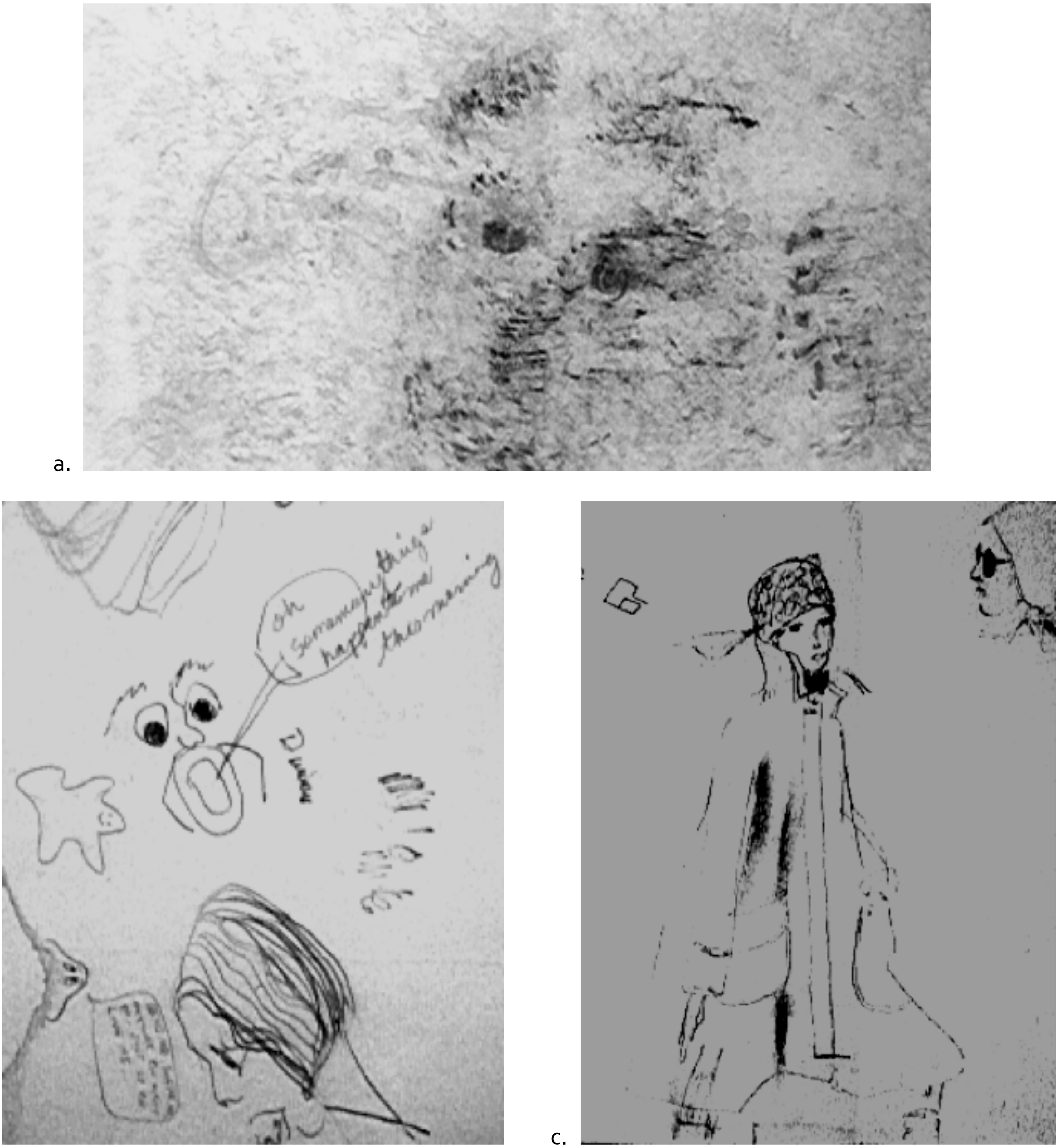
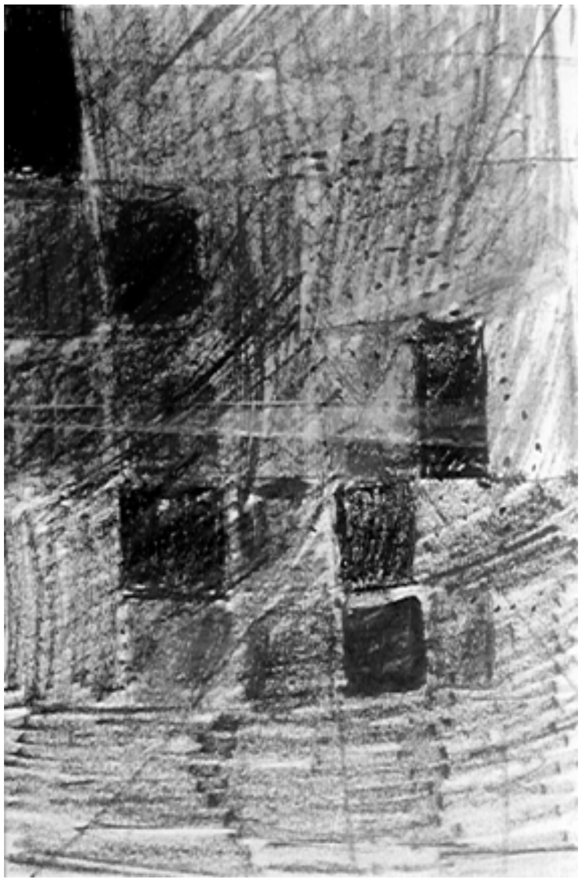


Figure 10. An example of psychiatric recovery (progression) in drawing levels. These drawings were done by a patient in a short-term psychiatric ward in New York City: the first (a) was drawn on the first day, when the patient was admitted, and is mostly Stage 1, with some Stage 2 and 3; the second (b), drawn on the second day, is primarily Stage 3; and the third (c), primarily Stage 4, was drawn shortly before her discharge from hospital on the third day.

a. 

b. 

c. 

Figure 11. An example of a psychiatric regression in drawing levels by a patient admitted to the same short-term psychiatric ward (see Figure 10) in New York City before being discharged to a long-term psychiatric ward. The drawings were produced on the first, third, and fourth day after his admission: (a) mostly Stage 3, with some Stage 2; (b) Stage 2 and Stage 1; and (c) mostly Stage 1, some Stage 2.

REVIEW

A REVIEW OF THE EFFECTIVENESS OF COMPUTER-BASED INTERVENTIONS IN AUSTRALIA FOR ANXIETY-BASED DISORDERS AND RECONCEPTUALIZATION OF THESE INTERVENTIONS FROM A NEUROPSYCHOTHERAPY FOCUS

Micah Bernoff[1] & Pieter J Rossouw[2]

Abstract

The purpose of this study was to analyze the effectiveness of computer-based interventions for anxiety-based disorders in Australia and to propose an alternative model informed by a neuropsychotherapeutic perspective. The number of Australians with an anxiety-based disorder appears to be growing, but of these it is estimated that only 37.8% are actively seeking treatment. This figure represents a substantial unmet need in the Australian community, and there is a demand for alternative treatment options to address this unmet need. In view of the significant economic impact identified, both for the individual suffering from an anxiety-based disorder and the community as a whole, governments also have a financial incentive to address the growing need. In this context, we conducted a critical review of the literature for internet-based anxiety disorder treatment programs to assess their effectiveness as part of any potential solution, finding that human-supported web-based therapeutic interventions have the capacity to be just as effective as traditional face-to-face psychotherapy, with similar levels of client dropout and adherence rates. We show how recent developments in neuropsychotherapy have improved mental health care and how the principles of neuropsychotherapy are applied in the treatment of anxiety disorders. Following on from this, we specify how internet-based treatments may be conceptualized through neuroscience and neuropsychotherapy. We conclude by proposing an alternative web-based therapeutic intervention model based on the analysis set out in the preceding section. This alternative model suggests that human-supported web-based treatment should include occasional traditional face-to-face interaction between client and therapist, such that the web-based therapeutic session would not act as a stand-alone service but serve to complement traditional interaction in a combined approach.

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The Prevalence of Anxiety-Based Disorders in Australia

According to the 2007 National Survey of Mental Health and Wellbeing (NSMHW), 45.5% of Australians aged 16-85 years have had a psychological disorder at some point in their life (ABS, 2008) and 1 in 5 had a psychological disorder in the 12 months prior to the survey. Psychological disorders were also found to account for 13% of the burden of disease in Australia in 2003 and have been ranked third in mortality and morbidity after cancer and cardiovascular disease (Begg et al., 2007). These statistics support the claim that psychological disorders are prevalent in Australian society and that they are significantly impacting on Australia's medical health system.

Based on the 2007 NSMHW, the most common psychological problem experienced by adult Australians at some time in the 12 months prior to the survey was an anxiety disorder (14.4% of the population). Anxiety disorders were also found to be the most common across all age brackets and genders, suggesting that they are wide-reaching and not limited to a specific population. This prevalence rate is noticeably higher than that of the 2004-05 Australian National Health Survey, where the rate was only 5% of the population (ABS, 2006), and points to an increase in anxiety-based disorders in the Australian community. Based on this, it is logical to assume that there is a consequent increase in the burden of resources used to aid the Australian community in addressing this problem.

As described in DSM-5 (American Psychiatric Association, 2013), there are many forms of anxiety-based disorders, ranging from panic disorders to various anxiety disorders not otherwise specified. The diagnostic criteria required for the clinical diagnosis of an individual is similarly very broad and can vary significantly between disorders. The key underlying feature between all of these anxiety-based disorders, however, is that individuals who are diagnosed with an anxiety-based disorder typically fear or worry about a negative future outcome (Saavedra, Silverman, Morgan-Lopez, & Kurtines, 2010).

It is normal for people to experience some level of discomfort when expecting some unpleasant event or negative future outcome. However, if an individual's way of life is significantly negatively impacted by a predicted future event that has no reasonable basis for his or her current level of fear-based symptoms, it is likely that the individual may be experiencing clinical levels of anxiety (American Psychiatric Association, 2013). Significant negative impacts include cognitive events such as feelings of apprehension or catastrophizing, and physical events such as headaches, stomach discomfort, or sweating (Badour & Fedner, 2013). These symptoms can then impact further on the individual by promoting non-adaptive behaviors such as avoiding situations that enhance the anxiety (Badour & Fedner, 2013; Waters, Farrell, & Schilpzand, 2013). This learned avoidance is often generalized to many day-to-day situations and can have a significantly negative impact on an individual's social life, their friends, family, and the wider community due to their reduced ability to engage with their surroundings (Saavedra et al., 2010). A typical consequence of this reduced ability to engage with their surroundings is that the individual may be unable to work or contribute in a productive manner because they are unable to cope with their elevated levels of emotional distress (Saavedra et al., 2010). Maladaptive coping behaviors such as avoidance are termed psychopathology and are symptoms of an individual's anxiety disorder.

Despite the significant impact an anxiety disorder can have on an individual, there is a large population of people diagnosed with an anxiety disorder who do not seek professional treatment; according to the 2007 NSMHW report, only 37.8% of those diagnosed sought professional help (ABS, 2008). Consequently there is a discrepancy between the percentage of individuals diagnosed with an anxiety disorder who seek professional treatment and those who do not. This discrepancy will be termed unmet need: Thus, in 2007, the unmet need for Australians diagnosed with an anxiety disorder was 62.2%. This high level of unmet need has also been found in many other first-world countries (e.g., the United States of America, the United Kingdom, and New Zealand), which suggests that the problem is not just confined to Australia (Bebbington, 2000; Oakley, Wells, & McGee, 2006; Wang et al., 2005).

There have been a number of suggested explanations for the high level of unmet need in Australia but, to date, no consistent features have been found to accurately explain its cause (Barney, Griffiths, Jorm, & Christensen, 2006; Green, Hunt, & Stain, 2012; Kessler, Olfson, & Berglund, 1998; Komiti, Judd, & Jackson, 2006; Olfson, Kessler, Berglund, & Lin, 1998; Thompson, Hunt, & Issakidis, 2004). Despite this, several government initiatives have been created in an attempt to deal with the problem; however, at present, the population of unmet need appears not to have been significantly reduced—rather, it appears to have grown (Andrews, Titov, & Schwencke, 2009). One treatment modality that has been argued to address at least a portion of the current unmet need in Australia are computer-based interventions, as these offer mental health care services that can reach consumers who are not otherwise able or willing to access conventional face-to-face treatment (Andrews et al., 2009).

In sum, anxiety-based disorders are prevalent in the Australian community, yet only a small percentage of Australians diagnosed with an anxiety disorder are actually seeking treatment. Consequently, there is a large population of Australians whose mental health care needs are not being met. Previous research has argued that one way to decrease the high percentage of unmet need in Australia is to increase alternative treatment options such as computer-based interventions (Andrews et al., 2009).

The Current Economic Impact of Mental Health Care

As mentioned previously, the prevalence of mental health disorders in Australia is large, with 1 in 5 Australians suffering from a mental health issue in the last twelve months (ABS, 2008). Furthermore, it appears that the number of people suffering from mental health issues is growing yearly (Andrews, Issakidis, Sanderson, Corry, & Lapsley, 2004), hence there is an ever-increasing need for mental health services in Australia. This increased need is apparent in information released by the Australian Institute of Mental Health and Welfare (AIMHW), which shows there has been an average general increase of more than 20% in the total number of mental health services recorded in the years between 2006-07 and 2010-11 (AIMHW, 2012). Similarly, the 2011 annual report summary for the Queensland Workers Compensation Regulatory Authority (Q-COMP) reported that the number of psychiatric claims had grown by over 10% in the five years to 2011, further supporting the argument that the recognition of psychological disorders is in fact on the rise, and the need for treatment is significant (State Government of Queensland, 2011).

The AIMHW also reported that $6.4 billion, or $287 per person, was spent on mental health related services in Australia during 2009-10, an increase from $241 per person in 2005-06 (AIMHW, 2012). It seems that the Australian government has identified the importance of addressing mental health in Australia and has allocated a large quantity of resources to deal with this issue. However, Andrews et al. (2004) have argued that the current mental health care delivery model has actually been reactively developed to meet the current demand and, consequently, that the Australian mental health care system has been identified as a crisis management model.

The primary goal of the crisis management model is to reduce the immediate risk of harm, both to the individual and those around the individual (Inglis & Baggaley, 2005). For instance, should an individual report suicidal ideation, he or she may be admitted to a psychiatric unit at a hospital to ensure their safety, but once their immediate safety has been guaranteed they will be released from the psychiatric unit back into the same environment. What this means is that only the individual's short-term needs (i.e., ensuring their short-term safety) are met. Unfortunately, the long-term ramifications of this are that the individual's psychological issues are often dealt with only at a surface level and they actually lie dormant until the next trigger occurs that then leads to the individual again contemplating suicide (Inglis & Baggaley, 2005).

The current focus of the Australian crisis management model for mental health services is reflected in the financial rebates that are currently available to individuals seeking treatment (Russell, 2011). Under this model, unless the individual has private health cover, or is supported through an employment access program, only people who have a Medicare rebated treatment plan will receive financial support for treatment. Furthermore, this support is typically restricted to a certain number of sessions per year, such that the individual has to pay the full session price if they feel that they need more sessions following completion of the Medicare rebated treatment plan.

The Australian Psychological Society (APS) has released data on their website from a 2013 APS survey, which indicates that the current Medicare treatment program is having a severe negative impact on the ability of individuals to access appropriate treatment. The survey data shows that 22% of the surveyed consumers had to postpone their treatment until the following year due to the lack of alternative treatment arrangements. The APS survey also found that, following the conclusion of their Medicare treatment plan, over half of the clients received additional treatment either free of charge (17%) or at a reduced rate (32%) because they were unable otherwise to access appropriate treatment for financial reasons. Consequently, it can be argued that the long-term support that is required to address severe mental illness is not available in Australia at present due to the current financial support available. As a result of this, there appears to be a need to introduce appropriate treatment services that are financially accessible to consumers and thus do not prohibit long-term treatment access.

The economic ramifications of mental health problems extend past the resources that are used for the direct cost of mental health services to the indirect costs of lost productivity and impaired functioning (Andrews et al., 2004; Issakidis, Sanderson, Corry, Andrews, & Lapsley, 2004). Q-COMP has also observed some of the wider economic ramifications for individuals suffering from a psychological disorder. The 2010-11 annual report noted that the average cost of a finalized time lost workers' compensation claim was $11,735. This figure includes payments made for weekly compensation of lost wages, lump sums for permanent impairment, and a broad range of services such as medical treatment and rehabilitation. The breakdown of the average cost shows that just over half (50.8%) of the cost is made up of weekly compensation for wages lost, 28.5% is made up of medical and rehabilitation payments, 15.6% accounts for lump sum payments, and the remaining 5.1% of the average cost is made up of other statutory payments. Clearly, therefore, the largest impact on the full cost is wages lost.

The Q-COMP report noted further that although psychiatric or psychological injury claims account for only 2.6% of all claims finalized, they are the most expensive, with an average finalized time lost cost of $32,670. This figure is almost three times the total time lost cost of the average time lost claim, suggesting that psychological injuries are more expensive to resolve than other injuries. It is also important to note that individuals who have a psychological component to their claim are the least likely to return to employment and almost 1 in 5 remain unfit to work at the end of the claim. When compared to any other injury, therefore, individuals who experience a psychological disorder struggle to re-engage in the workforce, thus their ability to support themselves and to contribute to their community is significantly compromised.

Despite the wider economic effects of the current Australian mental health services delivery model, a review of the literature regarding mental health care delivery models has revealed that there is very little research on different models and, with the current level of research available, there is no one ideal service delivery model (Andrews et al., 2004; Issakidis et al., 2004). Consequently, at this time, there is little research to show that the Australian mental health care system should change its delivery model.

As discussed by Andrews et al. (2009) and Q-COMP (State Government of Queensland, 2011), the burden of mental health in Australia is wide-ranging and has a significant economic impact on the Australian community. Research has also identified that the indirect costs of illness are at least five times greater than the direct treatment costs (Andrews et al., 2004). The current mental health care model is clearly not functioning—either as an optimal economic or outcome model (Andrews et al., 2004; Issakidis et al., 2004); nor is it reaching everyone who requires treatment, with 62.2% of Australians with an anxiety disorder currently not undergoing treatment (ABS, 2008).

Australian research has recently begun to focus on alternative service options that are available and can be included in the Australian mental health care model (Andrews et al., 2009). The research discussed above suggests that in order for the model to achieve optimal results, both at a therapeutic and financial level, any alternative services should focus on developing treatment modalities that can support increased service access (thereby reducing the population of unmet need) and promote service access duration (for promotion of therapeutic outcomes). As mentioned previously, computer-based interventions could potentially address these service access issues (Andrews et al., 2009).

Review of Current Australian Internet-Based Anxiety Disorder Treatment Programs

Research has identified that there is a large population of Australians with an anxiety disorder who are currently not seeking treatment (ABS, 2008). There also appears to be a financial disincentive for individuals to seek long-term mental health services (APS, 2013). As noted above, the long- and short-term consequences of individuals experiencing a psychological disorder like anxiety are not just limited to the individual, since the psychological disorder can also affect the individual's wider community. These effects also have significant economic ramifications, which suggests that the Australian government not only has an ethical responsibility to address this unmet need, but that they also have a financial incentive to do so.

The Australian mental health care system has identified that new treatment modalities need to be developed to address Australia's unmet need population and to promote service access duration. Computer-based therapeutic interventions have been recognized as one treatment modality that can potentially address this need (Andrews et al., 2009). As a result, there is now a growing interest in computer-based interventions and their efficacy.

Currently, there are many different computer-based interventions that have been identified by mental health care professionals, and the APS has produced a guide to create an awareness of these different interventions and their strengths and weaknesses (Fuller, Stokes, & Mathews, 2012). This guide, which is supported by a study by Barak, Klein and Proudfoot (2009), suggests there are four types of computer-based intervention, namely: web-based interventions, online counseling, internet-operated therapeutic software, and a fourth category termed "other online activities."

Web-based interventions is a blanket term for web-based education interventions, self-guided web-based therapeutic interventions, and human-supported web-based therapeutic interventions. Web-based education interventions are not structured therapeutic interventions, rather they typically aim to provide information and psychoeducation on a wide range of mental and physical health conditions. Thus, because they do not constitute a formal treatment and only focus on information about the relevant condition, there is little evidence to support these interventions as the most effective type of computer-based intervention (Barak et al., 2009). Instead, however, these web-based interventions can act as a catalyst for behavioral change and the beginning of help-seeking behavior (Andrews et al., 2009; van't Hof, Cuijpers, & Stein, 2009). While this is an important aspect of the response to some of the unmet need in Australia, there is a recognized need for more structured therapeutic interventions as well (Rickwood & Bradford, 2012), with the result that self-guided and human-supported therapeutic interventions have been designed to meet this need.

Self-guided web-based therapeutic interventions also provide psychoeduction; however, their primary aim is to provide structured therapeutic support for users to make therapeutic changes in order to address particular problems that they are experiencing. This usually occurs through a series of highly structured sessions that have been modeled on face-to-face psychological therapy. Research has identified that these types of intervention can be effective (Rickwood & Bradford, 2012; van't Hof et al., 2009) although they have been shown to have significant client dropout rates (Cuijpers & Stein, 2009; Hilvert-Bruce, Rossouw, Wong, Sunderland, & Andrews, 2012). Despite the dropout rates, a meta-analysis conducted by Barak, Hen, Boniel-Nissim, & Shapira (2008) identified that the effect size of these therapeutic interventions was nearly double that of a pure psychoeducational web-based intervention, which suggests that self-guided web based therapeutic interventions have the ability to service the unmet need in Australia.

Human-supported web-based therapeutic interventions are similar to self-guided web-based interventions in structure, except that they also incorporate a mental health professional or peer supporter to provide support, feedback, and guidance throughout the intervention. A meta-analysis by Andrews, Cuijpers, Craske, McEvoy, & Titov (2010) indicated that human-supported web-based interventions not only performed better than web-based interventions not supported by a therapist, but that they also performed as well as traditional face-to-face therapy. The results of these studies support the APS claim that human-supported web-based therapeutic interventions can provide therapeutic support for people with moderate to severe levels of distress compared to self-guided web-based therapeutic interventions that support people with mild to moderate levels of distress.

The second of the four types of computer-based interventions is online counseling and therapy, which utilizes communication via a number of different modalities (such as email, "real-time" chat, or online video chat/conference service) between the therapist and an individual or group. As mentioned by Fuller et al. (2012), when compared to web-based therapeutic interventions, there is very limited research on the efficacy of online counseling. In addition, a significant issue identified by the APS concerns the ethical and legal status of psychologists providing online therapy with regard to their registration, and where it extends, because their online clients may live in a state or even a country that does not recognise the therapist's registration.

The third type of computer-based intervention is internet-operated therapeutic software. This form of intervention refers to "therapeutic software that uses advanced computer capabilities such as artificial intelligence principles for (a) robotic simulation of therapists providing dialog-based therapy with patients, (b) rule-based expert systems, and (c) gaming and three-dimensional virtual environments" (Barak et al., 2009, p. 11). These programs are generally created to target specific problems; however, it has been suggested that any benefits from them may not be as generalizable as first thought (Owen et al., 2010).

The last type of computer-based intervention has been categorized by the APS as "other online activities," which recognizes that individuals may seek alternative methods to help with their problems, such as accessing blogs, chat rooms, and social networking sites. As these online activities are not formal treatment sites, they are non-regulated forms of online intervention and consequently are not as well researched.

The authors of the APS guide identified through their research that the main evidence for computer-based treatments points to developing web-based therapeutic interventions in preference to the other three types of computer-based treatments. As a consequence of this large body of research, it appears that Australian mental health care professionals have recognized the importance of web-based therapeutic interventions as a primary treatment modality and are currently attempting to develop these programs to become more effective in their application for the Australian public (Christensen & Petrie, 2013).

This finding is supported by a meta-analysis of computer-based interventions in Australia conducted by Christensen and Petrie in 2013. In this study the authors identified 73 web-based therapeutic interventions that are currently available and have had trial evaluations, and their meta-analysis supported the claim that web-based interventions are an effective form of intervention. The meta-analysis also identified that over half of all the programs used Cognitive Behavioral Therapy (CBT) as their primary therapeutic modality, thus indicating that CBT forms the basis for most web-based interventions. It appears, therefore, that web-based interventions primarily attempt to support individuals to make cognitive, behavioral and emotional changes. Christensen and Petrie (2013) noted that web-based interventions are not blanket treatment interventions for all forms of mental illness, as they typically focus on anxiety or depression-based disorders. In fact, the most frequently targeted psychological disorders for computer-based treatments are generalized anxiety disorder and panic disorder, with the next most frequently targeted psychological disorder being depression. This finding indicates that anxiety-based disorders are the major focus of current computer-based interventions.

As mentioned above, web-based interventions are the most widely researched and utilized form of computer-based therapy (Barak et al., 2008; Christensen & Petrie, 2013; Andrews et al., 2010). Within this subsection of web-based interventions, it appears that human-supported web-based therapeutic interventions are the most effective in therapeutic change. Moreover, as mentioned previously, when compared to traditional face-to-face psychotherapy, recent research has shown that human-supported web-based therapeutic interventions are not only effective but that they are also just as effective as traditional face-to-face psychotherapy (Andrews et al., 2010). This finding was further supported by Cuijpers et al. (2010), who also found no significant differences between face-to-face therapy and human-supported web-based therapeutic interventions at a one year follow-up test, further supporting the claim that human-supported web-based therapeutic interventions are an effective form of therapeutic intervention.

To gain a better understanding of the current composition of web-based therapeutic interventions for anxiety-based disorders, a brief search of the current Australian literature in this area was conducted. These articles are itemized in Table 1. As discussed by Barak et al. (2008), Christensen and Petrie (2013), and Andrews et al. (2010), and also as shown in this literature review, the majority of these web-based interventions specifically target anxiety disorders, with some interventions also targeting depression. All the interventions utilized CBT as the major theoretical framework. The duration of these interventions ranged between 6-10 weeks, with an average treatment duration of eight weeks. While not all web-based interventions are human-supported, all of the literature that was identified in this review utilized some form of therapist contact with each individual in the treatment condition. The most common form of contact was via weekly email, which was used to address any questions that the individual might have and to respond to their homework. Although not all the studies reported outcome effect sizes, all of the web-based treatment conditions showed significant therapeutic benefits when compared to the control conditions. The literature identified in Table 1 thus further supports the view that web-based therapeutic interventions are an effective treatment modality.

There are a number of significant strengths, and also limitations, in developing and utilizing web-based interventions for mental health care in Australia. First, as shown in Table 1, a major strength of web-based therapeutic interventions is their ability to effect therapeutic change. Second, when they include some form of human assistance, web-based interventions have been shown to work just as effectively as face-to-face therapies, both immediately after treatment and after a one-year follow-up (Andrews et al., 2010). This means that web-based interventions are not necessarily an inferior mode of treatment and may be utilized by Australian mental health services as an alternative option for individuals seeking effective treatment. Third, another advantage of such interventions is that they can save professional therapist time, as the therapist is not required to spend every session with the client (van't Hof et al., 2009). This reduced therapist one-on-one contact time is reflected in Table 1, where the only therapist contact is generally limited to weekly correspondence via a variety of communication mediums such as email averaging ten minutes in duration. Consequently, more people can be serviced by the same therapist, which allows for a greater population to receive treatment. This also has the added benefit of reducing the financial cost of providing treatment and allows individuals to receive more therapeutic sessions than in face-to-face therapy. For all these reasons web-based interventions appear to promote the duration of service access. Fourth, web-based interventions allow greater access to mental health care services by remote populations, or where there is no on-site psychologist.

While the above-mentioned benefits for web-based interventions are significant, there are a number of limitations that occur with their use. First, if the web-based intervention does not utilize a mental health professional, then individuals seeking treatment may select an intervention that is aimed at a specific mental health disorder when they may be suffering from another condition. Second, web-based interventions are clearly not suitable for people who are illiterate or who are not familiar with the required technology or do not have access to the Internet. Third, web-based interventions are not able to detect subtle verbal and

Table 1

Review of Australian Web-Based Interventions Comparing Problem Area, Duration of Intervention, Theoretical Underpinning of Intervention, Research Design, Therapist Contact, and Attrition Rate.

First Author & Year of Publication	Problem Area	Duration of Intervention	Theoretical Underpinning of Intervention	Research Design (duration, follow up)	Participants	Therapist Contact	Attrition Rate
Klein (2006)	Panic disorder	6 weeks	CBT	RCT with pre- and post- treatment and 3-month follow-up	N=55	Email support in iCBT treatment condition	5% in the PO (panic online) condition and 17% in the MAN (manualized CBT) condition
March (2009)	Children with anxiety disorders	10 weeks	CBT	Pre- and post- treatment and 6-month follow-up	N=73	30 min call mid- program regarding personal exposure hierarchy: 15 mins with child and 15 mins with adult. Therapist could access responses to homework and session activities and respond to them via email.	At post-treatment, 40% of parents and 66.6% of children did not complete all treatment sessions.
Richards (2002)	Panic disorder	8 weeks	CBT	Pre- and post- treatment and 3-month follow-up	N=9	Weekly telephone contact during intervention	36%
Richards (2006)	Panic disorder	8 weeks	CBT	RCT with pre- and post- treatment and 3-month follow-up	N=32	Weekly email contact during intervention	15.5% during intervention and 50% at the 3-month follow-up
Dear (2011)	Trans-diagnostic (anxiety/depression)	8 weeks	CBT	Pre- and post- treatment and 3-month follow-up	N=32	Weekly contact with a clinical psychologist (limit 10 mins per week) via email and telephone	19%
Kenardy (2003)	Anxiety disorders	6 weeks	CBT	RCT with pre- and post- treatment	N=83	Initial induction and orientation	9.6%
Titov (2011)	Anxiety or affective disorders	8 weeks	CBT	RCT with pre- and post- treatment and 3-month follow-up.	N=78	Monitoring of the discussion forum, sending and reading instant messages, and telephoning participants	25%
Wims (2010)	Panic disorder (with agoraphobia)	8 weeks	CBT	RCT with pre- and post- treatment and 1-month follow-up.	N=59	Weekly email contact, moderated discussion forum.	21%

nonverbal cues, which can aid in the understanding of the client's current level of functioning or accurate diagnosis. Fourth, should the individual become a danger to him/herself or to others, there is very little scope for a web-based intervention to ensure the individual's safety. The fifth limitation that has been recognized for the use of web-based interventions is the dropout rate.

There have been mixed results for the level of dropout rates and treatment adherence for web-based interventions. As can be seen in Table 1, the level of dropout rates reported in these studies varies from 5% to 66%. While some of these studies report alarmingly high dropout or treatment adherence rates, there are studies (Cuijpers et al., 2010) that suggest that web-based interventions have the same level of dropout rates as face-to-face interventions, suggesting that there are certain characteristics of mental health interventions that impact on treatment adherence. A study conducted by Hilvert-Bruce et al. (2012) supports this assumption, indicating that treatment adherence for web-based therapeutic interventions significantly improves with contact with a clinician.

Australian mental health care professionals have recognized the need to develop new therapeutic interventions that can address the current unmet need population in Australia. Current research has suggested that computer-based interventions are a likely modality that can potentially meet this need (Andrews, Titov, & Schwencke 2009). The research reported above has identified that the most widely researched computer-based intervention with the most therapeutic efficacy currently identified by mental healthcare professionals is human-supported. In fact, this type of therapeutic web-based intervention has been shown to have the capacity to be just as effective as traditional face-to-face psychotherapy with similar levels of client dropout and adherence rates.

The Principles of Neuropsychotherapy for Anxiety

Human-supported web-based therapeutic interventions have been identified as the most efficacious type of computer-based intervention for anxiety disorders. Researchers and therapists now need to consider how those interventions can potentially be improved, particularly in light of recent developments in neuropsychotherapy. Recent research into the functioning of the brain has revealed that psychological disorders develop from complex interactions between neurobiology and life experiences (Cozolino, 2010). Due to the increased ability for researchers to explore this link, brain science has become an important tool to assist in therapy (Siegel, 2010) while at the same time the development of neuropsychotherapy has created a new treatment process in the way therapists approach mental health care (Siegel, 2010). In the context of this new body of research (cf., Grawe, 2007), the current computer-based treatments available in Australia for anxiety disorders should be reviewed and updated for possible developments aimed at enhancing treatment outcomes. An overview of essential research findings in neuroscience that relate to neural development in general and anxiety in particular is now indicated in order to explore the implications of, and essential indicators for, various psychotherapeutic strategies (such as computer-based interventions).

According to the triune brain based model (Maclean, 1990), there are three major stages of development that occur in the brain—the reptilian complex, the paleomammalian complex, and the neomammalian complex. The first stage of brain development is the reptilian complex, which contains brain structures such as the brain stem and the pons, which are associated with automatic life support functions such as breathing (Maclean, 1990). The second stage of development is the paleomammalian complex, which contains the limbic system, a brain region heavily linked to emotion and learned behavior (Phan, Fitzgerald, Nathan, & Tancer, 2006). Similar to the brain regions in the reptilian complex, the limbic system has also been found to function automatically. The final stage is the development of the neomammalian complex (Maclean, 1990). This brain region contains brain structures such as the left prefrontal cortex (LPFC), a brain region associated with higher order cognition such as problem solving (Siegel, 2010). The neomammalian complex is only found in mammals and the brain structures within have been shown to be able to regulate or control the automatic functions associated with the other more primitive brain regions (Maclean, 1990).

Maclean (1990) further suggested that the development of these brain stages occurs through a priority model that revolves around the promotion of life for the individual. Thus, the first priority is all the basic, automatic life support functions of the reptilian complex, such as breathing. Once the brain regions associated with these basic functions are developed, the next developmental phase to occur is the growth of the primitive emotional and behavioral brain regions in the paleomammalian complex. The emotions that begin in the limbic system are utilized in the development of approach or avoidance behaviors and are consequently vital in the development of life-sustaining behaviors (Grawe, 2007; Rossouw, 2011). The last brain region to develop is the neomammalian complex, which promotes life-sustaining behaviors due to its capacity for higher order cognitive processes that allow for intelligent problem-solving and thus behavior adaptation (Maclean, 1990, Rossouw, 2011).

These neurobiological developmental stages do not develop brain structures that are isolated from each other (Maclean, 1990). Rather, the brain structures constantly inform each other across different developmental brain stages in an attempt to further advance life-promoting behaviors. Furthermore, Maclean's research has shown that the direction of neurobiological communication also occurs in the same priority direction as the developmental stages of the brain. Thus, the cortical blood flow moves from the deep structures of the brain (reptilian complex) towards the frontal structures (paleomammalian complex).

An example of this hierarchy of cortical communication can be seen through threat recognition and the processes the brain activates as a result. As mentioned previously, the limbic system is the brain region heavily linked with emotion. Research has identified that all sensory information is first passed into the limbic system for threat analysis (Easter et al., 2005). Consequently, should a threat be recognized, then it would be recognized in the limbic system first, deep within the brain (Grawe, 2007). Once identified, the limbic system will then activate the sympathetic nervous system to instigate the fight or flight response (the basis for the survival response) and this information will then travel to the other more frontal brain regions such as the LPFC for further information dissemination (Easter et al., 2005). This communication pathway allows for the individual to execute survival behavior first (a behavior typically known as the default behavior) before the individual can implement higher order cognitions (thereby changing the default behavior to a more contextual response) (Grawe, 2007).

Symptoms of psychopathology originate in neurobiological functions (Grawe, 2007; Rossouw, 2012). What this means is that the neurological mechanics of individuals who experience psychopathology are not the same as healthy individuals with no psychopathology. Research has shown that individuals who experience clinical levels of anxiety, for instance, have a number of significant differences both in the neurobiological structures themselves and in the way these structures communicate with each other when compared with healthy individuals (Meisenzahl et al., 2010; Siegel, 1999). For instance, Meisenzahl et al. (2010) found individuals with severe anxiety to have significantly enlarged amygdala and small hippocampi (both brain structures are found in the limbic system and integral to the fear response system) when compared to healthy individuals due to chronic activation of these brain structures.

Individuals with an anxiety disorder have also been found to have a significantly reduced ability to access a number of brain regions such as the LPFC, anterior cingulate cortex (ACC) and the orbitofrontal cortex (OFC) (Grawe, 2007). As mentioned above, the LPFC is the brain region associated with higher order cognition and is able to regulate automatic processes. The ACC is associated with motivation and the OFC is associated with personality (Siegel, 1999). What this research identified is that individuals who experience clinical levels of anxiety do not have the same level of full brain activation when compared to healthy individuals (Champagne et al., 2008; Meisenzahl et al., 2010; Grawe, 2007). This reduction in functionality was found to be due to the neural pathways that connect these brain structures being damaged and destroyed due to chronic exposure to cortisol, a stress hormone that is released through the activation of the threat recognition system found in the limbic system (Meisenzahl et al., 2010; Grawe, 2007).

As a consequence of this difference in full brain functionality, an individual with an anxiety disorder attempts to promote a feeling of safety in situations that provoke anxiety differently to that of healthy individuals (Grawe, 2007). For example, due to the decreased activation of the aforementioned brain regions, they are more likely to revert to default behaviors than a healthy individual because the healthy individual has a greater capacity to problem solve or consciously down regulate the fear response (Grawe, 2007). Consequently, the neural communication begins deep within the brain and will only effectively communicate with the frontal regions when the fear response systems are not over activated (Grawe, 2007). While the frontal regions of the brain have the ability to regulate these deeper cortical structures, this conscious regulation can only occur when the deep brain structures communicate with them (Grawe, 2007; Siegel, 1999).

This research has shown that the automatic functions that occur via brain regions such as the limbic system can be changed through the activation of neomammalian brain structures such as the LPFC (Grawe, 2007; Maclean, 1990). What this means is that when a healthy individual experiences limbic activation due to threat recognition of a stimulus, the individual has the potential to activate their LPFC and recategorize the perceived threat (Grawe, 2007). This is achieved by the individual consciously recognizing the stimulus to not be a threat, and thereby rationalizing that they will not be injured or hurt due to that threat. This rationalization changes the individual's default behavior into a behavior that is more adaptive to the situation.

For example, an individual is shark diving in a cage: The individual recognizes that the shark swimming around the cage is dangerous and that it may attack and injure the individual, but he or she is also aware that they are safe in the cage and so they do not rush to get out of the water. In this scenario the individual experienced limbic activation due to fear of the shark. The typical default behavior would be to exit the water but the individual was able to activate their LPFC and consequently down regulate the fear response. Thus the individual was able to change the default behavior (i.e., exiting the water and avoiding the shark) to continuing to swim in the water. This ability to adaptively change the default behavior is a form of neural resilience because even with the activation of the fear system, the individual was still able to access the frontal brain regions (Grawe, 2007).

The difference in adaptive and nonadaptive behavior can be seen clearly in the shark diving example given above. As mentioned, in this scenario, the adaptive individual was able to rationalize that the shark, while dangerous, posed no immediate threat to the individual because of the shark cage and consequently the individual was able to continue observing the shark. Conversely, should a person with a shark phobia be presented with the same situation, the individual would most likely avoid the situation entirely because they would not be able to rationalize that they would be safe in the shark cage. Here the individual does not have the neural resilience (i.e., full brain activation), that would allow for an adaptive change to occur (Grawe, 2007). Consequently, the individual would only be able to actualize their default behavior, (avoidance of the stressful stimulus).

In this scenario, the individual's default avoidance behavior can be termed psychopathology due to its inability to be regulated in an adaptive manner by the individual's higher order brain structures (Grawe, 2007). This finding forms the foundation for neuropsychotherapy, whose primary goal is to promote whole brain activation so that adaptive behaviors can be formed and utilized instead of default maladaptive behaviors (Grawe, 2007; Siegel, 1999). This therapeutic foundation acknowledges the power of the frontal brain systems, as it is this area that allows for conscious behavioral change (Cozolino, 2010). It also, however, emphasizes that the brain communicates in a priority-driven, bottom up survival pathway (Maclean, 1990). Consequently, any attempt to access the frontal brain for behavioral change should occur through activating the deep brain first (Cozolino, 2010; Grawe, 2007; Maclean, 1990).

Older therapeutic interventions such as cognitive behavioral therapy (CBT) have focused on treating psychopathology with documented short-term success (Dattilio, 2006; Gurman, 2008; DiMauro et al., 2013). However, Linford and Arden (2009) argue that these therapies did not have a full understanding of how psychopathology occurs in the individual's brain and consequently focused on a top down approach. The top down approach attempts to change an individual's behavior by first activating the frontal brain regions before the deeper brain regions are activated (Grawe, 2007) and does not recognize that (as mentioned above) the brain communicates in a bottom up pathway; consequently, the success that has been documented is typically not seen in longer-term studies as the client reverts to their default behaviors (Grawe, 2007).

What neural research has done is explain through an organic modality how the individual is changing their behavior through external stimulus (Grawe, 2007). As a consequence of this knowledge, neuropsychotherapy places more of an emphasis on the therapeutic intervention from a bottom up modality. This is achieved in neuropsychotherapy by addressing the consistency regulation model (Grawe, 2007) in session and ensuring that the individual's basic human need for safety and control are met: By first ensuring the individual's need for safety and control are met, the individual's distress will be down regulated (Grawe, 2007). This is a situation Grawe describes as creating controllable incongruence for the client; the opposite of this, which he labeled uncontrollable incongruence, is typically a by-product of having no neural empathy with the client in a therapeutic session. By first down regulating the individual's fear response system, the therapist is attempting to reduce cortisol production with the aim of ensuring that new neural connections to previously under-activated brain regions such as the LPFC can be activated and maintained (Grawe, 2007; Linford & Arden, 2009).

This primary goal reduces the client's chances of reverting back to maladaptive default behaviors and is an important therapeutic goal to establish before any positive gains can be expected through further therapeutic interventions (Grawe, 2007). This is because, as mentioned above, when an individual's fear response system is up regulated, the neurobiological pathways between cortical structures are limited to primitive life-preserving functions. Thus, the frontal cortical structures that are used to change default behaviors are not activated and therefore therapeutic interventions that require higher order cognitions to be effective are not accessible. Consequently, if fear activation increases in session, the individual will be more likely to revert back to the maladaptive default behavior as opposed to the desired adaptive behavior that has not been used as often (Allison & Rossouw, 2013; Grawe, 2007). Therefore, the therapist is attempting to promote adaptive conscious behaviors and to reduce automatic default behavior activation through first reducing the emotional distress the client experiences in session (Grawe, 2007; Siegel, 2010).

Once the individual's fear levels are reduced to a point that supports the formation of new behaviors, the therapist will then implement a wide variety of intervention strategies that best promote the target behaviors (Grawe, 2007). Typical intervention strategies used for rebuilding and creating new neural pathways in neuropsychotherapy are often therapeutic techniques (such as cognitive restructuring or positive behavioral scheduling) used in other therapeutic models (Linford & Arden, 2009). As mentioned above, the aim of these strategies is for the individual to activate conscious adaptive behaviors so that they eventually take the place of the individual's previous pathological default behavior.

Another important factor that has been identified in neuropsychotherapy is the importance of the mirror neuron system in session (Iacoboni et al., 2005). Mirror neurons are neurons located throughout the brain that are activated when an individual is doing something, listening to something, or observing someone doing something (Iacoboni et al., 2005). Research has shown that it is these mirror neurons that are used to aid individuals in learning about themselves and others (Iacoboni et al., 2005). What this means for neuropsychotherapy is that there is a large emphasis on face-to-face contact in therapy as opposed to providing therapeutic interventions with little or no contact between the therapist and the client (Siegel, 2010). Consequently, one goal of the therapist who utilizes neuropsychotherapy is to provide opportunities in session for the client to activate their mirror neuron system in situations that either aid the formation of adaptive neural feedback loops (adaptive behaviors) or further strengthen preexisting adaptive neural feedback loops (Siegel, 2010).

Neurobiological research into mental health disorders such as anxiety emphasizes an understanding and awareness of the biological processes and consequences of psychopathology. Neuropsychotherapy has created therapeutic goals that are formed around a neurobiological empathy for the client (such as meeting the client's need for safety and control), which lead to down regulating the client's fear before effective therapeutic interventions can take place. While neuropsychotherapy still utilizes similar therapeutic strategies to other efficacious therapeutic models such as CBT, it places greater emphasis on a bottom up modality so that the client's emotional distress can be down regulated before further progress is attempted. Neuropsychotherapy also places a large emphasis on face-to-face interactions between the therapist and the client, due largely to the recognition of mirror neurons and the role they play in learned behavior. While other therapeutic models such as CBT have been shown to be effective, it has been suggested that the long-term efficacy of these interventions can be further improved with the adaptation of neuropsychotherapy into therapeutic practice (Grawe, 2007).

Conceptualization of Internet-Based Treatments through Neuropsychotherapy

As discussed by Fuller, Stokes and Mathews (2012), web-based therapeutic interventions are the most researched and evidence-supported form of computer-based interventions of the four identified types. This high level of research reflects the level of interest mental health care professionals have in the current and future use of web-based therapeutic interventions for mental health issues such as anxiety disorders. At present, these web-based therapeutic interventions are primarily created utilizing CBT as their therapeutic framework with little input from other therapeutic frameworks. In this section the key processes and therapeutic outcomes of web-based therapeutic interventions from a neurobiological perspective are presented with the aim of identifying potential areas for change and best-practice.

As discussed above, and more comprehensively expressed by Grawe (2007), the neurobiological process of psychopathology can be explained through the consistency model, which emphasizes the importance of the basic human needs for safety and control. When these needs are violated, the resulting up regulated neurochemicals, such as cortisol, compromise neural pathways and structures and increase unhelpful neural activation in cortical areas, specifically the limbic system. This increased activation in the limbic system then leads to the activation of default behaviors and the inability of the frontal cortical structures (e.g., the left prefrontal cortex, which has the capacity to change default behaviors) to activate.

Neuropsychotherapy argues through the consistency model that positive therapeutic change cannot take place until the individual's basic needs for safety and control are facilitated. Thus, until the therapist introduces controllable incongruence into the session—that is, ensuring that the individual feels safe and in control—the therapeutic benefit that the individual is intended to receive in treatment is often compromised. It is important to note that irrespective of the modality of therapeutic intervention, neuropsychotherapy requires a down regulation of distress before any positive therapeutic change can occur. The implications of this neurobiological conceptualization of psychopathology for current web-based therapeutic interventions are far-reaching and different to that of traditional face-to-face therapy.

At present, very little of the current CBT face-to-face setting focuses on a bottom up modality (Beck & Alford, 2009). It can be argued that the closest aspect of this process in such a mainstream intervention is the therapeutic alliance, but this can take some time to form (Ackerman & Hilsenroth, 2003). Web-based therapeutic interventions, however, operate with the expectation that when an individual accesses a web-based therapeutic intervention, they are most likely accessing it when they are at home or in a location that they already feel safe and in control, and at a time of their choosing. Consequently, web-based therapeutic interventions actually seem to address this goal inherently with the modality of the therapy, while traditional face-to-face therapy only generates the feeling of control and safety for the individual after the therapeutic alliance has been established. Once the individual's distress is down regulated, neurobiological change can take place. At this stage in the treatment process, therefore, through neuropsychotherapy the CBT strategies utilized in web-based interventions can actually be processed by the individual at a level that allows for whole brain activation and thus allow for therapeutic change.

Another important aspect of neuropsychotherapy discussed above is the mirror neuron system and the role it plays in therapeutic change. Neuropsychotherapy places a large emphasis on the activation of the mirror neuron system in therapy as a means of observational learning. While traditional face-to-face therapy actively utilizes mirror neurons in session, the research identified in Table 1 suggests that there is little visual contact between a therapist and the individual. It should be noted that, when web-based interventions do include therapist contact, the therapeutic outcome of the intervention actually increases to a similar effect size of face-to-face therapy. However, as shown in Table 1, the typical therapist interactions for web-based interventions are by email or telephone and not face-to-face. The principles of neuropsychotherapy suggest that the inclusion of some face-to-face contact in web-based interventions would actually lead to an increase in therapeutic change for the client, hence the web-based therapeutic interventions as identified in Table 1 do not actively maximize the use of the mirror neuron system in their treatment.

There are also mixed reports regarding treatment adherence and dropout rates for web-based interventions. As mentioned previously, some studies report significant dropout rates while others report dropout rates comparable to face-to-face therapy. The reasons for this have yet to be fully explored (Hilvert-Bruce et al., 2012), although it has been shown that the dropout and treatment adherence rates are significantly better when there is therapist contact combined with the web-based intervention. Neuropsychotherapy argues that the increased adherence rate found in web-based interventions with face-to-face intervention is due to the client's activation of mirror neurons. In other words, not only is it important for clients to have face-to-face interactions with their therapist for therapeutic change, but face-to-face interactions are also important for treatment adherence due to the activation of mirror neurons in treatment.

Neuropsychotherapy further recognizes that for positive long-term therapeutic change to occur, the client needs long-term activation of the target neural pathways for healthy pathology (Rossouw, 2012). As mentioned previously, the more a neural feedback loop is activated the more resilient the neural feedback loop becomes (Rossouw, 2011). Currently, the duration of the identified web-based interventions range from 6 to 10 weeks, suggesting through neuropsychology that the current web-based interventions may improve in long-term therapeutic benefit with an increase in treatment duration.

As noted above, CBT is the model of choice in the web-based therapeutic interventions identified in Table 1 although, currently, there have been suggestions that the therapeutic outcomes that occur through CBT could be enhanced with the combined use of neuropsychotherapeutic principles. Consequently, while the reported efficacy of web-based therapeutic interventions appears to be high, this efficacy could be enhanced by including some neuropsychotherapeutic principles. While several aspects of the web-based interventions are currently seen by neuropsychotherapy to be strong assets to the therapeutic intervention, there are also aspects of the current web-based interventions that could be further addressed to recognize the importance neuropsychotherapy on therapeutic change.

Suggested Future Progression of Web-Based Therapeutic Interventions for Anxiety-Based Disorders

As mentioned previously, anxiety-based disorders are prevalent in the Australian community, yet only a small percentage of Australians diagnosed with an anxiety-based disorder are actually seeking treatment, which means there is a large population of Australians whose mental health care needs are not being met. The consequence of not treating an individual's anxiety-based disorder impacts not only on the individual but also the wider community: The individual will experience significant impairments in their every day-to-day functioning as well as potentially being a significant financial burden on the community. For these reasons the Australian government has an ethical responsibility and a financial incentive to address this unmet need.

Despite this demand for increased service access, it appears that the current mental health care model is not functioning either as an optimal economic or outcome model. Nor does it appear able to promote long-term therapeutic support for individuals who require it. Consequently, there is a need in Australia to address both service access (unmet need) as well as service access duration (promotion of therapeutic outcomes). This has been recognized by mental health care professionals and alternative services are currently being developed in an attempt to respond to this need. One alternative service that has been argued to address at least a portion of the current unmet need and service access duration in Australia is computer-based interventions because these interventions offer mental health care services that can reach consumers who may not be able or willing to access conventional face-to-face treatment (Andrews et al., 2009).

While there are four different modes of computer-based interventions that have been identified, the research identified in Table 1 indicates that the most widely researched computer-based intervention with the greatest efficacy is human-supported web-based therapeutic intervention. This type of intervention has been shown to be just as effective as traditional face-to-face psychotherapy with similar levels of client dropout and adherence rates. Despite this therapeutic efficacy, it has been suggested that in light of the new body of research surrounding neuropsychotherapy, the current computer-based treatments available in Australia for anxiety disorders should be reviewed and updated for possible developments aimed at enhancing treatment outcomes.

Consequently, as mentioned above, there are a number of aspects of the web-based interventions that are seen by neuropsychotherapy to be strong assets to the therapeutic intervention. There are also aspects to the current web-based interventions that could be further addressed to recognize the importance neuropsychotherapy has on therapeutic change. In light of the information gathered in this paper, there are a number of possible adaptations web-based therapeutic interventions could make to enhance treatment outcomes.

The adaptation proposed in this paper, based on the evidence reported above, is the inclusion of occasional face-to-face interactions between the therapist and the client throughout human-supported web-based treatment in order to address the limitations of web-based interventions. This face-to-face interaction does not need to be extensive; for example, after every fourth web-based session, say, the client could have a face-to-face session with their therapist. Under this proposed model, the web-based therapeutic session would not act as a stand-alone service but actually serve as a complementary intervention combined with traditional face-to-face therapy.

This would have a number of key effects in the treatment process. First, compared with traditional face-to-face interaction, the proposed model addresses cost and accessibility issues, thereby potentially meeting some portion of the unmet need. Second, as a result of only seeing the therapist after every fourth web-based therapeutic session, the individual is prolonging their service contact, thereby maximizing therapeutic outcomes. This suggestion potentially addresses the concerns that were identified by the APS surrounding the prohibitive cost of increased service duration access. Third, in the face-to-face therapeutic sessions, the individual would also be more effectively activating their mirror neuron system. And last, as was discussed previously, treatment adherence may be improved by face-to-face contact with a therapist. In order to assess the efficacy of the proposed model, future research into web-based therapeutic interventions for anxiety-based disorders should investigate the therapeutic outcomes of complementary web-based therapeutic interventions combined with traditional face-to-face therapy.

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RESEARCH

The Impact of Technology Use on Couple Relationships: A Neuropsychological Perspective

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Abstract

We are in the midst of an Internet revolution and entering an era of enhanced digital connectivity (Hoffman, Novak, & Venkatesh, 2004). The increasing use and accessibility of technology today allows humans to engage and disconnect continuously during face-to-face interactions. Technology is not only used in workspaces but in everyday social relationships as well. The impact of technology use on couple relationships from a neuropsychological perspective has not yet been explored, however. This study investigated the use of television (TV), mobile phones, computers, and laptops in a sample of 21 couples to assess how this impacts on an individual's sense of safety, control, and attachment. It was found that using a laptop while in the presence of a partner, but without engaging/interacting with them, was associated with a couple's negative perception of the relationship, but this effect was not found in relation to mobile, computer, or TV use. Conversely, it was found that couples using technology together while engaging/interacting was linked to positive perceptions about their relationship. This was found most specifically in TV use. It was concluded that technology may enhance or hinder couple relationships depending on the couple's ability to manage, monitor, and reflect on its use.

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The Impact of Technology Use on Couple Relationships: A Neuropsychological Perspective

From the moment we are born, we as humans are surrounded by an external environment that consists of other beings. This may include a community or caregiver/s who play a part to increase our chances of survival in the world. Cozolino (2006) observed there is safety in numbers and larger social groups. Our brains are also developed in such a way that we are able to form social relations, respond to social cues, and integrate with our surroundings (Grawe, 2007). This process can be seen in the expansion of the cortex in primate brains, which allows us to respond to a large variety of challenges across diverse environments (Cozolino, 2006). Regardless of the context of our external environment, human beings strive to connect with others in order to survive, develop and thrive within the social world (Siegel, 2010). This requires the development of intricate connections within the brain, which consists of billions of neurons (Grawe, 2007). Neurons are, by nature, social: They shun isolation and depend on their neighbors for survival (Cozolino, 2006). Neurons interconnect and build pathways in our brains. In response to one's individual experiences, this leads to the development of neuronal pathways that determine our feelings and behaviors. Not only does this occur within our individual brains, but—like a wireless network—our neurons have a way to connect with other brains as well. This network, known as the mirror neuron system, was originally discovered in macaque monkeys when researchers observed neurons firing in the prefrontal cortex of a monkey's brain when it performed a particular action, and observed the same process occurring in the same region when the monkey watched the same action in another monkey (Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). Subsequent research has also demonstrated the same system in the human brain (Kilner, Friston, & Firth, 2007; Yuan & Hoff, 2008).

The more we feel connected to another, the more likely it is that our neurons fire together, leading to repetition of behaviors and the strengthening of neuronal pathways. Although we cherish our individuality, we live in constant relationships with others who participate in stimulating neuronal pathways and regulating or dis-regulating our emotions, thoughts, intentions, and behavior (Cozolino, 2006). Advances in technology, and the increase in its use in everyday life, not only in the office, but socially and in the home environment (Hertlein, 2012), suggests a need for social connection and attachment; however, the impact of the frequent use of technology between couples within their relationship is not yet known (Hertlein, 2012). According to Hertlein, increasing technology use may create difficulties for couples attempting to inhibit problematic phone usage and set clear boundaries. Further, some partners may feel more comfortable expressing certain aspects of their personality (e.g., vulnerabilities) only via social media or online forums, thus creating a greater divide between couples (Cooper, Galbreath, & Becker, 2004). For example, Cooper et al. (2004) indicated that men have been shown to use the Internet to express behaviors (e.g., sexual chatting) that they feel they cannot express in their face-to-face relationships. The Internet has the potential to blur the boundaries between online social relationships and face-to-face relationships; recent research has also explored the blurred boundaries between work and couple/family relationships (Campbell & Ling, 2009. Some researchers have proposed that blurred boundaries due to the overuse of technology have a negative impact on social relationships (Galinsky, Kim, & Bond, 2001; Weil & Rosen, 1997). Others have found that negative work issues extended via technology use into family life is related to increased distress and decreased family satisfaction (Chesley, 2005). Contrasting research has shown, however, that technology use can provide flexibility regarding working arrangements, which reduces relationship conflict (e.g., Hill, Hawkins, Ferris, & Weitzman, 2001; Valcour & Hunter, 2005). In addition, Campbell and Ling (2009) found that frequent mobile phone use contributes to intimacy, and that frequent connection via the mobile phone allows for the sharing of a person's activities and whereabouts to their partner, which enhances connections between couples. Thus far, therefore, research has suggested both that problematic phone use leads to blurred boundaries within relationships, and that it can enhance connections between couples. The impact of technology on satisfaction, feelings, and perceptions of the relationship has not yet been explored.

Developing a Connection

Human infants, unlike some animals, are born in complete dependency on their primary caregivers. During this time, developing a bond and connection with caregivers allows the infant's brain to grow, adapt and be shaped by specific experiences, and survive. Infants have the ability to detect and explore their caregivers from their smell, taste, feel, and facial expressions. In this way they experience the caregiver's presence, which becomes synonymous with safety. Through discovering their caregivers, a connection is formed, and the infant then survives, based on the abilities of the caretaker to detect the needs and intentions of those around them (Cozolino, 2006). For humans and other primates, successful relationships are an indication that we have adequate food, shelter, and protection, and our basic needs will be met. Striving to meet our basic needs requires a process of consistency regulation (Grawe, 2007). This process continues into adult relationships throughout the lifespan.

Consistency Regulation and Congruence

Grawe (2007) regards consistency as a core principle of mental functioning. Humans strive for consistency and congruence to fulfil basic human needs. Consequently, if the condition of striving for consistency is compromised, or even violated, individuals are unable to satisfy their basic needs, thus leading to patterns of protection for survival. Ongoing avoidant patterns of protection result in mental un-wellness (psychopathology). From a neuropsychological point of view, such patterns are the result of the survival response (Grawe, 2007). The survival response is a protective system that ensures safety (Rossouw, 2013). Ongoing activation of the survival response leads to robust neural activation in the primitive neural areas (i.e., the limbic system), which, in psychotherapeutic terms, is referred to as a pattern of avoidance. Patterns of approach, on the other hand, are activated when individuals are surrounded by an enriched environment (Cozolino, 2006; Kandel, 1998). Enriched environments enhance safety, which encourages cortical blood flow to the frontal parts of the brain. When blood flow moves away from the limbic system and into the frontal parts of the brain, individuals are able to function as a whole—meaning that they can think, problem solve and communicate, rather than staying focused in the primitive neural areas (fight or flight for survival). Individuals in an enriched environment are more likely to develop patterns of approach than patterns of avoidance.

Striving for consistency is a way in which humans can safely maintain their goals and fulfil important needs. Once individuals have learned one way of being, they are more likely to repeat it as the process becomes predictable and safe. On the other hand, a situation that becomes unpredictable and inconsistent with our expectations leads to cognitive dissonance, a process whereby emotional distress arises (Grawe, 2007). Inconsistency as described by Grawe is a state that humans strive to avoid, and the human mental system has developed many mechanisms to avoid or remove it. How this relates to couple relationships is that conflict can occur when there is inconsistency tension. If one partner strives for consistency to have their needs met in one way, for instance, and the other partner strives to meet their own needs in another way, there is inconsistency and incongruence in the relationship. The couple's needs become compromised, or even violated, leading to distress and the development of avoidant patterns.

Approach and Avoid Patterns

The basis for developing approach and avoidance patterns occurs as an individual strives to meet basic needs. From birth, the limbic structures (the emotional center) of infant brains constantly scan the environment for cues to danger, discomfort, and risk. In order to feel safe, therefore, and for the stress response in our brains to be regulated, infants look toward their primary caregivers to provide them with a safe and enriched environment to fulfil their basic needs (Rossouw, 2011); but if these needs are compromised or violated, avoidant patterns are developed as a way to protect the self. Grawe (2007) suggests that avoidance goals (i.e., striving to avoid an unpleasant event) require constant control and focused attention—in other words, a person is unable to relax and is constantly scanning the environment for danger or inconsistency. Conversely, when approach patterns are developed, individuals are more likely to approach their goals without a sense of anxious tension. Avoidance goals do not permit efficient goal pursuit or real goal attainment. Feinberg (2009) further suggested that neural responses of protection and avoidance may form as a result of trauma (the violation of a basic need), whereas approach patterns and growth are likely to occur due to positive experiences.

Basic Human Needs

Mental wellness requires healthy neuronal development in a safe and secure environment so that approach patterns rather than avoidance patterns can develop, which in turn facilitates healthy adult relationships. In order to achieve this, humans display four basic needs that must be fulfilled from the time of their birth (Grawe, 2007). These are

- the need for secure attachment;
- the need for orientation and control;
- the need for self-esteem enhancement and self-esteem protection; and
- the need for pleasure maximization and distress avoidance.

According to Grawe, violations of these needs lead to dysfunctions in brain development and social interactions. For the purpose of this study, the needs for attachment and control are the focal point, as these are the most prominent of the four basic needs. Although individuals have a need for self-esteem enhancement and pleasure maximization, these needs cannot be met without first meeting the need for attachment and control.

The need for secure attachment. The need for attachment can be regarded as the empirically most substantiated basic need, especially with regard to its neurological foundation (Grawe, 2007). Attachment describes our unique human need to form and maintain lasting relationships, not only with our caregivers but also relationships throughout our lifespan (Harrison, 2003). The theory of attachment, developed by John Bowlby in the 1960s, indicates that the quality of the attachment relationship forms the basis for emotional development (Colmer, Rutherford, & Murphy, 2011). The core postulates of attachment theory are set out in Bowlby (1973) as follows:

1. When an individual trusts that an attachment figure will be available when needed, then this individual will be less likely to experience intensive or chronic anxiety than a person who does not have this trust.
2. Trust in the availability of an attachment figure, or the lack thereof, develops prior to adulthood, little by little, during infancy, childhood, and adolescence, and whatever expectancies develop during these years tend to remain relatively unchanged for the rest of life.
3. Expectancies that the primary caregiver will be available reflect actual experiences.

When the attachment need is violated or not met, children and adults tend to develop insecure and avoidant attachment styles within relationships. One of the side effects of an insecure attachment is poor emotional regulation because the infant did not learn effective emotional regulation with his/her own primary caregiver. Following Bowlby's attachment theory, a classic lab procedure, the Strange Situation, was devised by Mary Ainsworth in the 1970s. The Strange Situation Test was the first standardized observational procedure designed to explore attachment patterns (Ainsworth, Blehar, Waters, & Wall, 1978). Using this method, children between the ages of 11 and 20 months were observed in situations where they were first separated for a few minutes and then reunited with their mothers. Their reactions to the separation and being united were observed, and from this Ainsworth identified four attachment patterns termed secure, insecure-avoidant, insecure-ambivalent, and insecure-disorganized, described below.

Secure attachment. Children were observed to react with distress to separation from their mothers and immediately sought proximity upon her return. Infants were soothed by their mothers when they were reunited.

Insecure and avoidant attachment. These children avoided proximity after being separated from their mothers and showed no signs of distress upon separation. Rather than seeking proximity, these children remain distant without exposing themselves to the possibility of further harm. Although this is a protective mechanism to survive, ongoing avoidant patterns lead to poor positive satisfaction of the attachment need (Grawe, 2007).

Insecure and ambivalent attachment. These children displayed anxious behaviors when separated from their mothers. They became preoccupied with the relationship after the separation and did not pursue other activities in the room. Upon the return of their mothers they would fluctuate between seeking proximity and an aggressive rejection of contact. Children in this category learn to associate closeness with worries of losing the attachment figure, leading to fears of being alone.

Insecure and disorganized/disorientated attachment. This attachment style is less common than the previous three. In this condition, children respond to separation from and return of their caregiver with bizarre behaviors. These reactions are the result of severe violations of the attachment need due either to abuse by the primary caregiver, or their absence.

Regardless of the attachment style one develops from early childhood and into adulthood, the underlying drive is to fulfil the need to feel safely attached to another. If our attachment and emotional development is compromised, our thoughts, state of mind, emotions, and immunological functioning become inconsistent with well-being and healthy long-term survival (Cozolino, 2006). Emotional development continues throughout the lifespan but is rooted in the earliest experiences of attachment with caregiver/s. According to Cozolino (2006), children engage in a pattern of insecure attachment if their carer abuses, neglects, or abandons them. These actions send a message to the child that the world is unsafe and dangerous, and the child's brain consequently becomes shaped in a way that protects itself, leading to patterns of avoidance rather than approach. On the other hand, infants surrounded by an enriched environment in close proximity to their primary caregivers encourages neural proliferation and enhanced cortical blood flow to the pre-frontal cortex (Grawe, 2007), leading to the development of approach patterns in the brain. Effective neural connections in open firing patterns are essential for effective neural development, enhanced memory systems, and a sense of well-being (Rossouw, 2012a). A study by Luby and colleagues (Luby et al., 2012) explored the link between children in enriched environments (maternal nurturance) and hippocampal volumes. The hippocampus is the structure in the brain that most closely aligns to memory formation—large hippocampal volume suggest healthy memory systems, whereas hippocampal atrophy can be linked to depression (Sheline, Mittler, & Mintun, 2002). In this study, Luby et al. measured the brains of 92 early school aged children and found that maternal support (i.e., an enriched environment) was strongly predictive of larger hippocampal volume compared to children who were not raised in an enriched environment. They also found that hippocampal volume was greater in children who were not depressed than it was in children who were depressed.

The influence of the external environment on brain development and behavior has been studied in non-human primates. Disturbances in attachment relationships in rhesus monkeys were investigated in a study by Stephen Suomi (1999) who found that when the monkeys were reared without the presence of their mothers, they tended to be retarded in their play and social contact behavior and responded more sensitively to being socially isolated, both in terms of their behavior and in terms of their stress hormone and noradrenergic neurotransmitter release. These responses were present over the long term, into adolescence and adulthood.

Similar findings extend to studies on humans. A study conducted by Chugani et al. (2001) explored brain dysfunction and social deficits in children between the ages of 7 and 11 years who had been adopted out from Romanian orphanages. Many of these children were placed in an orphanage within the first month of life. As the carers in these facilities were few, at a ratio of 10:1, the infants spent 20 hours a day in their cribs isolated from others. As childhood social deprivation on brain function in humans had been largely unexamined, Chugani and colleagues aimed to examine the neurological effects of such isolation on children. To do this, they scanned the brains of ten children adopted out of the Romanian orphanages using positron emission tomography (PET). The neuropsychological assessment of these orphans revealed mild neurocognitive impairment, impulsivity, and attention and social deficits. In terms of survival, a lack of social interaction in orphanages has been shown to lead to alarming death rates, and it was not until the children were held, rocked, and allowed contact with one another that their survival rate improved (Blum, 2002). Another study conducted by Zeanah, Smyke, Koga, and Carlson (2005) examined children who were raised with little social interaction in another Romanian orphanage. Ratings from caregivers' reports and the Strange Situation Test revealed that children raised in these circumstances were at a high risk of severe disturbances in attachment and related social and behavioral problems. These studies shed light on the importance of secure attachment and how the external environment can shape the way these needs are met, impacting and altering brain development.

The need for orientation and control. According to Epstein (1990), the need for orientation and control is the most fundamental of human needs. Our need for control is satisfied when a maximum number of options are available to us. Conversely, this need is violated when our options are no longer available—if we experience a severe flood, for example, our options decrease and control over our environment is compromised. Although we are still able to survive, if our need for control is violated, this reduces our sense of orientation. In early childhood, control is linked to attachment and the relationship with the primary caregiver. Further, when an individual is introduced to a safe and enriched environment, their options and sense of orientation increase, leading to an increased sense of control and mental wellness.

Control involves the processes of controllable and uncontrollable incongruence (Grawe, 2007). Incongruence refers to the interaction between the individual and his/her environment. In adult relationships, incongruence may occur in a long-distance relationship, for example, when the number of options the couple has to feel or be attached to one another is decreased, which leads to a decreased sense of control. This is known as uncontrollable incongruence. If the couple have plans to reunite and have the means to connect via technology consistently, thereby maximizing their options, their sense of control over the situation would increase. This is known as controllable incongruence. In another example, if a couple were sitting together in the same room and one person is consistently using technology without engaging with the other, this may compromise that person's sense of attachment and safety. As one person is striving to feel attached while the other person engages with technology, uncontrollable incongruence is enhanced, leading to distress within the relationship.

Technology Use and Couple Relationships

Hoffman, Novak, and Venkatesh (2004) stated that we are in the midst of an Internet revolution and entering an era of enhanced digital connectivity. The consequent increase in the use of social media and technology can either enhance or hinder our need for attachment and control. Computers, mobile phones, and the Internet have an enormous influence, not only on how we function at work but also on how we communicate and interact outside the office (Kraut, Brynin, & Kiesler, 2006). According to the Australian Bureau of Statistics (ABS, 2009), in 2009, 74% of Australians aged 15 years and over accessed the Internet at least once in the previous 12 months. By 2013 this figure had increased to 84% (ABS, 2013). The main social sites used are Facebook, Twitter, and YouTube. Not only is social media and technology used for social connection, technology is increasingly used for education and the sharing of information, which globally aims to make the world more accessible than previously (Selwyn, 2013). With the increasing use of technology to achieve social connection, questions arise as to what the implications are for face-to-face interactions within couple relationships. Hertlein and Blumer (2013) posited that a technological revolution has intruded into couple life in subtle ways, where couples are not always aware of the changes that have emerged in their relationships. They began their book *The Couple and Family Technology Framework: Intimate Relationships in a Digital Age* with the following account:

> I (K. H.) was having dinner at a local restaurant with a colleague. As we sat and talked, I could not help but notice a couple sitting together at a table just behind my companion. They appeared very much in love: They spent some time holding hands, facing each other gazing in each other's eyes, and smiling at one another a good proportion of the time. Then, as the dinner continued, I noticed the emergence of their mobile phones. At first, the involvement of the phones seemed rather innocuous: One person brought out a phone to show his partner something, and the phone was quickly put away. As I continued to observe them, new media made an increasing presence in the date. After taking photos of the meal and making it most of the way through dinner, one of the phones made another appearance at the dinner table. One partner offered the phone to the other to view something on the screen. This continued for several minutes. By the end of the meal, their phones had made another appearance, but in a different way. The couple stopped talking to one another; one partner was sitting at the table, and the other was positioned with her body away from the table and, consequently, her partner. Each had a cell phone in hand, and they were seemingly not engaged with one another. They both appeared to be scrolling through options and reading things on their independent screens. This continued for several minutes, and they appeared so disconnected to me that I wondered if I had missed an argument and they were no longer speaking. After the check was paid, however, they put away their phones, smiled at one another, and left the restaurant quietly, hand in hand. (p. 1)

This observation illustrates the need for connection—not just while being in the *presence* of another but also being present with that person. According to Siegel (2010), presence is a process whereby we remain open and focused on the other without external or internal distraction. When we are present with another, that person feels connected and safe. Questions arise as to whether, in a relationship, presence should or should not be maintained at all times. Nevertheless, if presence is not maintained due to technological distraction, how long can couples remain satisfied in their relationships without feeling heard or connected? Individuals can develop strong relationships with mobile phones, which combine communication, computing abilities, and personalized applications (Lang & Jarvenpaa, 2005), and the advancement of technology, particularly with the mobile phone, has introduced a process of distraction and separation in couple relationships (Hertlein, 2012). Lang and Jarvenpaa described an engaging/disengaging paradox in relation to mobile phone use, where the mobile phone provides a means to disengage regularly from face-to-face interactions with increasing SMS, email, and social media technology. Mobile phone users frequently disengage from meetings, face-to-face conversations, parties, and family in order to engage with their devices. On the other hand, technology has been shown to positively impact relationships, as the increased accessibility means an increase in connection, especially when couples are apart. What happens, then, when a couple are face-to-face and using technology separately? Hertlein and Blumer (2013) noted that it is difficult for researchers to access a current and coherent view of the research literature on couple relationships and technology use, though the limited research in this area has brought light to this current study. The purpose of this study, therefore, is to explore the impact of technology use on couple relationships and, in so doing, to investigate how technology may impact on an individual's sense of attachment and control within the relationship. Links between couple satisfaction and current technology use are explored specifically.

The study investigated three hypotheses. First, it is hypothesized that using technology in the presence of a partner without engagement/interaction will negatively impact on relationship satisfaction. Second, it is further hypothesized that if a couple uses technology together while interacting with each other, this will have a positive impact on relationship satisfaction. Finally, it is hypothesized that the mobile phone may be the mode of technology that has the greatest impact on relationship satisfaction compared to other modes.

Method

A questionnaire was designed to obtain information about couple satisfaction and current technology use. The questionnaire was administered via online and social media where volunteers were invited to participate in the study. Data were collated and t-tests were performed. No significant differences were found between the variables, therefore bivariate correlations were used to explore any existing relationships between couples and technology use.

Participants

Fifty-nine individuals volunteered to participate and completed the 10- to 15-minute questionnaire. Of these 59 volunteers only 42 participants (21 couples) were included in the analysis. The remaining participants were excluded because they did not provide a matching code name, or because their partners did not complete the questionnaire. Participants were approached online via social and professional media—Facebook and email, as well as by word of mouth through acquaintances. Of the 42 participants, there were 21 males and 21 females in heterosexual relationships with ages ranging from 21 to 46 years ($M = 30.81$, $SD = 4.78$).

Procedure

The survey questions were devised and powered through Qualtrics online survey software. The first section of the questionnaire contained questions relating to individual demographics such as year of birth, gender, work status, and relationship status. The second section included questions regarding "agreement" within the relationship on a 7-point Likert-type scale, for example, "Thinking about your relationship with your partner, how often do you agree or disagree on the amount of time spent together?" The following questions about the nature of the relationship, feelings about the relationship, and relationship satisfaction were on a 5-point Likert scale. The third section targeted personal technology use as well as perceptions of partner usage, for example, "Which of the following does your partner use?" The final section of the questionnaire included questions relating to technology use while in the presence of one another, such as, "When using technology together such as watching television, how often do you interact and engage with your partner at the same time?"

A Facebook page with the name "Couple Relationships and Technology Use" was created to provide information about the study, where volunteers were invited to complete the survey (see https://www.facebook.com/CoupleRelationshipsAndTechnologyUse). Once they agreed to participate in the study, participants were sent a URL link to their individual email accounts. The URL was linked directly to the questionnaire, which consisted of 36 items (not including subsections). Individuals completed the questionnaire via two separate links to ensure that both partners participated. The survey was completed online in the participants' own time. Respondents were de-identified by entering a code name that replicated their partner's code name, being any number from 1 to 99 followed by any letter in the alphabet. To avoid double-ups in code names, two other questions were asked in order to link the couples. These questions were, "What is the date that you celebrate or acknowledge as your anniversary?" and "How long have you been with your partner?"

After completion of the questionnaire, participants were sent a debriefing sheet containing a note of thanks, information about the study, and a list of support services.

Design

Bivariate correlations were used in the data analysis to report the relationship between technology use and couple relationships. The fourteen dependent measures were Relationship Agreement, Relationship Perception, Engage/Interact while using technology (Engage/Interact TV, MOB, COMP, LAP), using technology separately while being physically together with partner (UseTogSep TV, MOB, COMP, LAP), and Feeling Close with partner while using technology (Feel Close TV, MOB, COMP, LAP).

Results

Frequencies

Length of relationship. Couples reported being in their relationship for a number of years ranging from 1 to 11 years (M = 6.29, SD = 3.03). A majority of participants (23%) had been in their relationship for 2 to 3 years at the time of completing the questionnaire, and a minimum of participants (2%) had been in a relationship for 4 to 5 years.

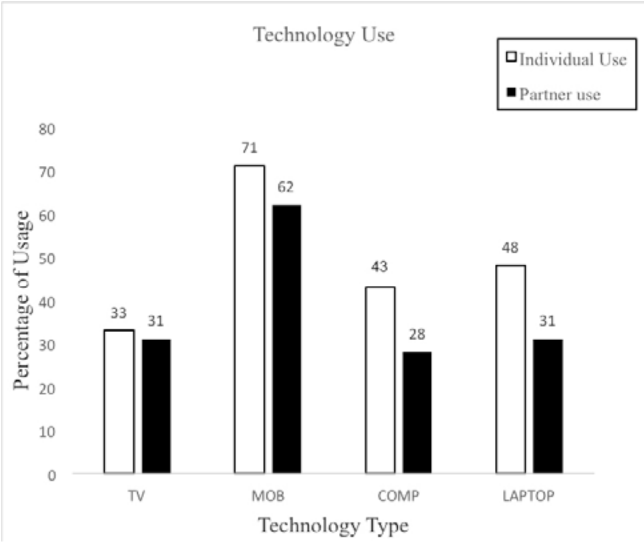

Figure 1. Frequency of technology use, comparing individuals' frequency of use of television (TV), mobile (MOB), computer (COMP) and laptop (LAPTOP) and perceptions of their partner's use. (See Frequency Table, Appendix C, for validated percentage data.)

Technology use. Figure 1 compares individuals' frequency of technology use and their perception of their partner's use of technology. As the figure shows, the participants' reports of individual TV usage coincided closely with how their partner perceived their TV usage. On the other hand, individual computer use and their partner's perception of their use of computers differed considerably; the differences for mobile phones and laptops between individual use and perceptions of use were not as great. Participants reported mobile phones as their main modality of technology compared to TV, computer, or laptop usage.

Correlational Analysis

Correlational analysis was used in this study. Prior to conducting the correlations, the data were screened for outliers and normality by visually inspecting z-scores and conducting a Shipiro–Wilk Test of normality. The normality assumption was met (see Appendix C).

Descriptive. Data revealed that 72 individuals began the questionnaire and 59 completed all the questions. If an individual completed the questionnaire but their partner did not, their data were excluded due to the need for a complete data set from both partners in this study. In the end, a sample of 42 participants (N = 42) was retained for analysis. Table 1 depicts the means and standard deviations for the variables used in the study.

Table 1

Descriptive Table for Variables: Means and Standard Deviations

Relationship	n	Mean	S.D.	Skewness	Kurtosis
Partner agreement	42	5.95	.533	-.49	.64
Relationship Perception	42	4.17	.35	-.31	-.66
Engage/Interact TV	41	3.68	.72	-.27	.08
Engage/Interact MOB	41	3.12	.87	-.01	.00
Engage/Interact COMP	40	2.98	1.09	-.19	-.32
Engage/Interact LAP	40	3.03	.95	-.24	.31
UseSepTog TV	41	2.34	.94	.39	.28
UseSepTog MOB	42	2.71	.74	-.60	.46
UseSepTog COMP	41	1.95	.95	.66	-.51
UseSepTog LAP	41	2.24	.86	.24	-.49
Feel close TV	41	3.98	.69	-.45	.68
Feel close MOB	41	2.76	.99	.68	.12
Feel close COMP	39	2.56	1.07	.43	-.22
Feel close LAP	39	2.82	1.05	.52	-.43

S.D. = Standard Deviation

Reliability analysis. A reliability analysis was conducted to determine whether items fit together (capturing the essence of measured construct) within each variable. Table 2 illustrates the reliability values.

Table 2

Reliability Values (Cronbach's Alpha)

Subscale	n	Cronbach's Alpha Coefficient
Relationship Agreement	42	.813
Relationship Satisfaction	42	.715
Relationship Feelings	42	.777
Relationship Perception	42	.781

For the variable Relationship Agreement, Cronbach's alpha analysis revealed a high reliability score (α = .813). For the Relationship Satisfaction variable, the first item (confide in partner) was removed due to its impact on the alpha score. Removing item one increased the alpha level (α = .715). For the Relationship Feelings variable, reverse scoring was required for one question ("How often do you feel challenged negatively by your partner?"). With nine items, reliability was low (α = .578); however, the alpha level was increased when two questions were removed (financially dependent on partner, and vulnerable with your partner) as outcomes of these items were ambiguous in interpretation. Removing these items increased reliability (α = .777).

The Relationship Perception variable was created when Relationship Feelings and Relationship Satisfaction were merged. Merging these variables yielded high reliability (α = .781).

Although Relationship Agreement yielded high reliability, items with Relationship Feelings and Relationship Satisfaction were not combined as the scales differed.

The correlations demonstrated in Table 3 revealed significant correlations between technology use and couple relationships.

Table 3

Correlations for Technology Use and Couple Relationships

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Partner agreement	-													
2. Relationship Perception	.560**	-												
3. UseSepTog TV	-.117	.137	-											
4. UseSepTog MOB	-.205	.106	.435**	-										
5. UseSepTog COMP	-.021	-.017	.300	.397*	-									
6. UseSepTog LAP	-.137	-.394*	.429**	.463**	.415**	-								
7. Engage/Interact TV	.366*	.633**	.245	.143	.075	-.196	-							
8. Engage/Interact MOB	.331*	.360*	.038	.020	.014	-.103	.429**	-						
9. Engage/Interact COMP	.302	.498**	.187	.022	.263	-.189	.437**	.536**	-					
10. Engage/Interact LAP	.342*	.426**	.085	-.071	-.057	-.036	.353*	.828**	.665**	-				
11. Feel Close TV	.430**	.515**	.237	-.008	.233	-.147	.336*	.203	.429**	.193	-			
12. Feel Close MOB	.289	.357*	-.205	-.155	-.114	-.242	.088	.583**	.403*	.560**	.420**	-		
13. Feel Close COMP	.376*	.370*	-.215	-.273	.197	-.265	.066	.250	.536**	.406*	.507**	.727**	-	
14. Feel Close LAP	.341*	.308	-.038	-.311	-.141	-.258	.127	.413**	.281	.526**	.464**	.716**	.597**	-

** Correlation is significant at the 0.01 level (2 tailed)

* Correlation is significant at the 0.05 level (2 tailed)

UseSepTog variable. A moderate negative relationship between UseSepTog LAP with Relationship Perception was significant, r (41) = -.39, p < .05. This suggests that using the laptop separately while in the presence of a partner is associated with a negative perception of the relationship. Conversely, a moderate positive relationship between Feel Close LAP and Relationship Agreement was significant, r (40) = .34, p = .05. This suggests that couples tend to feel close with their partners during laptop usage when there are also agreements within the relationship.

Engage/Interact variable. There were several positive correlations between technology use while engaging and interacting between couples and perception of their relationship. A moderate-strong positive relationship between Engage/Interact TV with Relationship Perception was significant, r (41) = .63, p < .01. This suggests that engaging and interacting with a partner while watching TV is positively associated with one's perception of the relationship.

Feel Close variable. Several positive correlations were found between feeling close in the relationship and perception of the relationship. A moderate-strong positive relationship between Feel Close TV and Relationship Perception was significant, r (41) = .52, p < .01. This suggests that couples feel close to their partners while watching TV, which impacts on their positive perception of the relationship.

Discussion

The aim of this study was to examine the impact of technology use on couple relationships. It was hypothesized that using technology without engaging/interacting with a partner negatively impacts relationship satisfaction. Results from this study found that laptop use while in the presence of a partner without engaging/interacting is linked to negative perceptions of the relationship. The negative impact was not demonstrated for computer, TV, or mobile phone use. From a neuropsychological view, individuals experience a decrease in their sense of control when their partner uses a laptop in their presence without interaction. The decrease in the sense of control up-regulates the limbic system (emotional area of the brain) which detects potential compromise or violation of the individual's safety and need for attachment and control. The up-regulation of the limbic system leads to activation of the hypothalamus-pituitary-adrenal system (HPA), which facilitates the production and release of the stress hormone cortisol (Rossouw, 2012b). Cortisol triggers a feedback loop to the hypothalamus, which then down-regulates the stress response. However, continual cortisol release leads to hypercortisolemia, a process involving the destruction of glia and neurons (Rossouw, 2012b). Damage to neural areas can lead to a variety of chronic conditions such as depression and anxiety, which in turn could lead to conflict within relationships triggered by technology use. If one partner in a relationship disengages from a face-to-face interaction while engaging in technology (i.e., the laptop), the other partner may experience a sense of threat to their need to feel attached and in control in that relationship. Therefore couple satisfaction and positive perceptions about the relationship may be compromised, leading to uncontrollable incongruence. Although it was postulated that a decrease in one's sense of control would be apparent in mobile phone use, this phenomenon was found in laptops rather than mobile phones. Possible explanations for the difference of impact between laptop use and mobile phone use is yet to be explored.

Research has suggested that problematic phone use leads to blurred boundaries within relationships. However, the results from this study do not provide support for a negative impact of mobile phone use on couple relationships. Contrary to this result, Kross et al. (2013) found that mobile phone use, particularly for accessing Facebook social media, leads to a decline in life satisfaction. Further research to explore these alternative findings in the area of mobile phone and laptop use and couple satisfaction could be conducted in the future by using a larger sample size than was used in this study. It may be that a mobile phone is quickly accessible and therefore is used frequently but in shorter time periods, whereas a laptop may be used for individual purposes infrequently but in longer time periods. The computer or TV are also larger devices that tend to involve and fill a shared space (i.e., lounge room). Therefore the likelihood of couples engaging/interacting with each other while using these modalities is greater than while using a laptop or mobile phone.

It was also hypothesized that if a couple uses technology together while interacting with each other, there will be a positive impact on relationship satisfaction. The current study found that using all forms of technology while engaging and interacting with one another is related to positive perceptions of the relationship. This was found most particularly for TV. Watching TV together with a partner while engaging and interacting was linked to positive perceptions of the relationship. However, watching TV separately from a partner was not linked to either positive or negative perceptions of the relationship. Lang and

Jarvenpaa (2005) indicated that individuals develop their own coping strategies to manage conflict situations caused by technology. Thus, individuals are constantly altering, accommodating, and adjusting social relations in response to the increasing use of technology. This finding coincides with the neuropsychological view of controllable versus uncontrollable incongruence. If couples are managing technology use together, they are enhancing a sense of control within their relationship leading to controllable incongruence. If a sense of control is not achieved (i.e., partners are not managing or agreeing on the type or frequency of technology use) we may see conflict within a relationship, which results from uncontrollable incongruence. It seems that TV is the main mode of technology shared between couples. Even though couples use this form of technology apart from each other as well as together, this does not seem to impact on the relationship. This study found that engaging/interacting while watching TV enhances a sense of safety in couples. From a neuropsychological perspective, an individual's attachment need is being met when couples engage with one another while watching TV. In this case, the limbic areas in the brain are not activated, hence not producing the stress hormone cortisol, leading to a sense of safety, well-being, and effective neural sprouting (Rossouw, 2012b). This leads to the development of positive neural pathways that enhance approach patterns related to well-being. The results from this study have demonstrated that couples are more likely to develop helpful neuronal patterns while watching TV together and interacting than when using laptops together and not interacting. Moreover, watching TV together while interacting is more likely to lead to approach patterns rather than avoid patterns in brain development. It appears that TV is the mode of technology that supports controllable incongruence between couples, whereas laptop use seems to be associated with creating distance between couples, leading to uncontrollable incongruence.

Finally, it was hypothesized that mobile phone usage may be the mode of technology that has the most impact on relationship satisfaction compared to other modes of technology. Unlike computers or laptops, the mobile phone is rarely separated from its owner (Lang & Jarvenpaa, 2005). One study from Finland, carried out in 2001, found that mobile phone use was extensive in a sample of 3,485 adolescents, aged 14 to 16 years (Leena, Tomi, & Arja, 2004). The researchers found that 89% of respondents used mobile phones with 13% using them for at least one hour daily. They compared mobile phone use with health/lifestyle variables, such as smoking and alcohol use, to explore the association between mobile phone use and well-being, and found that the intensity of mobile phone use was positively associated with health-compromising behaviors. In contrast to this finding by Leena et al., while the participants in this current study reported that mobile phone use was their main modality of technology use (71%), this study did not find a negative connection between mobile phone use and relationship perception. In fact, when a mobile phone was used while engaging and interacting with a partner, there was a positive link with relationship perception. Therefore, if a couple has a positive perception of their relationship, they are also likely to engage/interact positively with their partner while using mobile phones. Previously, Hertlein (2012) indicated that technology introduces a process of separation and distraction. Although the findings from this study do not support this view, Hertlein and Blumer (2013) explained that couples are not always aware of the subtle changes in their relationship due to technology use. Future studies might aim to use a larger sample size to examine this phenomenon and measure participants in a longitudinal study in order to explore changes within the relationship in the context of mobile phone use.

Couples' reports of personal TV use matched closely to their partner's perception of their TV use. On the other hand, their reports of computer use did not match closely to their partner's perception of their computer use. It may be that computer use has declined with the increasing accessibility of laptops or mobile phones leading to individuals not being aware of the actual frequency of use. Other possibilities for differences in reporting may be that couples do not tend to use computers together as often as TV. The gap between personal and partner computer use may suggest that computers create a divide between couples compared to other forms of technology. If laptops were not available, we could see an increase in reports regarding computer use in the home environment, possibly leading to a more accurate measure of personal use and perception of partner computer use. On the other hand, the similarity of couples' reports of individual and partner TV use suggests that couples are more aware of each other's use. Based on these findings, TV is the mode of technology that specifically seems to enhance couple connection rather than create a divide.

Verbal feedback from participants was voluntarily provided after the completion of the questionnaires. Various participants reported that they acknowledged the intensity of technology use in their external environment, especially in their relationships. One participant disclosed that the questionnaire generated thought and discussion between her and her partner regarding the quality of their relationship. Another participant explained that she and her partner have rules surrounding technology use, such as a "technology-free" bedroom space. Interestingly, another participant acknowledged that she only realized *after* completing the questionnaire that there had been an issue regarding mobile phone use in the relationship. As a result, she did not relay this in her responses in the questionnaire. This feedback suggests there is acknowledgment of technology having the potential to create separation and disconnection between couples. It also indicates that couples are finding ways to manage the increasing use of technology in their lives. From a neuropsychological point of view, couples working together to manage their technology use enhances a sense of safety, attachment, and controllable incongruence in their relationship. Technology use within a relationship without engaging or connecting, on the other hand, particularly with laptop use, may create uncontrollable incongruence, where a sense of control over the external environment is compromised. In order to enhance a sense of control leading to controllable incongruence, couples find ways together to manage their use of technology, such as watching programs separately on TV in their own times, or creating technology-free zones within their physical space.

Relevance of the study

The increasing accessibility and use of technology implies greater choice and control over social connections than previously (Spears & Lea, 1994). However, the sense of safety and control can be compromised if the use of technology is not successfully managed within couple relationships. Couples faced with conflict due to the use of technology could benefit from support and intervention that encourages controllable incongruence. The brain is a dynamic and plastic entity that continues to grow, develop, and change in response to the external environment. Therefore, the development of avoid patterns can be altered, re-directed, and changed towards approach patterns in the brain. Conflict within relationships due to compromises in safety, attachment, and control can be altered by couples reflecting on the use of technology and its impact on their relationships. If couples are aware of their current technology use and the impact it has on their relationship, then they can consciously make changes, and manage and monitor their use to enhance the sense of controllable incongruence.

Couples can also participate in modes of technology that enhance connections between partners—using technology together rather than apart, for example—and using forms of technology that provide entertainment or interaction, such as TV or interactive virtual games. Technology may be used to enhance the quality of life for couples, as it can provide closer connection while couples are apart and also provide a means to organizing and managing daily life (Campbell & Ling, 2009). Future studies relating to technology use and couple relationships could encourage self-reflection in relationships in order to establish change if necessary. Hertlein (2012) indicated that the subtle influences of technology use could go undetected by couples. Therefore, intervention involving psychoeducation and programs assisting individuals to monitor and reflect on their technology use could provide a sense of safety, control, and attachment within their relationships.

Limitations of the study and future recommendations

Future research could benefit from exploring how couples manage technology use within their relationship and provide further insight into how individuals can enhance control and attain controllable incongruence. Longitudinal studies using large sample sizes could assist researchers to explore subtle changes in relationships due to technology use. This current study only provided data for heterosexual relationships and did not focus on factors relating to culture, gender, or socioeconomic status. Future studies could aim to explore cultural differences, gender differences, and same-sex relationships in the general population. Questions remain as to how separate laptop use is connected with negative perceptions of the relationship whereas TV, computer, and mobile phone use shows differing results. Contrary to some researcher suggestions, mobile phone use was not linked to negative or positive perceptions of a relationship when used in the presence of a partner without engagement. It is possible that the sample size used within this study did not allow for adequate exploration of mobile phone use and couple relationships in the general population. The variables used in this study (relationship agreement and relationship perception) could not be combined due to differing scale sizes: one variable being on a 7-point Likert-type scale and the other on a 5-point Likert scale. Using the same scales across variables may provide a more robust measure of couple satisfaction and hence decrease the chance of biased/leading questioning within surveys. Future research could also explore the specific characteristics of different forms of technology (i.e., TV, mobile, computer and laptop) and how they fit into the external environment in ways that enhance or hinder couple relationships. Future research might also include neurobiological markers as a variable using saliva to measure cortisol levels. This could provide neurobiological information on the impact of technology use on stress levels within couple relationships.

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Appendix A
Questionnaire

WELCOME TO THE COUPLE RELATIONSHIPS AND TECHNOLOGY QUESTIONNAIRE

Both you **AND** your partner will need to participate in this questionnaire in order for data to be collated.

You can complete the questionnaire at a different time or day to your partner. Simply click on the link when either one of you is ready to begin the questionnaire.

The questionnaire will take approximately 10-15 mins to complete.

Thank you for your participation in this study 'Couple Relationships and Technology Use'

Before Completing this survey, please choose a number between 1 -100 and a single letter of the alphabet (e.g. 26J). This will be your anonymous 'couple code' that both you and your partner will need to specify.

CODE NAME (your code name will be the same as your partners):

What is your Gender?

- ○ Male (1)
- ○ Female (2)
- ○ Inter-sex (3)

What year were you born?

How long have you been with your partner?

- ○ Click to write Choice 1 (1)
- ○ Click to write Choice 2 (2)
- ○ Click to write Choice 3 (3)
- ○ Click to write Choice 4 (4)
- ○ Click to write Choice 5 (5)
- ○ Click to write Choice 6 (6)
- ○ Click to write Choice 7 (7)
- ○ Click to write Choice 8 (8)
- ○ Click to write Choice 9 (9)
- ○ Click to write Choice 10 (10)

What is your occupation?

Do you work with your partner?

- ○ Yes (1)
- ○ No (2)

In terms of your relationship, how often would you agree on:

	Always disagree (1)	Almost always disagree (2)	Frequently disagree (3)	Occasionally disagree (4)	Almost always agree (5)	Always agree (6)
Amount of time spent together (1)						
Matters of recreation (2)						
Handling family/ relationship finances (3)						
Aims, goals, and things believed to be important (4)						
Making minor decisions (5)						
Making major decision (6)						
Household tasks (7)						
Leisure time interest and activities (8)						
Career decisions (9)						
Amount of time being intimate together (10)						

How often do you:

	Never (1)	Rarely (2)	Occasionally (3)	More often than not (4)	Most of the time (5)	All the time (6)
Confide in your partner (1)						
Have a quarrel with your partner (2)						
Show affection to your partner (3)						
Compliment your partner (4)						
Listen to your partner (5)						
Share ideas (6)						
Laugh together (7)						
Work on a project together (8)						
Feel too tired for sex (9)						

Do you feel:

	Never (1)	Rarely (2)	Occasionally (3)	More often than not (4)	Most of the time (5)	All the time (6)
Respected by your partner (1)						
Attractive to your partner (2)						
Attracted to your partner (3)						
Supported by your partner (4)						
You are in a 'team' with your partner (5)						
Challenged by your partner (6)						
Angry or frustrated with your partner (7)						
You want your relationship to improve (8)						
Satisfied with your sex life (9)						
Satisfied with the amount of time spent together (10)						
Satisfied with the communication between you and your partner (11)						
Your partner attends to you when you need (12)						
Your partner focuses on you when you are speaking (13)						
Listened and heard by your partner (14)						
Relaxed and calm with partner (15)						
Vulnerable with your partner (16)						
Satisfied with your relationship overall (17)						

The next section outlines your use of technology and how you perceive your partner's use of technology

Do you use technology everyday?

- ○ Yes (1)
- ○ No (2)

What do you mainly use the Internet for?

Which of the following do YOU use?

	Very Seldom (1)	Rarely (2)	Some times (3)	Often (4)	Very Often (5)
Television (1)					
Smart phone/ mobile phone (2)					
Computer (3)					
Laptop (4)					
Other (Please Specify) (5)					

When using your smart phone/mobile phone, on an average day how much time would YOU spend:

	0 - 30 mins (1)	30 mins - 1 hr (2)	1 hr - 2 hrs (3)	2 hrs - 3 hrs (4)	3 hrs - 4 hrs (5)	4 hrs- 5 hrs (6)	5 hrs - and over (7)
Talking (1)							
Tex-ting (2)							
Browsing the Internet (3)							
Being on face-book (4)							
Other (please specify) (5)							

In general, how quickly do you respond to your phone?

- ○ Immediately (1)
- ○ As soon as possible (2)
- ○ At dedicated times (3)
- ○ Every few days (4)
- ○ Hardly ever (5)

In general, how quickly do you respond to your emails?

- ○ Immediately (1)
- ○ As soon as possible (2)
- ○ At dedicated times (3)
- ○ Every few days (4)
- ○ Hardly ever (5)

Which of the following does YOUR PARTNER use?

	Very Seldom (1)	Rarely (2)	Some times (3)	Often (4)	Very Often (5)
Television (1)					
Smart phone/ mobile phone (2)					
Computer (3)					
Laptop (4)					
Other (Please specify) (5)					

When using a smart phone/mobile phone, on an average day how much time do you believe YOUR PARTNER spends:

	0 - 30 mins (1)	30 mins - 1 hr (2)	1 hr - 2 hrs (3)	2 hrs - 3 hrs (4)	3 hrs - 4 hrs (5)	4 hrs- 5 hrs (6)	5 hrs - and over (7)
Talking (1)							
Tex-ting (2)							
Browsing the Internet (3)							
Being on face-book (4)							
Other (please specify) (5)							

In general, how quickly do you believe YOUR PARTNER responds to their phone?

- Immediately (1)
- As soon as possible (2)
- At dedicated times (3)
- Every few days (4)
- Hardly ever (5)

In general, how quickly do you believe YOUR PARTNER responds to their emails?

- Immediately (1)
- As soon as possible (2)
- At dedicated times (3)
- Every few days (4)
- Hardly ever (5)

On an average day, how many hours would you spend using the following FOR WORK purposes?

	0-30 mins (1)	30 mins - 1 hr (2)	1 - 2 hrs (3)	2-3 hrs (4)	3 -4 hrs (5)	5 hrs - and over (6)
Television (1)						
Smart phone/ mobile phone (2)						
Computer (3)						
Laptop (4)						
Other (please specify) (5)						

On an average day, how many hours would you spend using the following NOT FOR WORK purposes?

	0 - 30 mins (1)	30 mins - 1 hr (2)	1 - 2 hrs (3)	2 -3 hrs (4)	3 - 4 hrs (5)	5 hrs - and over (6)
Television (1)						
Smart phone/ mobile phone (2)						
Computer (3)						
Laptop (4)						
Other (Please specify) (5)						

On an average day, how many hours do you notice YOUR PARTNER using the following FOR WORK purposes?

	0 - 30 mins (1)	30 mins - 1 hr (2)	1 - 2 hrs (3)	2 - 3 hrs (4)	3 - 4 hrs (5)	5 hrs - and over (6)
Television (1)						
Smart phone/ mobile phone (2)						
Computer (3)						
Laptop (4)						
Other (Please Specify) (5)						

On an average day, how many hours do you notice YOUR PARTNER using the following NOT FOR WORK purposes?

	0 - 30 mins (1)	30 mins - 1 hr (2)	1 - 2 hrs (3)	2 - 3 hrs (4)	3 -4 hrs (5)	5 hrs - and over (6)
Television (1)						
Smart phone/ mobile phone (2)						
Computer (3)						
Laptop (4)						
Other (Please Specify) (5)						

What is it like for you using technology while being in the presence of your partner?

	I tend to be uncomfortable (1)	I am somewhat uncomfortable with it (2)	I am okay with it (3)	I am somewhat comfortable with it (4)	I tend to be comfortable with it (5)
Television (1)					
Smart phone/ mobile phone (2)					
Computer (3)					
Laptop (4)					
Other (Please Specify) (5)					

What is it like for you when YOUR PARTNER uses technology while in your presence?

	I tend to be uncomfortable (1)	I am somewhat uncomfortable with it (2)	I am okay with it (3)	I am somewhat comfortable with it (4)	I tend to be comfortable with it (5)
Television (1)					
Smart phone/ mobile phone (2)					
Computer (3)					
Laptop (4)					
Other (Please Specify) (5)					

How often do you use technology WITH your partner (e.g. watching television together, reading emails together etc)?

	Never (1)	Not usually (2)	Sometimes (3)	Most of the time (4)	Always (5)
Television (1)					
Smart phone/ mobile phone (2)					
Computer (3)					
Laptop (4)					
Other (Please Specify) (5)					

When using technology together such as watching television, do you interact and engage with your partner?

	Never (1)	Not usually (2)	Sometimes (3)	Most of the time (4)	Always (5)
Television (1)					
Smart phone/ mobile phone (2)					
Computer (3)					
Laptop (4)					
Other (Please Specify) (5)					

To what extent do you feel close to your partner while engaging in technology (e.g. watching television while holding hands, sitting close, sharing an idea, and/or showing affection)?

	I never feel close (1)	I don't usually feel close (2)	I sometimes feel close (3)	I feel close (4)	I feel very close (5)
Television (1)					
Smart phone/ mobile phone (2)					
Computer (3)					
Laptop (4)					
Other (Please Specify) (5)					

How often do you use technology separately from your partner while being physically together with your partner (e.g. reading text messages while eating dinner, watching television while in the middle of a discussion)?

	Never (1)	Not usually (2)	Sometimes (3)	Most of the time (4)	Always (5)
Television (1)					
Smart phone/ mobile phone (2)					
Computer (3)					
Laptop (4)					
Other (Please Specify) (5)					

Appendix B

Debrief and Information Sheet

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

School of Psychology

Thank you for your Participation

Thank you for your participation in this study. Your participation in this study is valuable in exploring the dynamics within current couple relationships. Information from this study can assist with helping individuals to explore and improve on their relationships with their partners. Your input also assists the researcher to further explore how technology use can enhance or hinder the quality of relationships

If you are interested in the final research findings, you can contact the researcher Christina Nguyen at Christina.nguyen@uq.net.au.

Should there be any concerns, discomfort, or questions arising from the completion of this questionnaire, please contact the researcher, or refer to the list of support services. You are encouraged to access any of the services if there is a raised concern that you wish to address.

Relationships Australia: www.relationships.org.au

Headspace: www.headspace.org.au

Lifeline: www.lifeline.org.au 13 11 14

UQ counselling support: ss@uq.edu.au (07) 3365 1702 (Only available if you are a student at UQ)

Kids Helpline: www.kidshelp.com.au 1800 55 1800

Parentline: www.parentline.com.au 1300 30 1300

Many thanks for your participation in this study

Christina Nguyen
UQ student researcher

Appendix C
SPSS Syntax and Outputs

SYNTAX

*** Frequencies for length of relationship and technology use of self and partner.**

```
DATASET ACTIVATE DataSet1.
FREQUENCIES VARIABLES=length_relationship tech_typeU_tv tech_typeU_mob tech_typeU_comp
    tech_typeU_lap tech_typeP_tv tech_typeP_mob tech_typeP_comp tech_typeP_lap
  /NTILES=4
    /STATISTICS=STDDEV VARIANCE RANGE MINIMUM MAXIMUM SEMEAN MEAN MEDIAN
MODE SUM SKEWNESS SESKEW
    KURTOSIS SEKURT
  /ORDER=ANALYSIS.
```

*** Test for Normality**

```
EXAMINE VARIABLES=PartnerAgree RelationPercept Use_interact_tv Use_interact_mob Use_interact_
comp
    Use_interact_lap feel_close_tv feel_close_mob feel_close_comp feel_close_lap use_sep_tog_tv
    use_sep_tog_mob use_sep_tog_comp use_sep_tog_lap
  /PLOT BOXPLOT NPPLOT
  /COMPARE GROUPS
  /STATISTICS DESCRIPTIVES
  /CINTERVAL 95
  /MISSING LISTWISE
  /NOTOTAL.
```

***Descriptives/Frequencies for all 14 variables**

FREQUENCIES VARIABLES=length_relationship tech_typeU_tv tech_typeU_mob tech_typeU_comp
tech_typeU_lap tech_typeP_tv tech_typeP_mob tech_typeP_comp tech_typeP_lap
/NTILES=4
/STATISTICS=STDDEV VARIANCE RANGE MINIMUM MAXIMUM SEMEAN MEAN MEDIAN MODE SUM SKEWNESS SESKEW
KURTOSIS SEKURT
/ORDER=ANALYSIS.

***Correlations for all 14 variables**

CORRELATIONS
/VARIABLES=PartnerAgree RelationPercept Use_interact_tv Use_interact_mob Use_interact_comp
Use_interact_lap feel_close_tv feel_close_mob feel_close_comp feel_close_lap use_sep_tog_tv
use_sep_tog_mob use_sep_tog_comp use_sep_tog_lap
/PRINT=TWOTAIL NOSIG
/STATISTICS DESCRIPTIVES
/MISSING=PAIRWISE.

OUTPUTS

Frequencies

[DataSet1] C:\Users\Stina\Desktop\Psychology\Thesis\Results and Stats\thesis working db v5.sav

Statistics

		How long have you been with your partner?	Which of the following do YOU use?-Television	Which of the following do YOU use?-Smart phone/mobile phone	Which of the following do YOU use?-Computer	Which of the following do YOU use?-Laptop/tablet	Which of the following does YOUR PARTNER use?-Television	Which of the following does YOUR PARTNER use?-Smart phone/mobile phone	Which of the following does YOUR PARTNER use?-Computer	Which of the following does YOUR PARTNER use?-Laptop/tablet
N	Valid	42	42	42	42	42	42	42	42	42
	Missing	0	0	0	0	0	0	0	0	0
Mean		6.29	3.36	4.69	3.79	3.90	3.14	4.43	3.38	3.69
Std. Error of Mean		.469	.198	.080	.203	.159	.203	.133	.196	.182
Median		6.00	4.00	5.00	4.00	4.00	3.00	5.00	3.50	4.00
Mode		3	4	5	5	4	4	5	3[a]	5
Std. Deviation		3.039	1.284	.517	1.317	1.031	1.317	.859	1.268	1.179
Variance		9.233	1.650	.268	1.733	1.064	1.735	.739	1.607	1.390
Skewness		.059	-.573	-1.398	-.728	-1.202	-.410	-1.462	-.473	-.576
Std. Error of Skewness		.365	.365	.365	.365	.365	.365	.365	.365	.365
Kurtosis		-1.201	-.574	1.078	-.661	1.507	-.868	1.391	-.620	-.510
Std. Error of Kurtosis		.717	.717	.717	.717	.717	.717	.717	.717	.717
Range		10	4	2	4	4	4	3	4	4
Minimum		1	1	3	1	1	1	2	1	1
Maximum		11	5	5	5	5	5	5	5	5
Sum		264	141	197	159	164	132	186	142	155
	25	3.00	3.00	4.00	3.00	3.75	2.00	4.00	3.00	3.00
	50	6.00	4.00	5.00	4.00	4.00	3.00	5.00	3.50	4.00
	75	9.00	4.00	5.00	5.00	5.00	4.00	5.00	4.00	5.00

a. Multiple modes exist. The smallest value is shown

Frequency Table

How long have you been with your partner?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-1 years	2	4.8	4.8	4.8
	2-3 years	10	23.8	23.8	28.6
	3-4 years	4	9.5	9.5	38.1
	4-5 years	1	2.4	2.4	40.5
	5-6 years	5	11.9	11.9	52.4
	6-7 years	2	4.8	4.8	57.1
	7-8 years	7	16.7	16.7	73.8
	8-9 years	5	11.9	11.9	85.7
	10 years or more	6	14.3	14.3	100.0
	Total	42	100.0	100.0	

Which of the following do YOU use?-Television

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Seldom	6	14.3	14.3	14.3
	Rarely	3	7.1	7.1	21.4
	Some times	11	26.2	26.2	47.6
	Often	14	33.3	33.3	81.0
	Very Often	8	19.0	19.0	100.0
	Total	42	100.0	100.0	

Which of the following do YOU use?-Smart phone/mobile phone

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Some times	1	2.4	2.4	2.4
	Often	11	26.2	26.2	28.6
	Very Often	30	71.4	71.4	100.0
	Total	42	100.0	100.0	

Which of the following do YOU use?-Computer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Seldom	3	7.1	7.1	7.1
	Rarely	5	11.9	11.9	19.0
	Some times	8	19.0	19.0	38.1
	Often	8	19.0	19.0	57.1
	Very Often	18	42.9	42.9	100.0
	Total	42	100.0	100.0	

Which of the following do YOU use?-Laptop/tablet

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Seldom	2	4.8	4.8	4.8
	Rarely	2	4.8	4.8	9.5
	Some times	6	14.3	14.3	23.8
	Often	20	47.6	47.6	71.4
	Very Often	12	28.6	28.6	100.0
	Total	42	100.0	100.0	

Which of the following does YOUR PARTNER use?-Television

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Seldom	8	19.0	19.0	19.0
	Rarely	3	7.1	7.1	26.2
	Some times	12	28.6	28.6	54.8
	Often	13	31.0	31.0	85.7
	Very Often	6	14.3	14.3	100.0
	Total	42	100.0	100.0	

Which of the following does YOUR PARTNER use?-Smart phone/mobile phone

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Rarely	2	4.8	4.8	4.8
	Some times	4	9.5	9.5	14.3
	Often	10	23.8	23.8	38.1
	Very Often	26	61.9	61.9	100.0
	Total	42	100.0	100.0	

Which of the following does YOUR PARTNER use?-Computer		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Seldom	5	11.9	11.9	11.9
	Rarely	4	9.5	9.5	21.4
	Some times	12	28.6	28.6	50.0
	Often	12	28.6	28.6	78.6
	Very Often	9	21.4	21.4	100.0
	Total	42	100.0	100.0	

Which of the following does YOUR PARTNER use?-Laptop/tablet		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Seldom	2	4.8	4.8	4.8
	Rarely	5	11.9	11.9	16.7
	Some times	10	23.8	23.8	40.5
	Often	12	28.6	28.6	69.0
	Very Often	13	31.0	31.0	100.0
	Total	42	100.0	100.0	

Explore

[DataSet1] C:\Users\Stina\Desktop\Psychology\Thesis\Results and Stats\thesis working db v5.sav

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Extent of agreement with partner (average of 10 "agreement" questions)	35	83.3%	7	16.7%	42	100.0%
Perception of relationship (mean of 16 relationship feel andrelationship sat questions)	35	83.3%	7	16.7%	42	100.0%
When using technology together such as watching television, how often do you interact and engage wit...-Television	35	83.3%	7	16.7%	42	100.0%
When using technology together such as watching television, how often do you interact and engage wit...-Smart phone/mobile phone	35	83.3%	7	16.7%	42	100.0%
When using technology together such as watching television, how often do you interact and engage wit...-Computer	35	83.3%	7	16.7%	42	100.0%
When using technology together such as watching television, how often do you interact and engage wit...-Laptop/tablet	35	83.3%	7	16.7%	42	100.0%
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Television	35	83.3%	7	16.7%	42	100.0%

To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Smart phone/mobile phone	35	83.3%	7	16.7%	42	100.0%
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Computer	35	83.3%	7	16.7%	42	100.0%
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Laptop/ tablet	35	83.3%	7	16.7%	42	100.0%
How often do you use technology separately from your partner while being physically together with yo...-Television	35	83.3%	7	16.7%	42	100.0%
How often do you use technology separately from your partner while being physically together with yo...-Smart phone/mobile phone	35	83.3%	7	16.7%	42	100.0%
How often do you use technology separately from your partner while being physically together with yo...-Computer	35	83.3%	7	16.7%	42	100.0%
How often do you use technology separately from your partner while being physically together with yo...-Laptop/tablet	35	83.3%	7	16.7%	42	100.0%

Descriptives

			Statistic	Std. Error
Extent of agreement with partner (average of 10 “agreement” questions)	Mean		5.9000	.09294
	95% Confidence Interval for Mean	Lower Bound	5.7111	
		Upper Bound	6.0889	
	5% Trimmed Mean		5.9135	
	Median		6.0000	
	Variance		.302	
	Std. Deviation		.54987	
	Minimum		4.40	
	Maximum		6.90	
	Range		2.50	
	Interquartile Range		.60	
	Skewness		-.428	.398
	Kurtosis		.544	.778
Perception of relationship (mean of 16 relationship feel andrelationship sat questions)	Mean		4.1214	.05882
	95% Confidence Interval for Mean	Lower Bound	4.0019	
		Upper Bound	4.2410	
	5% Trimmed Mean		4.1260	
	Median		4.1875	
	Variance		.121	
	Std. Deviation		.34797	
	Minimum		3.50	
	Maximum		4.69	
	Range		1.19	
	Interquartile Range		.56	
	Skewness		-.301	.398
	Kurtosis		-.934	.778

When using technology together such as watching television, how often do you interact and engage wit...-Television	Mean		3.60	.117
	95% Confidence Interval for Mean	Lower Bound	3.36	
		Upper Bound	3.84	
	5% Trimmed Mean		3.61	
	Median		4.00	
	Variance		.482	
	Std. Deviation		.695	
	Minimum		2	
	Maximum		5	
	Range		3	
	Interquartile Range		1	
	Skewness		-.380	.398
	Kurtosis		.160	.778
When using technology together such as watching television, how often do you interact and engage wit...-Smart phone/mobile phone	Mean		3.09	.144
	95% Confidence Interval for Mean	Lower Bound	2.79	
		Upper Bound	3.38	
	5% Trimmed Mean		3.10	
	Median		3.00	
	Variance		.728	
	Std. Deviation		.853	
	Minimum		1	
	Maximum		5	
	Range		4	
	Interquartile Range		1	
	Skewness		-.170	.398
	Kurtosis		-.033	.778
When using technology together such as watching television, how often do you interact and engage wit...-Computer	Mean		2.97	.176
	95% Confidence Interval for Mean	Lower Bound	2.61	
		Upper Bound	3.33	
	5% Trimmed Mean		2.97	
	Median		3.00	
	Variance		1.087	
	Std. Deviation		1.043	
	Minimum		1	
	Maximum		5	
	Range		4	
	Interquartile Range		2	
	Skewness		-.270	.398
	Kurtosis		-.088	.778
When using technology together such as watching television, how often do you interact and engage wit...-Laptop/tablet	Mean		3.09	.155
	95% Confidence Interval for Mean	Lower Bound	2.77	
		Upper Bound	3.40	
	5% Trimmed Mean		3.10	
	Median		3.00	
	Variance		.845	
	Std. Deviation		.919	
	Minimum		1	
	Maximum		5	
	Range		4	
	Interquartile Range		1	
	Skewness		-.177	.398
	Kurtosis		.509	.778
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Television	Mean		3.91	.119
	95% Confidence Interval for Mean	Lower Bound	3.67	
		Upper Bound	4.16	
	5% Trimmed Mean		3.94	
	Median		4.00	
	Variance		.492	
	Std. Deviation		.702	
	Minimum		2	
	Maximum		5	
	Range		3	
	Interquartile Range		0	
	Skewness		-.422	.398
	Kurtosis		.574	.778
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Smart phone/mobile phone	Mean		2.71	.167
	95% Confidence Interval for Mean	Lower Bound	2.38	
		Upper Bound	3.05	
	5% Trimmed Mean		2.68	
	Median		3.00	
	Variance		.975	
	Std. Deviation		.987	
	Minimum		1	
	Maximum		5	
	Range		4	
	Interquartile Range		1	
	Skewness		.623	.398
	Kurtosis		.022	.778

To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Computer	Mean		2.51	.166
	95% Confidence Interval for Mean	Lower Bound	2.18	
		Upper Bound	2.85	
	5% Trimmed Mean		2.48	
	Median		2.00	
	Variance		.963	
	Std. Deviation		.981	
	Minimum		1	
	Maximum		5	
	Range		4	
	Interquartile Range		1	
	Skewness		.354	.398
	Kurtosis		-.047	.778
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Laptop/tablet	Mean		2.77	.174
	95% Confidence Interval for Mean	Lower Bound	2.42	
		Upper Bound	3.13	
	5% Trimmed Mean		2.75	
	Median		3.00	
	Variance		1.064	
	Std. Deviation		1.031	
	Minimum		1	
	Maximum		5	
	Range		4	
	Interquartile Range		2	
	Skewness		.490	.398
	Kurtosis		-.484	.778
How often do you use technology separately from your partner while being physically together with yo...-Television	Mean		2.26	.166
	95% Confidence Interval for Mean	Lower Bound	1.92	
		Upper Bound	2.59	
	5% Trimmed Mean		2.20	
	Median		2.00	
	Variance		.961	
	Std. Deviation		.980	
	Minimum		1	
	Maximum		5	
	Range		4	
	Interquartile Range		1	
	Skewness		.635	.398
	Kurtosis		.443	.778
How often do you use technology separately from your partner while being physically together with yo...-Smart phone/mobile phone	Mean		2.71	.127
	95% Confidence Interval for Mean	Lower Bound	2.46	
		Upper Bound	2.97	
	5% Trimmed Mean		2.74	
	Median		3.00	
	Variance		.563	
	Std. Deviation		.750	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		1	
	Skewness		-.353	.398
	Kurtosis		.140	.778
How often do you use technology separately from your partner while being physically together with yo...-Computer	Mean		1.94	.164
	95% Confidence Interval for Mean	Lower Bound	1.61	
		Upper Bound	2.28	
	5% Trimmed Mean		1.88	
	Median		2.00	
	Variance		.938	
	Std. Deviation		.968	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		2	
	Skewness		.738	.398
	Kurtosis		-.400	.778
How often do you use technology separately from your partner while being physically together with yo...-Laptop/tablet	Mean		2.20	.147
	95% Confidence Interval for Mean	Lower Bound	1.90	
		Upper Bound	2.50	
	5% Trimmed Mean		2.17	
	Median		2.00	
	Variance		.753	
	Std. Deviation		.868	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		1	
	Skewness		.447	.398
	Kurtosis		-.232	.778

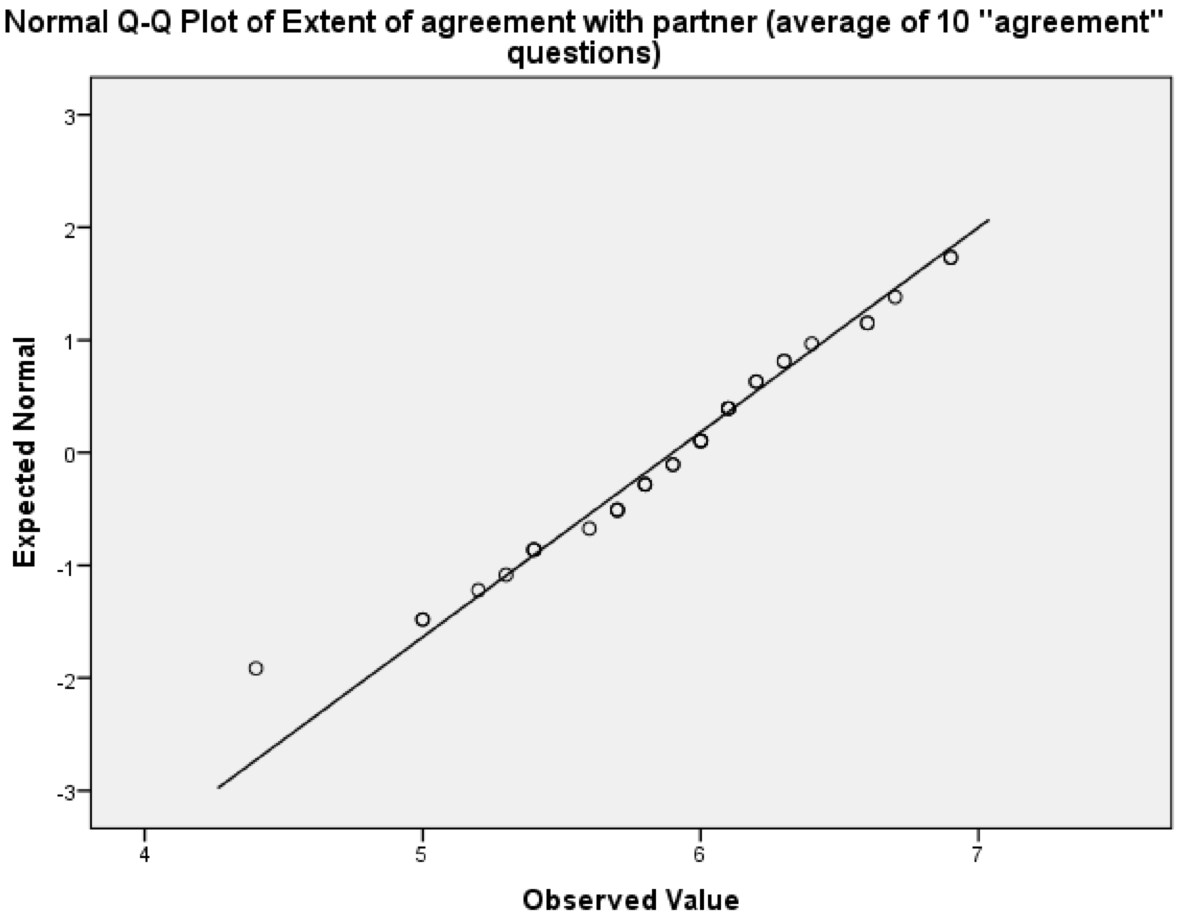
Tests of Normality

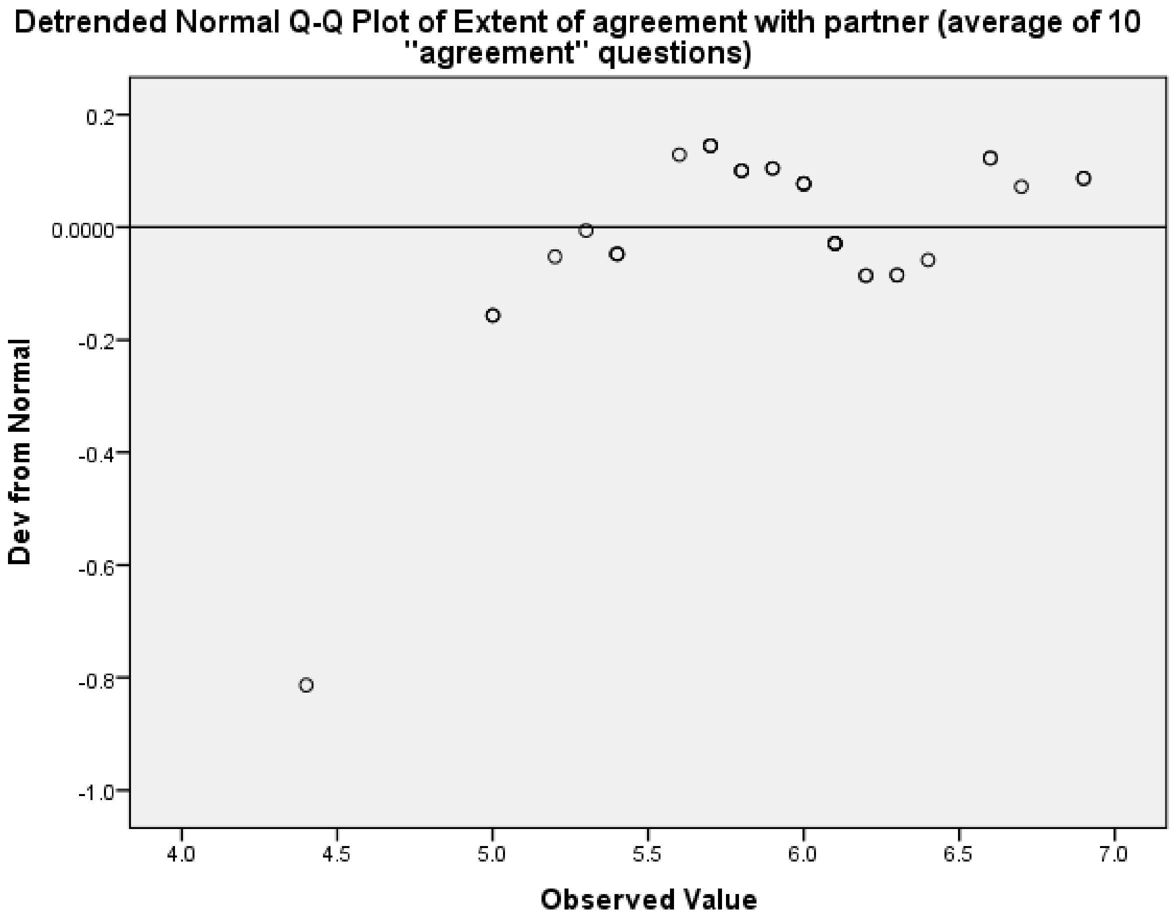
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Extent of agreement with partner (average of 10 "agreement" questions)	.101	35	.200*	.975	35	.610
Perception of relationship (mean of 16 relationship feel andrelationship sat questions)	.109	35	.200*	.949	35	.108
When using technology together such as watching television, how often do you interact and engage wit...-Television	.318	35	.000	.817	35	.000
When using technology together such as watching television, how often do you interact and engage wit...-Smart phone/mobile phone	.231	35	.000	.888	35	.002
When using technology together such as watching television, how often do you interact and engage wit...-Computer	.254	35	.000	.897	35	.003
When using technology together such as watching television, how often do you interact and engage wit...-Laptop/tablet	.263	35	.000	.886	35	.002
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Television	.320	35	.000	.816	35	.000
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Smart phone/mobile phone	.251	35	.000	.877	35	.001
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Computer	.214	35	.000	.902	35	.004
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Laptop/tablet	.258	35	.000	.881	35	.001
How often do you use technology separately from your partner while being physically together with yo...-Television	.232	35	.000	.879	35	.001

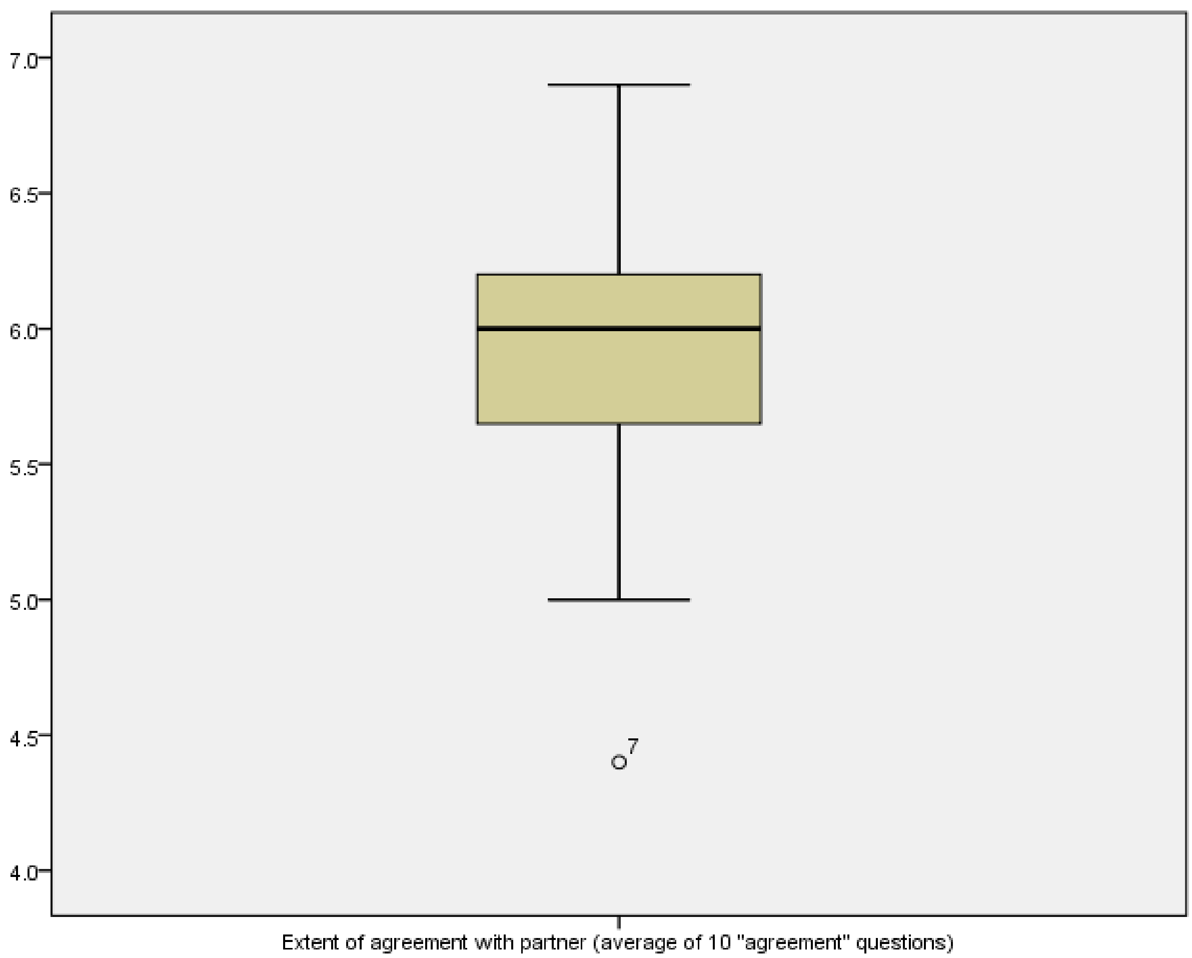
How often do you use technology separately from your partner while being physically together with yo...-Smart phone/mobile phone	.305	35	.000	.840	35	.000
How often do you use technology separately from your partner while being physically together with yo...-Computer	.235	35	.000	.825	35	.000
How often do you use technology separately from your partner while being physically together with yo...-Laptop/tablet	.277	35	.000	.860	35	.000

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

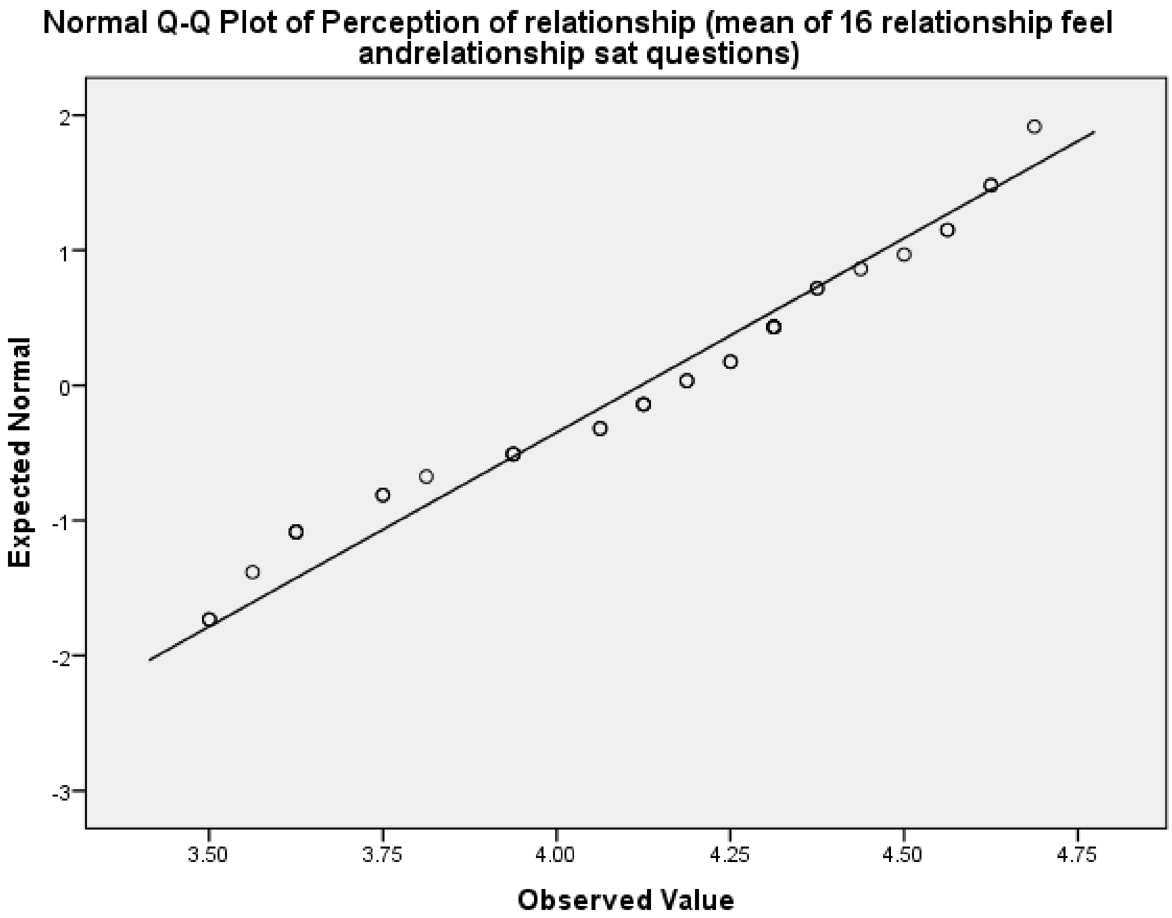
Extent of agreement with partner (average of 10 "agreement" questions)

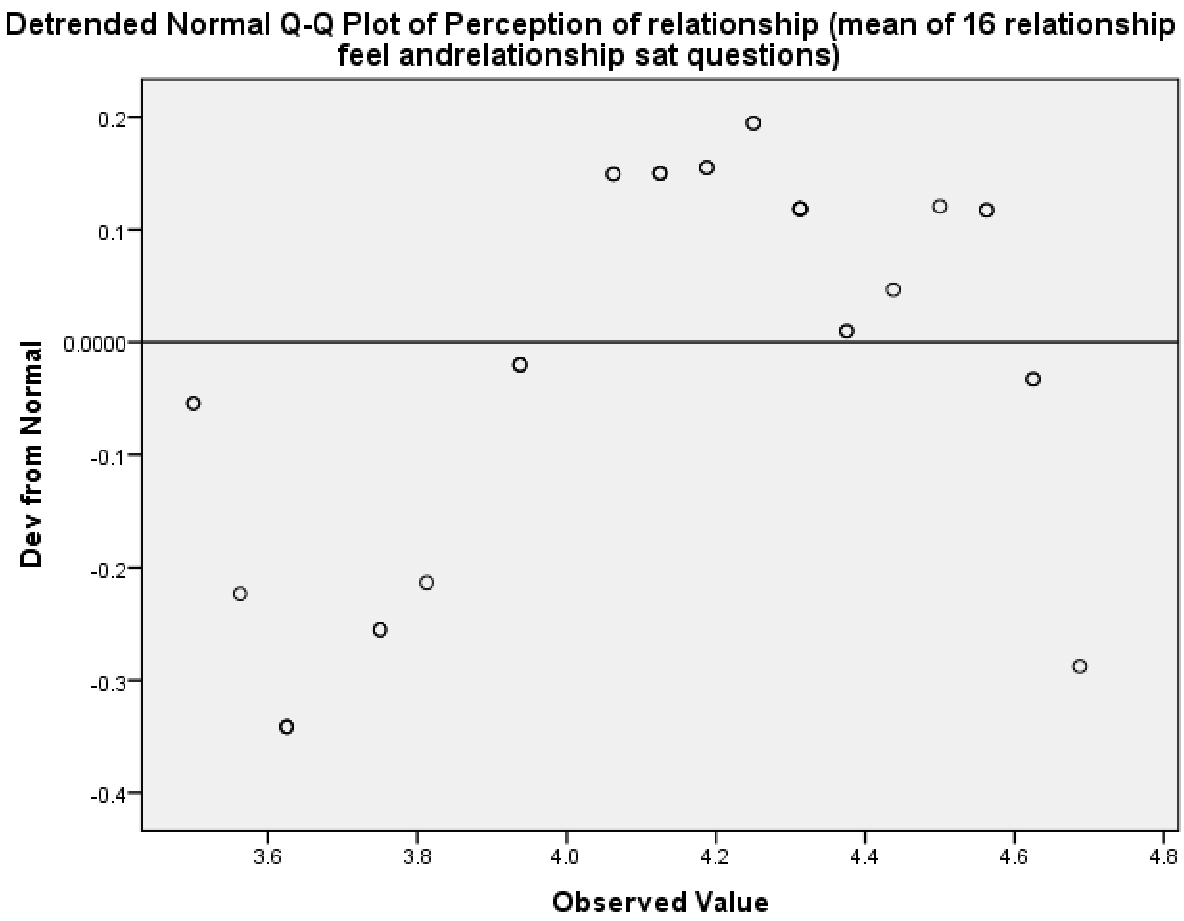


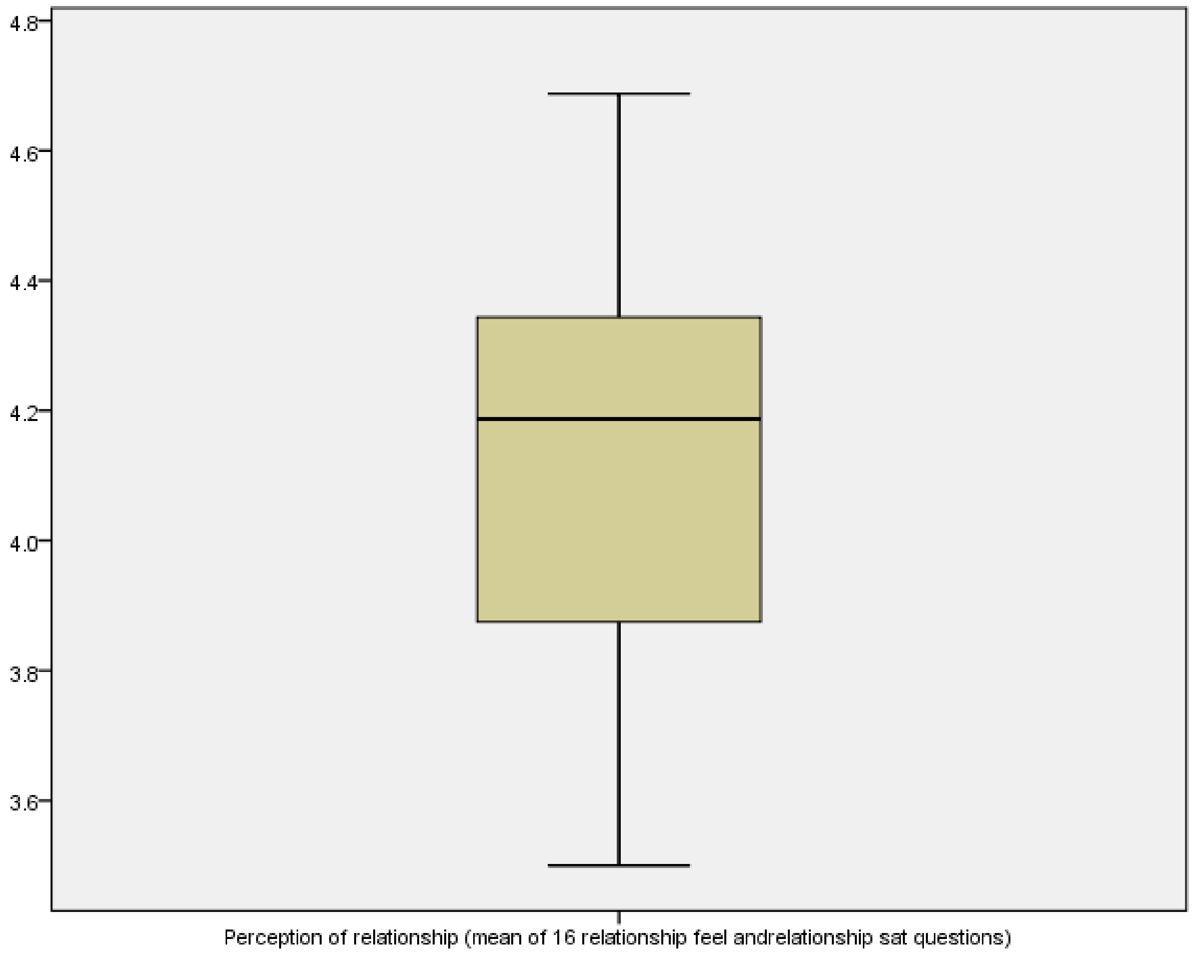

Detrended Normal Q-Q Plot of Extent of agreement with partner (average of 10 "agreement" questions)
Dev from Normal
0.2
0.0000
-0.2
-0.4
-0.6
-0.8
-1.0
4.0
4.5
5.0
5.5
6.0
6.5
7.0
Observed Value


7.0
6.5
6.0
5.5
5.0
4.5
4.0
7
Extent of agreement with partner (average of 10 "agreement" questions)

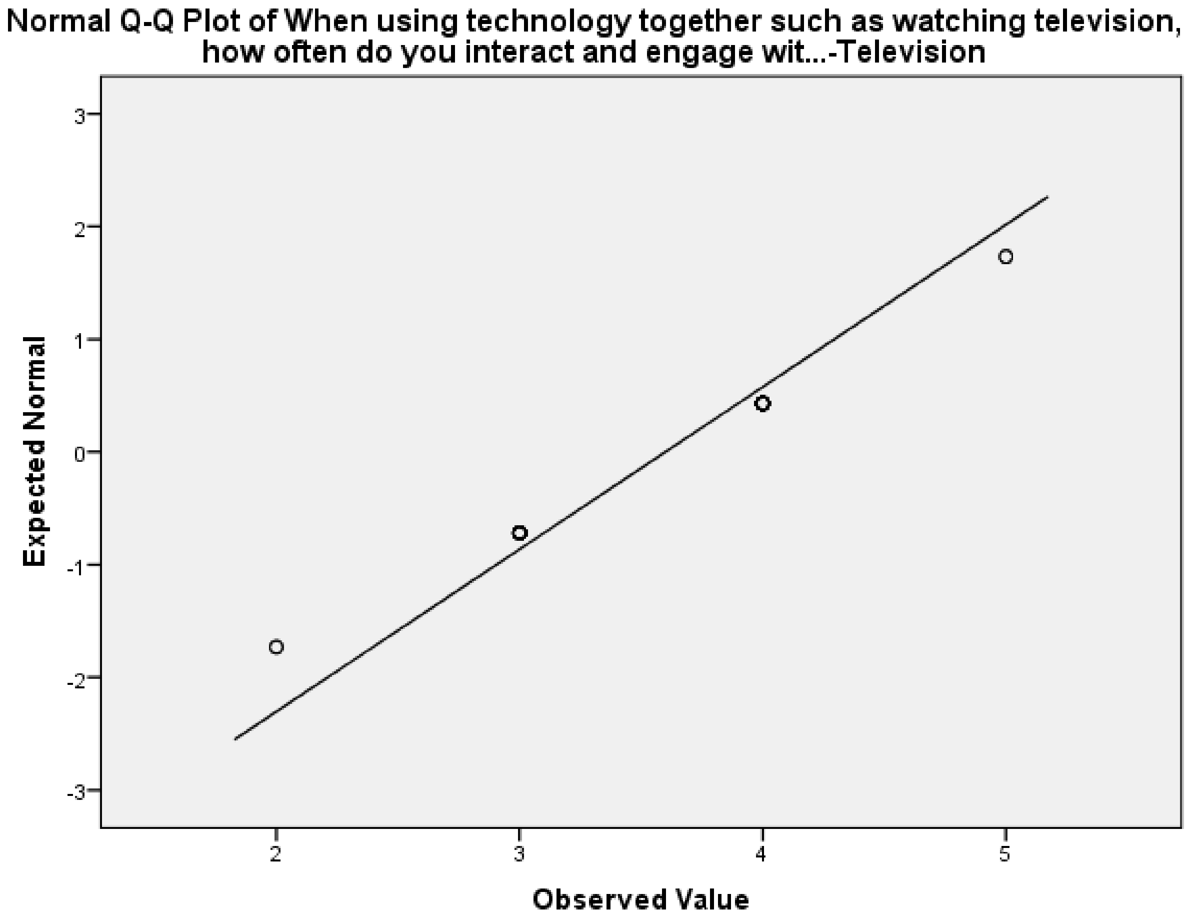
Perception of relationship (mean of 16 relationship feel andrelationship sat questions)

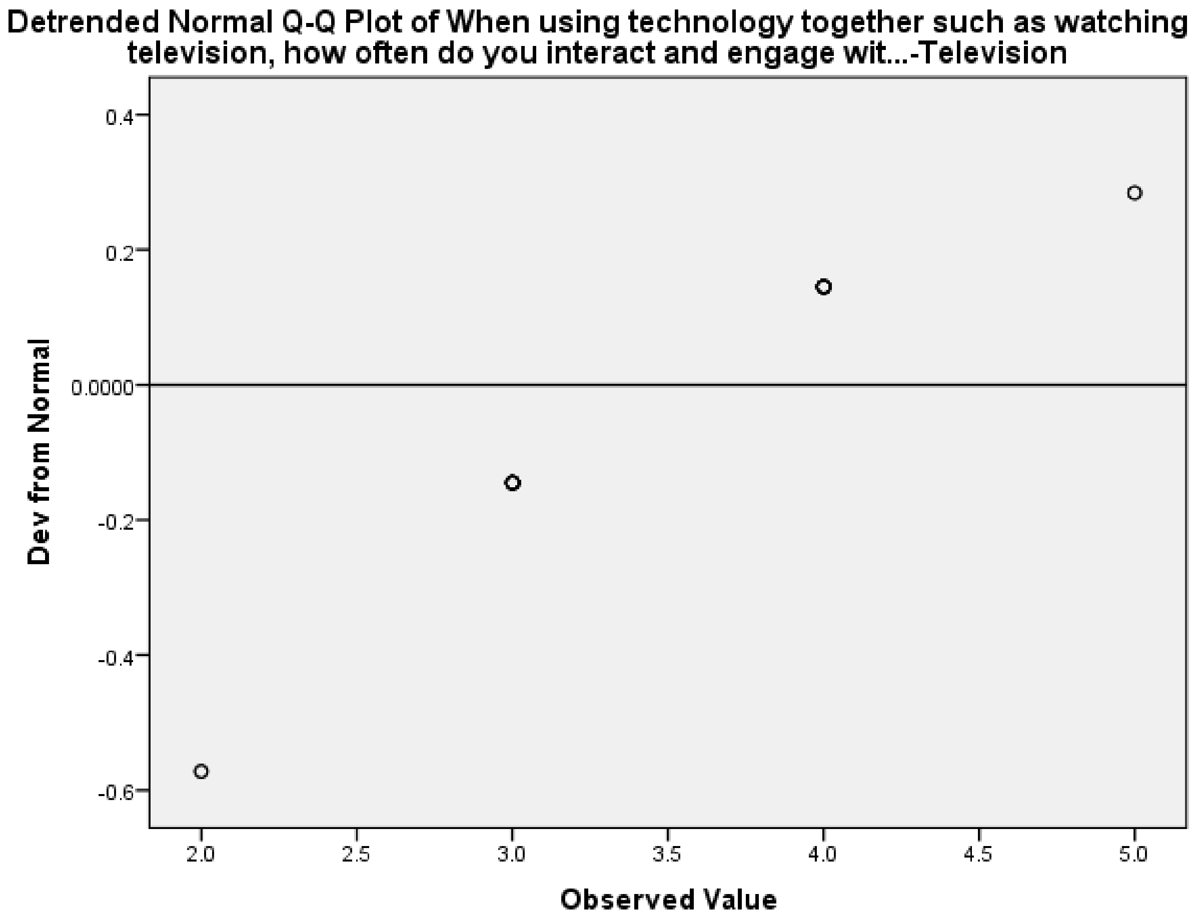


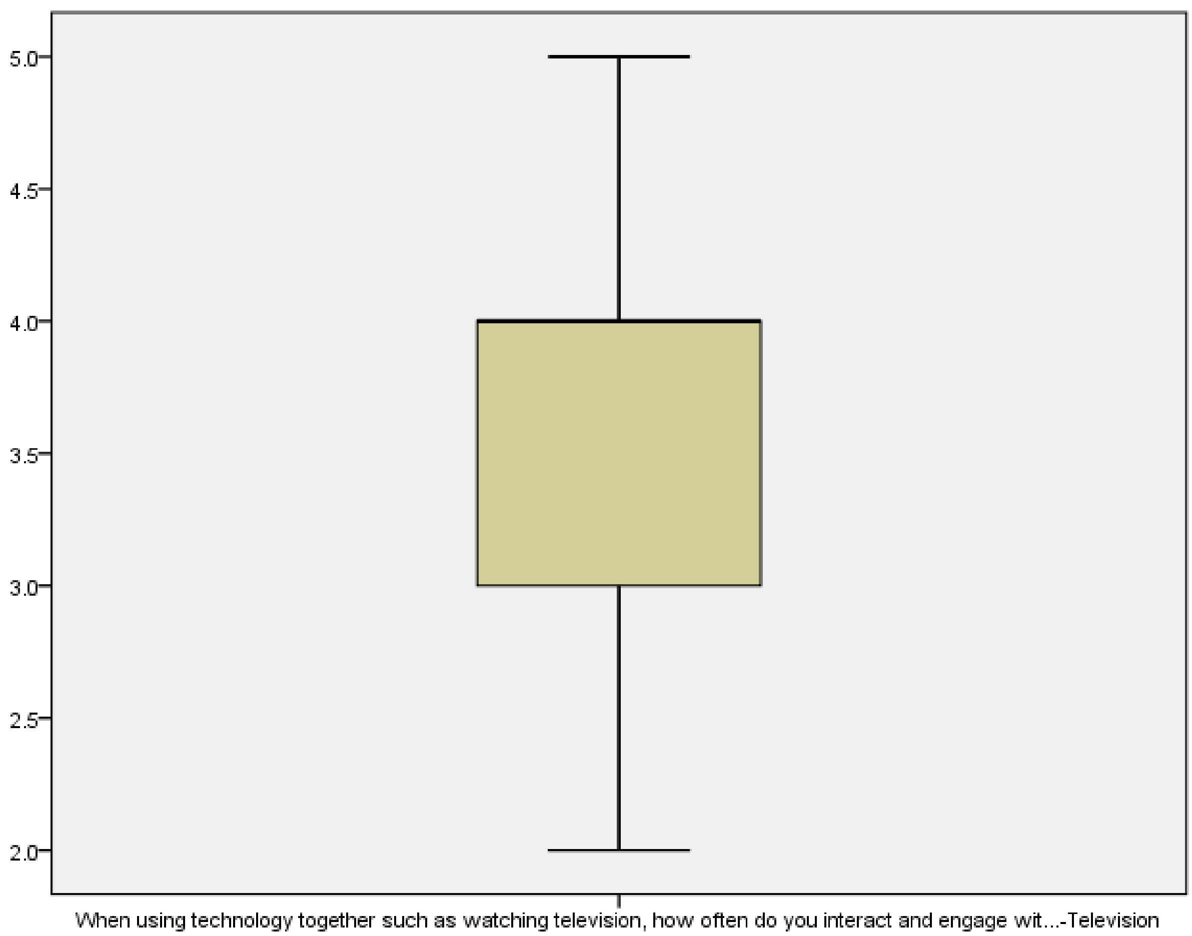




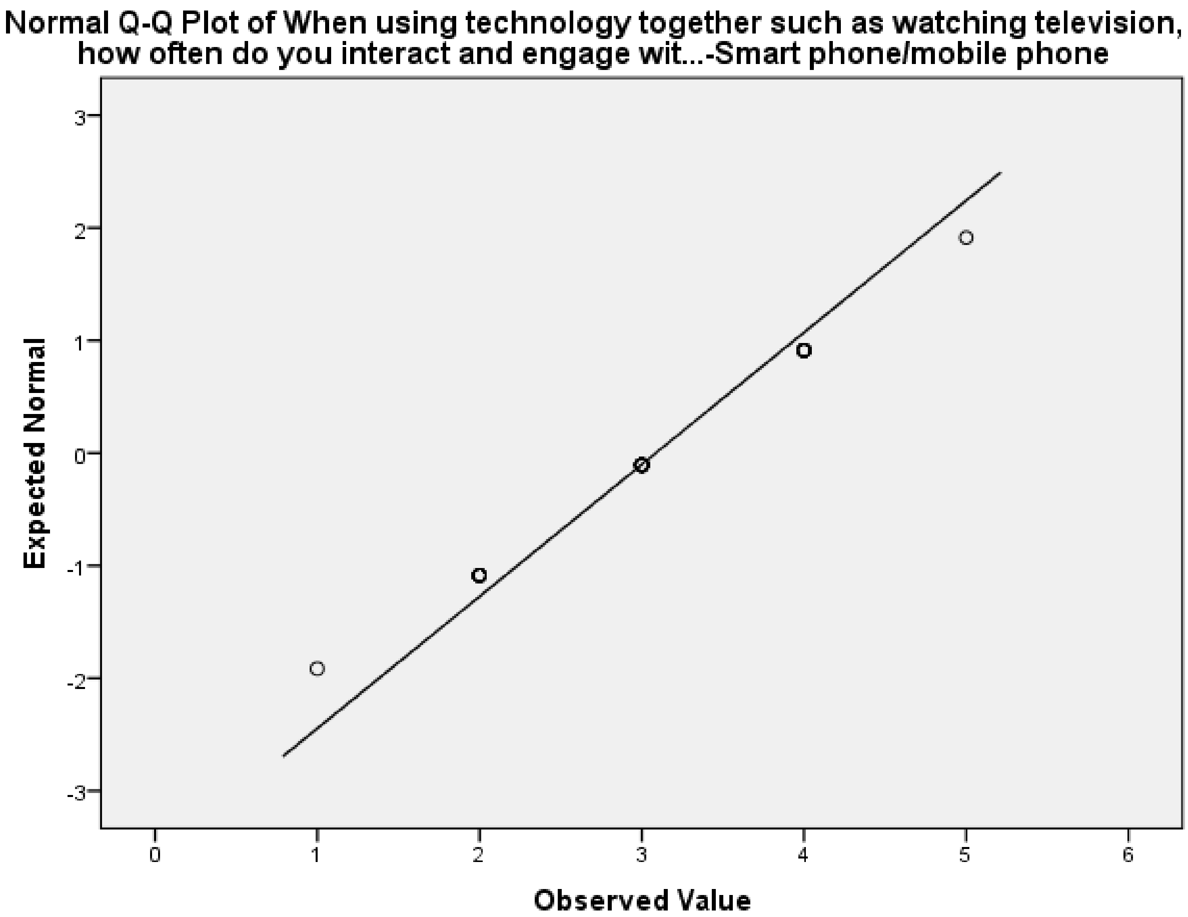
When using technology together such as watching television, how often do you interact and engage wit...-Television

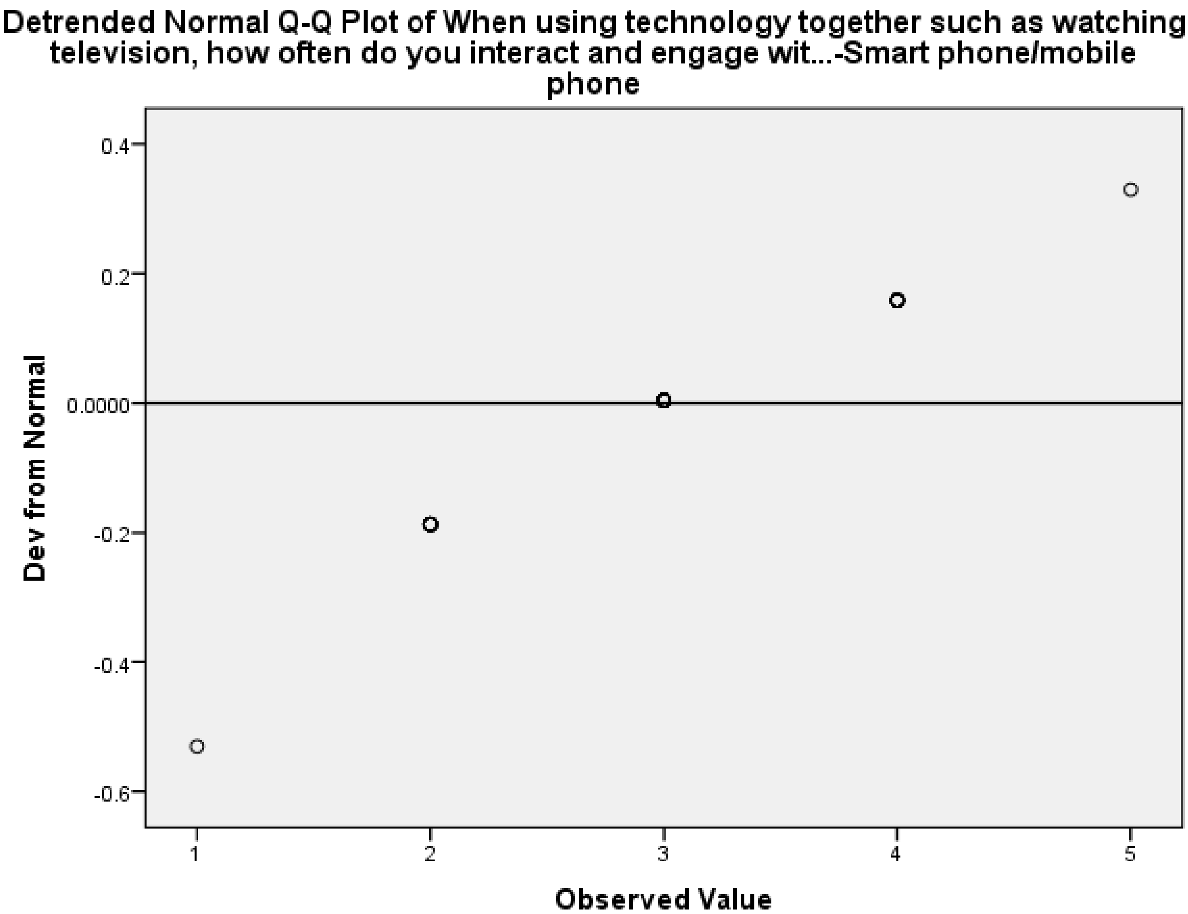



Detrended Normal Q-Q Plot of When using technology together such as watching television, how often do you interact and engage wit...-Television
Dev from Normal
0.4
0.2
0.0000
-0.2
-0.4
-0.6
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Observed Value

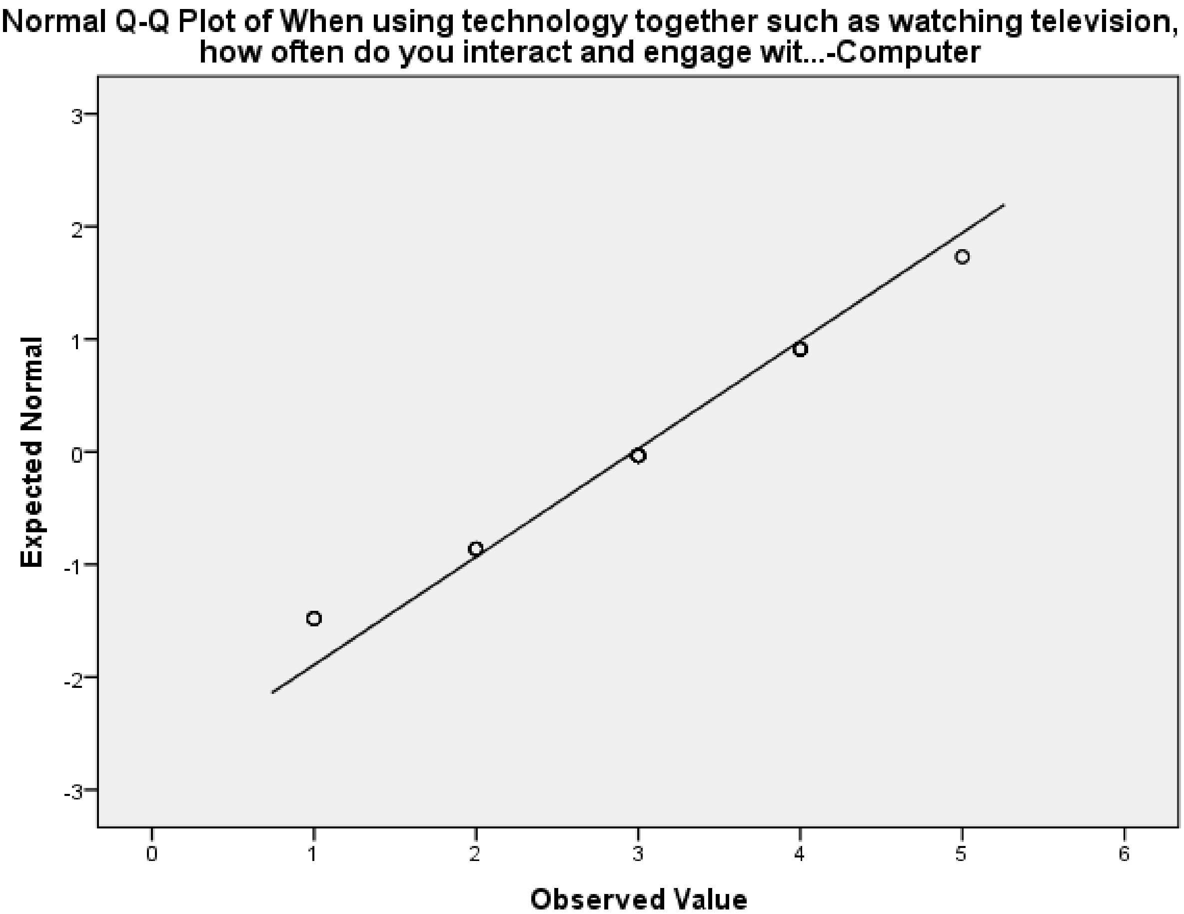

5.0
4.5
4.0
3.5
3.0
2.5
2.0
When using technology together such as watching television, how often do you interact and engage wit...-Television

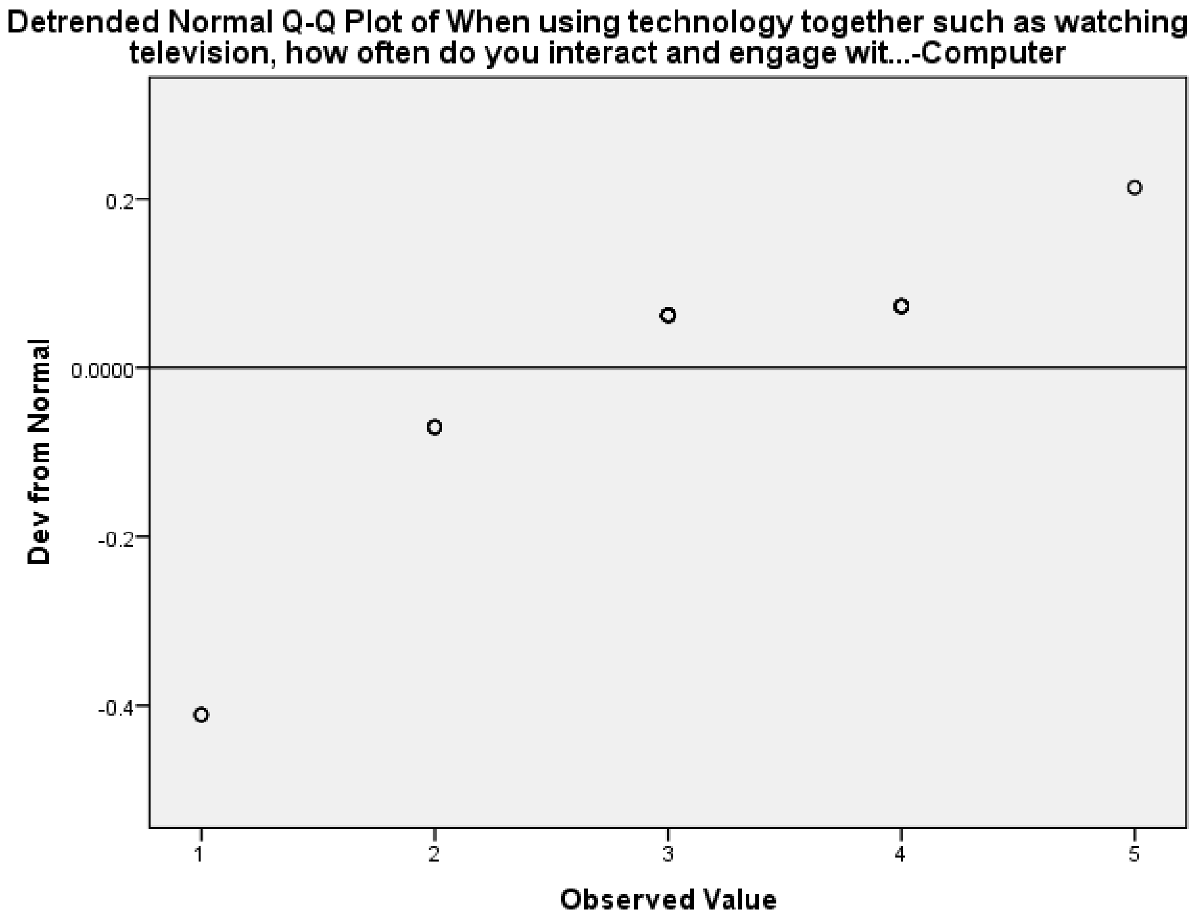
When using technology together such as watching television, how often do you interact and engage wit...-Smart phone/mobile phone

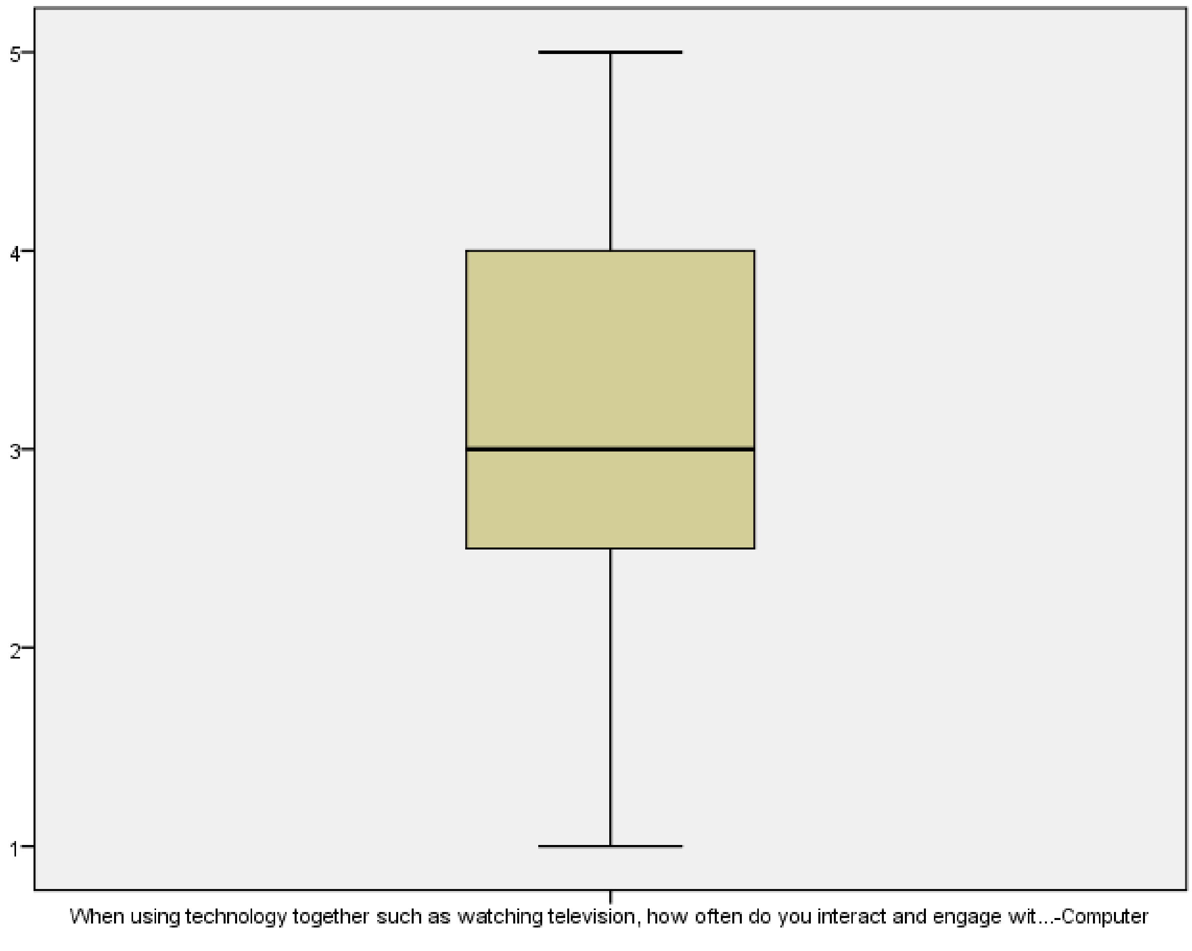




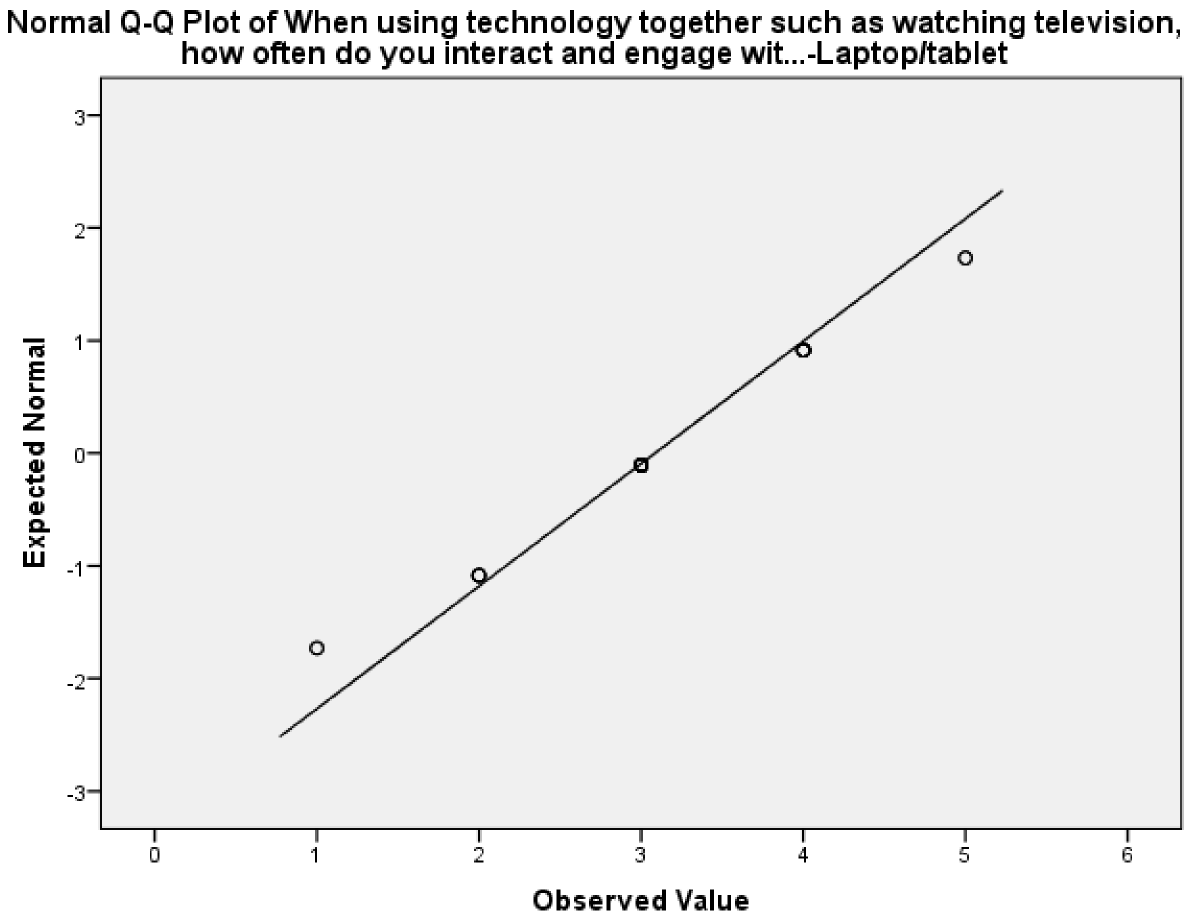
When using technology together such as watching television, how often do you interact and engage wit...-Computer

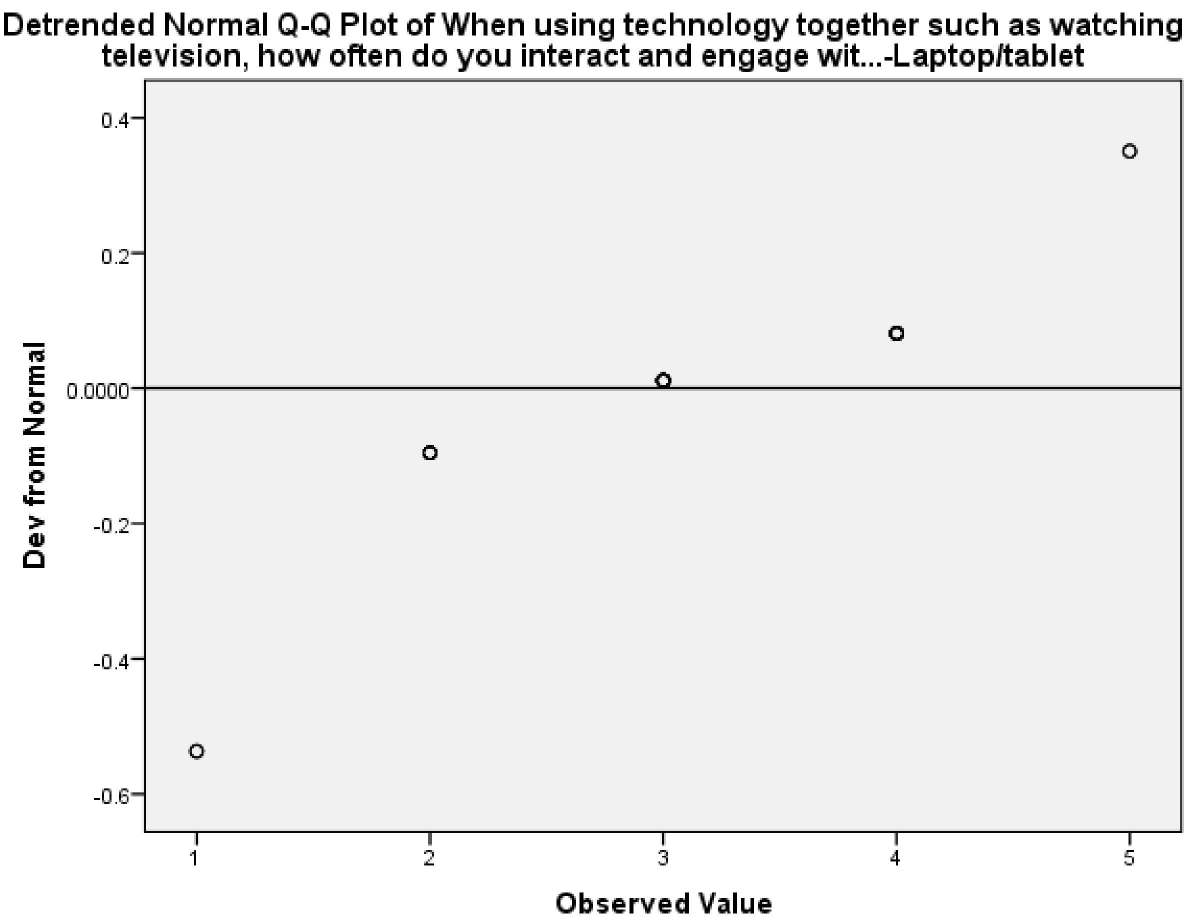


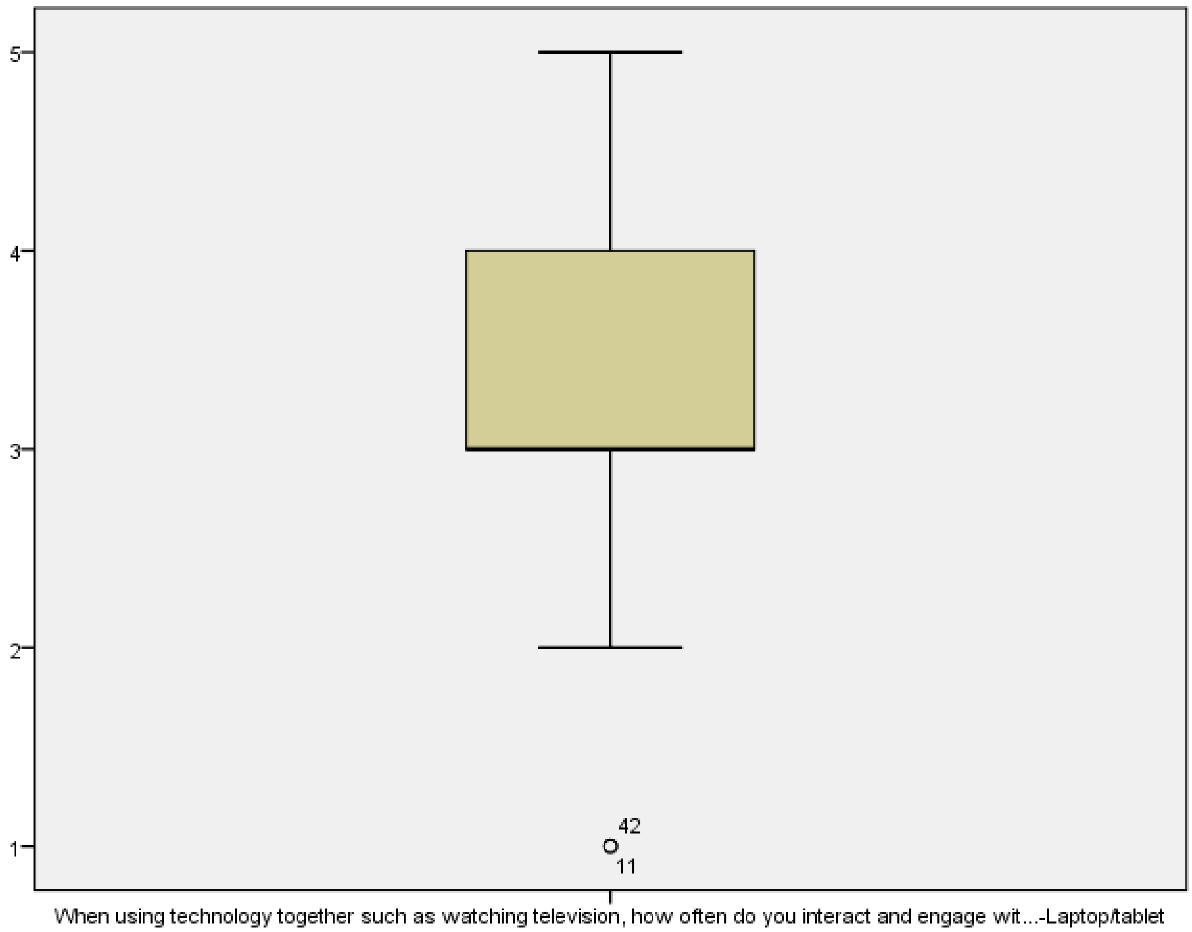

Detrended Normal Q-Q Plot of When using technology together such as watching television, how often do you interact and engage wit...-Computer
0.2
0.0000
-0.2
-0.4
Dev from Normal
1
2
3
4
5
Observed Value


5
4
3
2
1
When using technology together such as watching television, how often do you interact and engage wit...-Computer

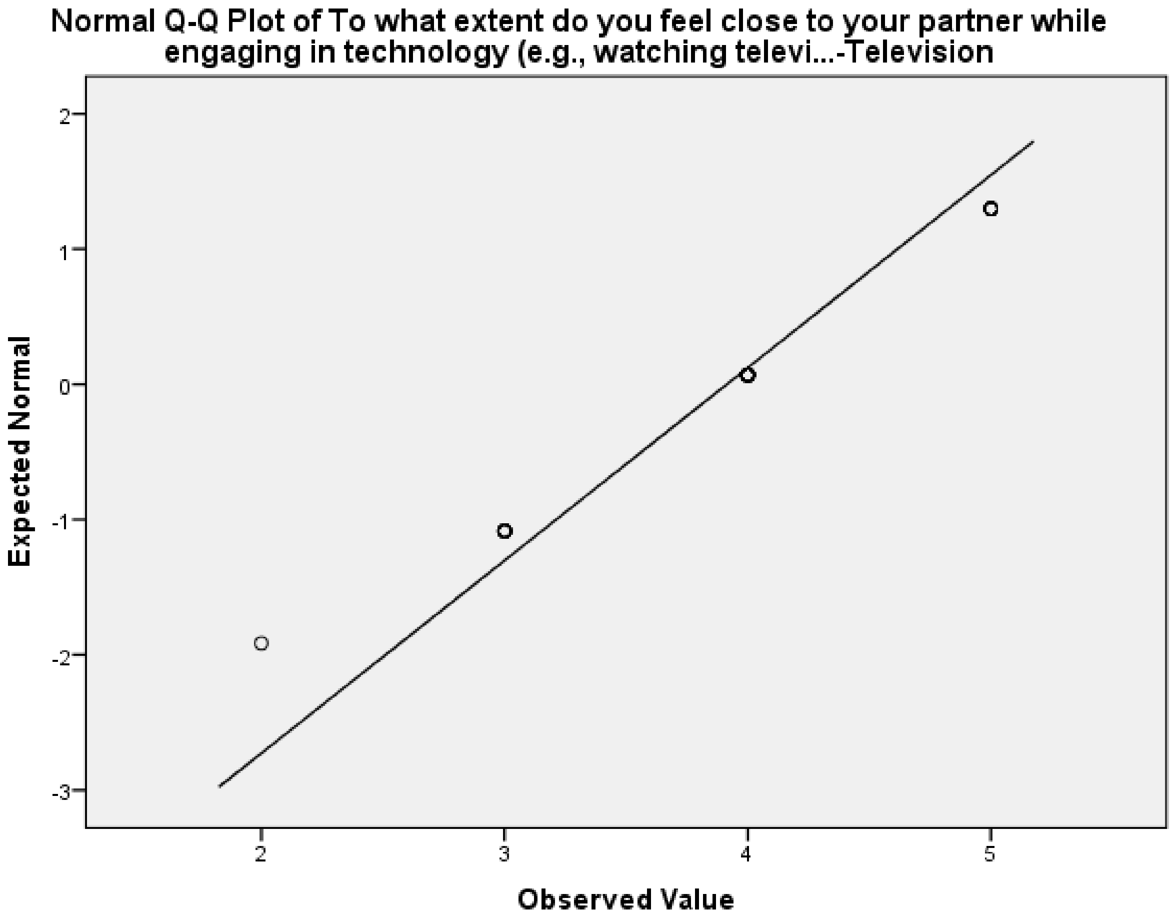
When using technology together such as watching television, how often do you interact and engage wit...-Laptop/tablet



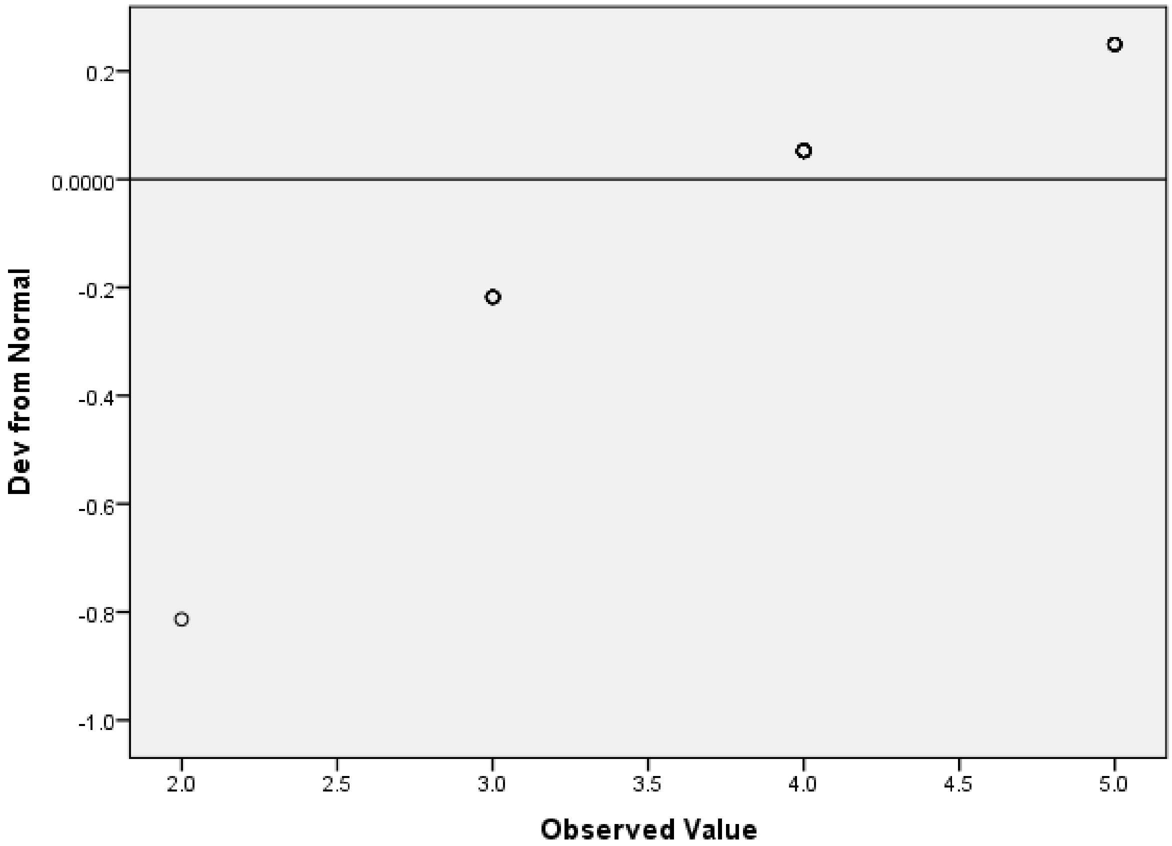


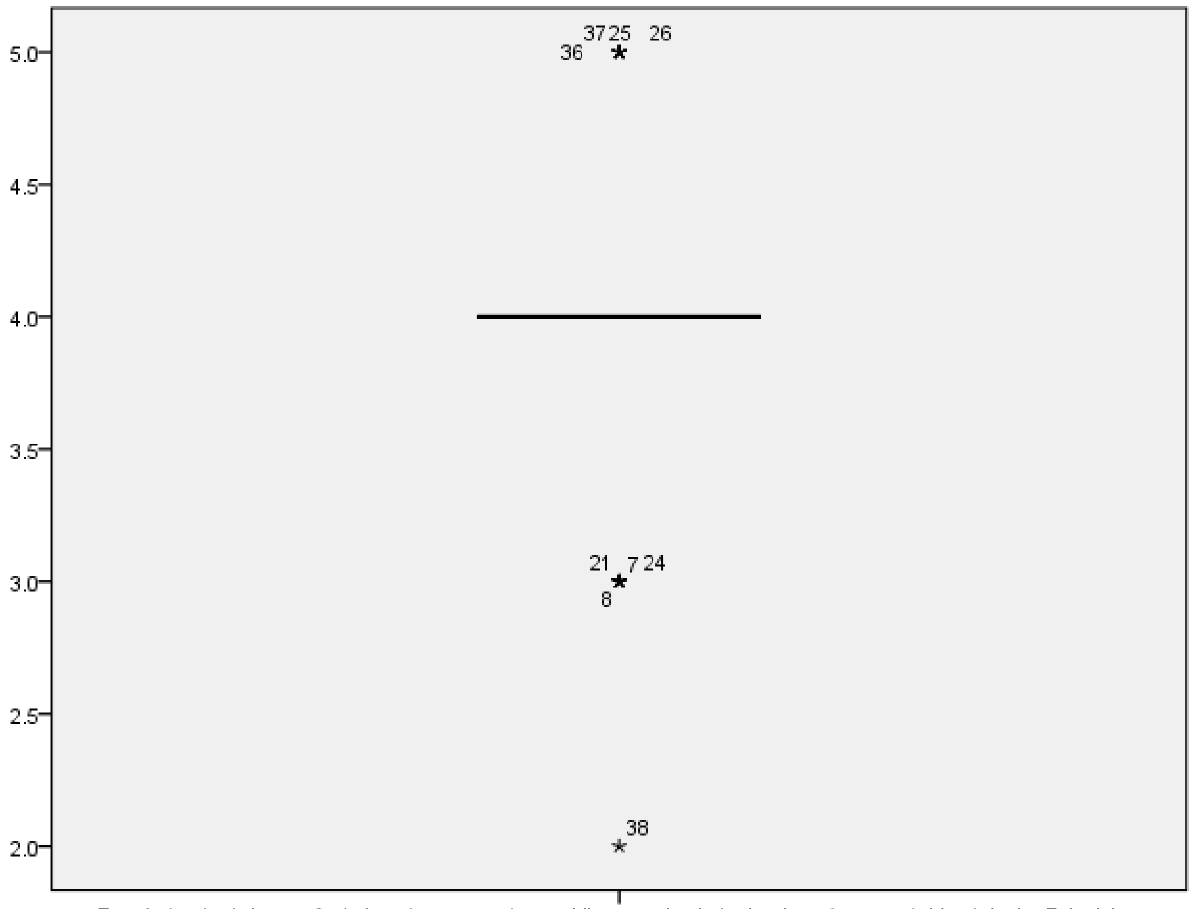


To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Television

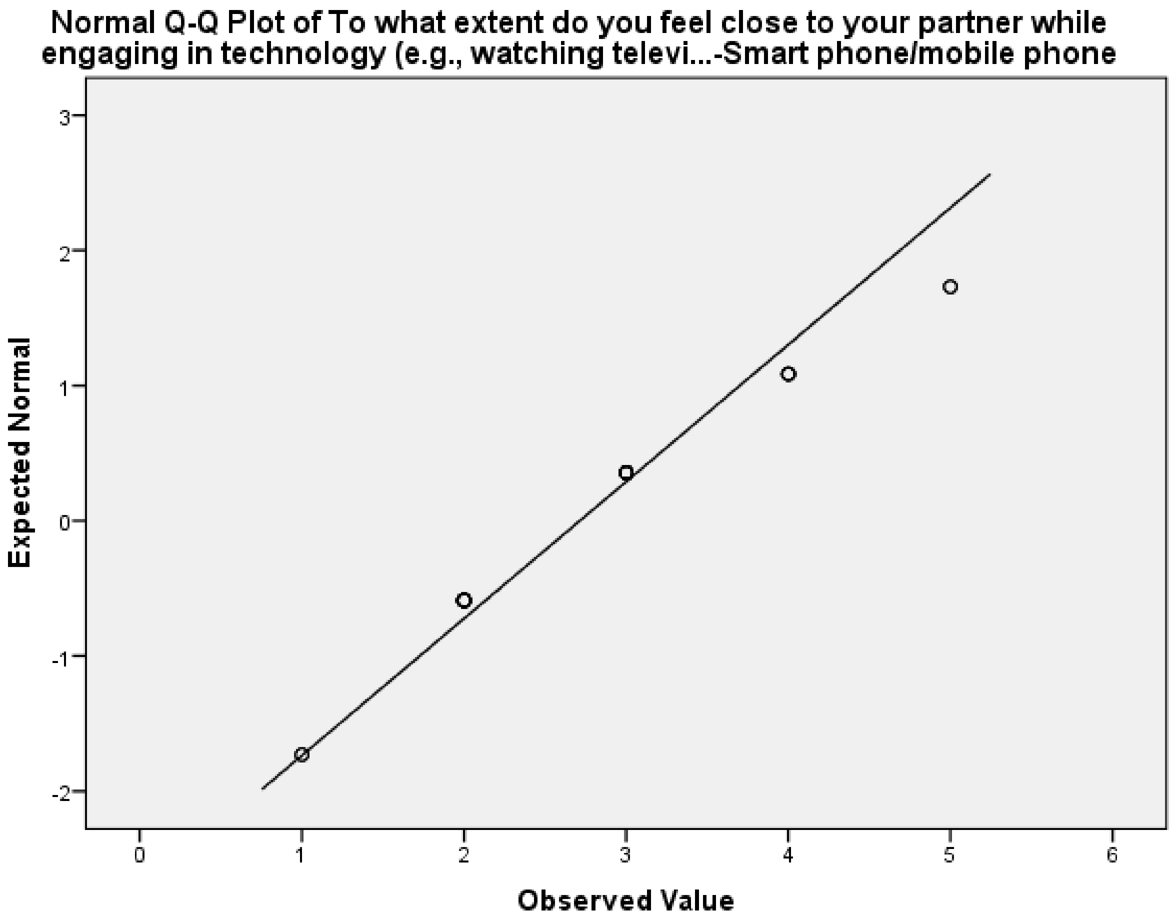


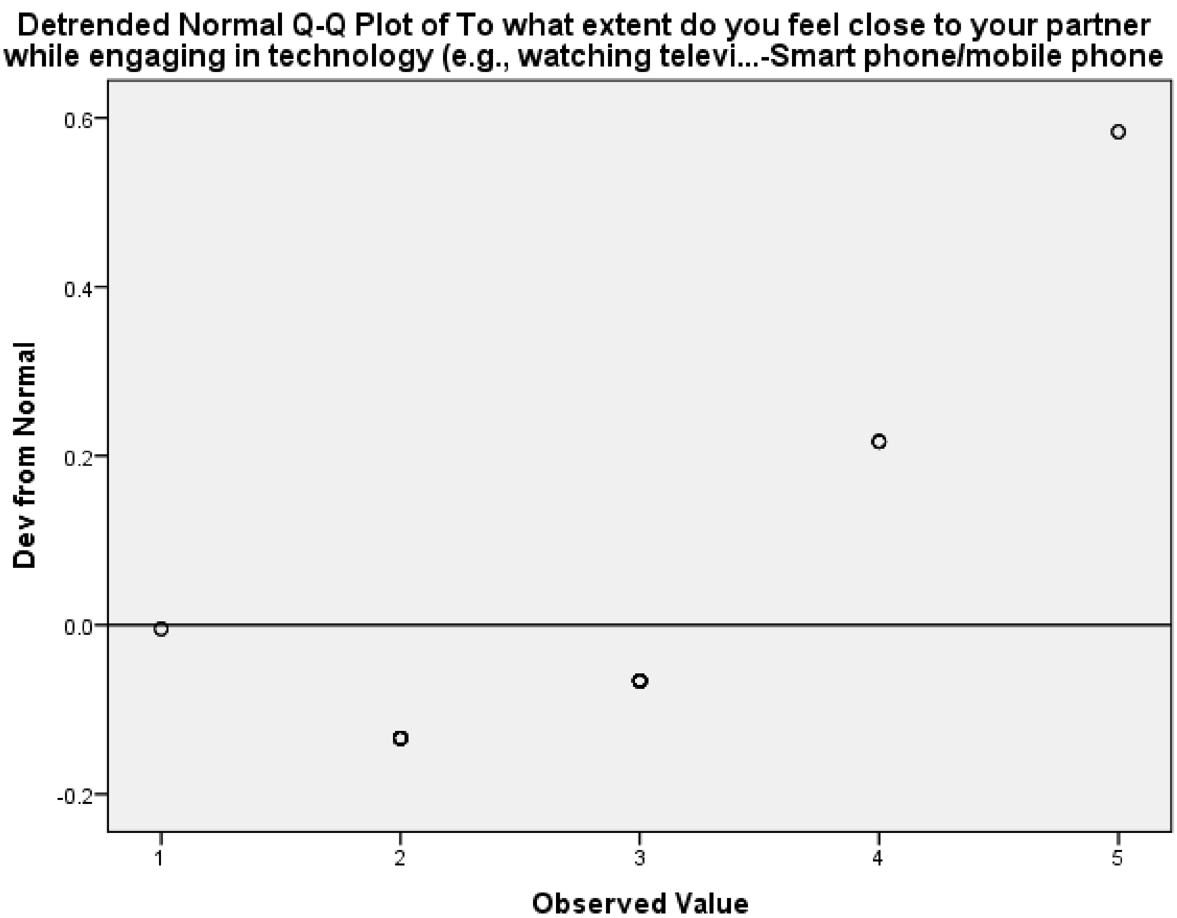
Detrended Normal Q-Q Plot of To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Television

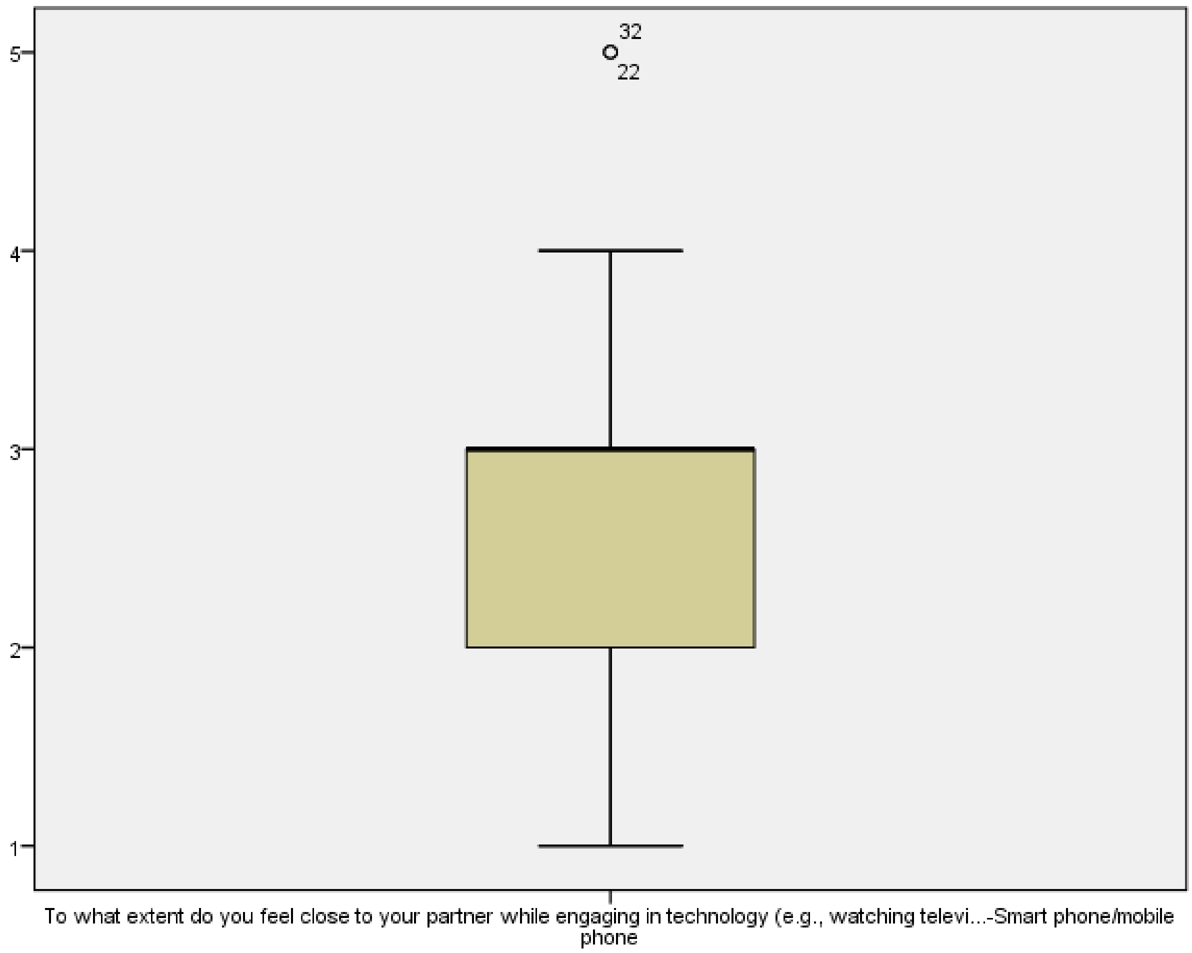




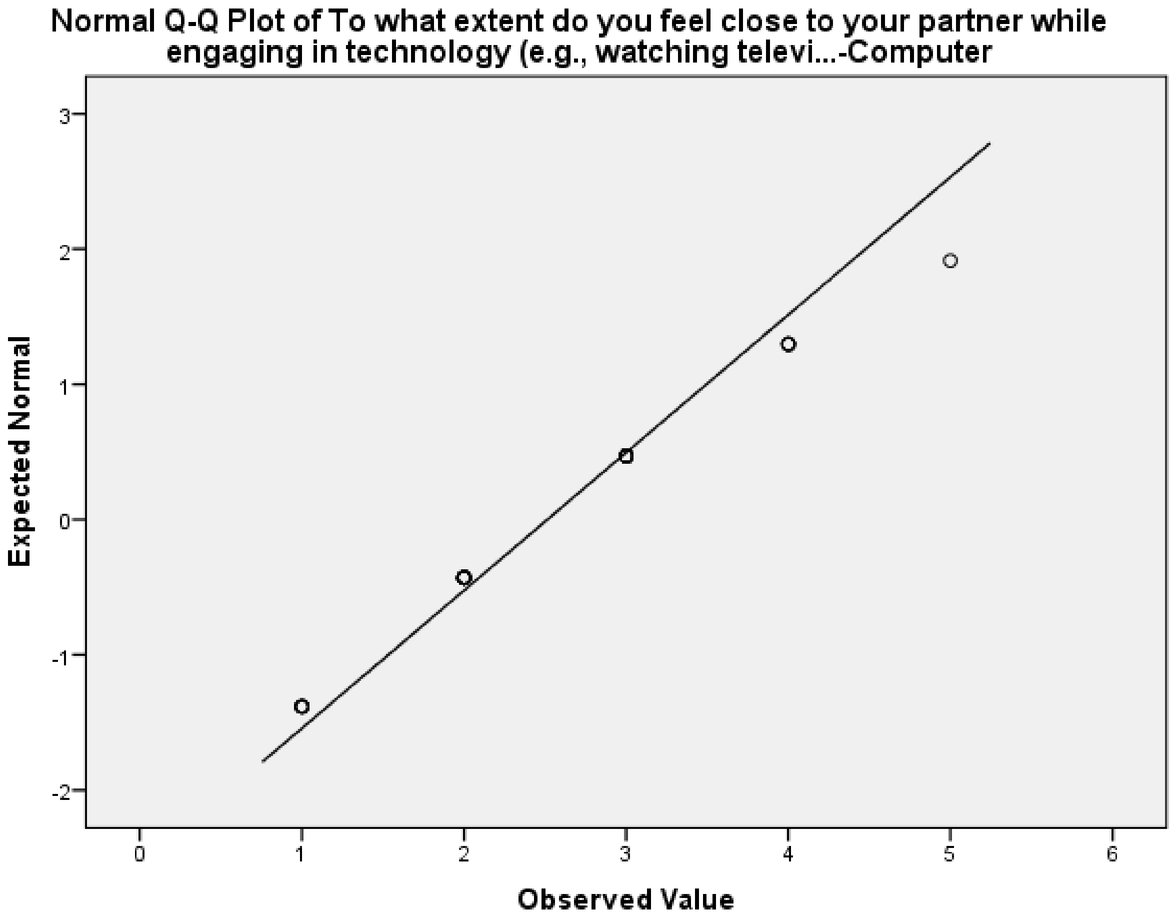
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Smart phone/mobile phone

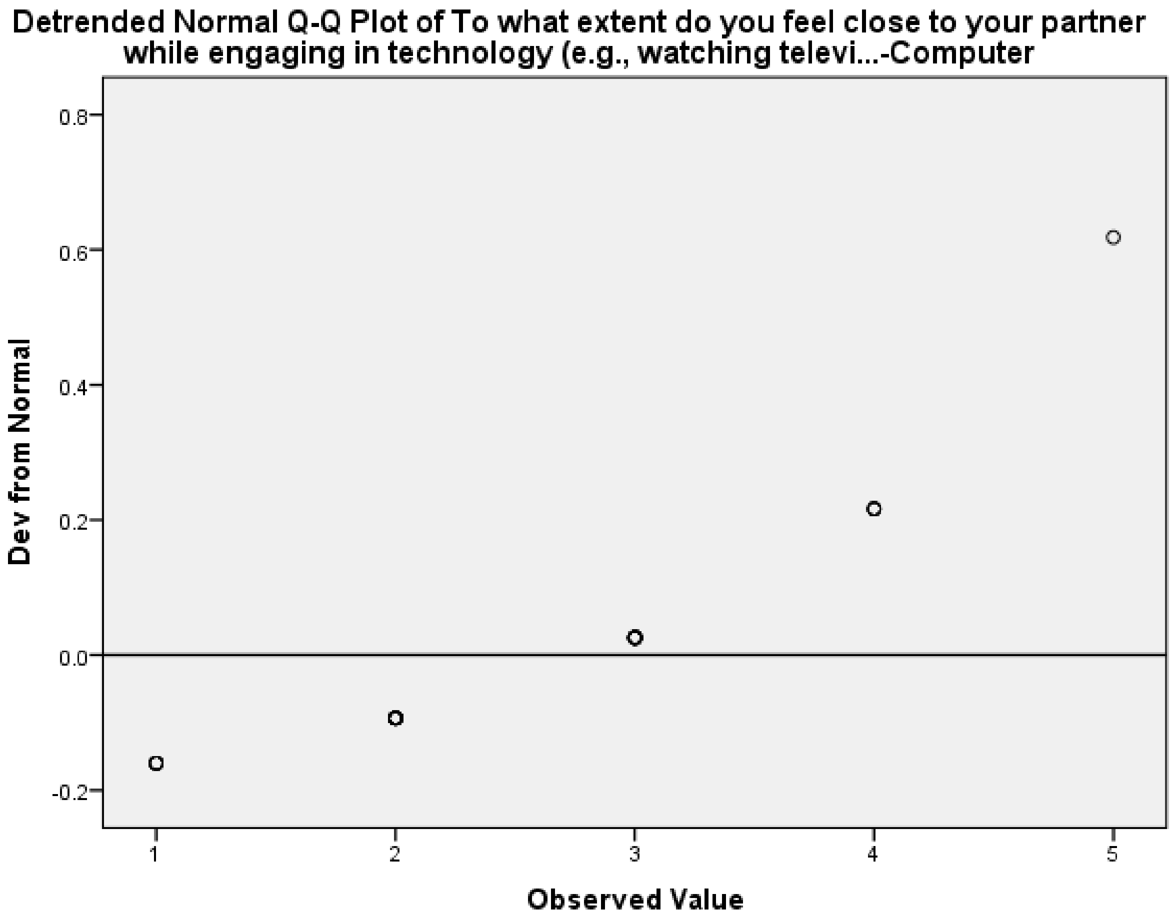


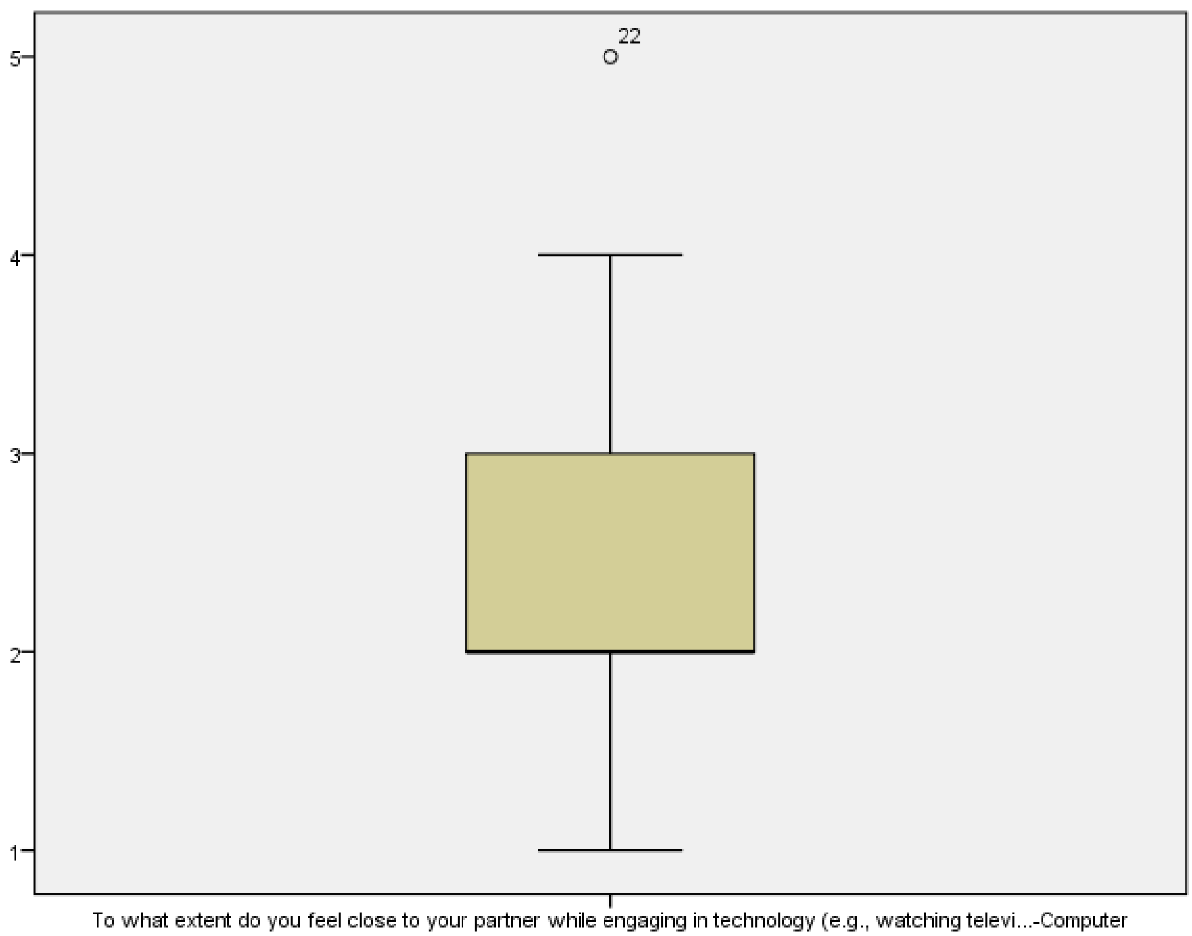




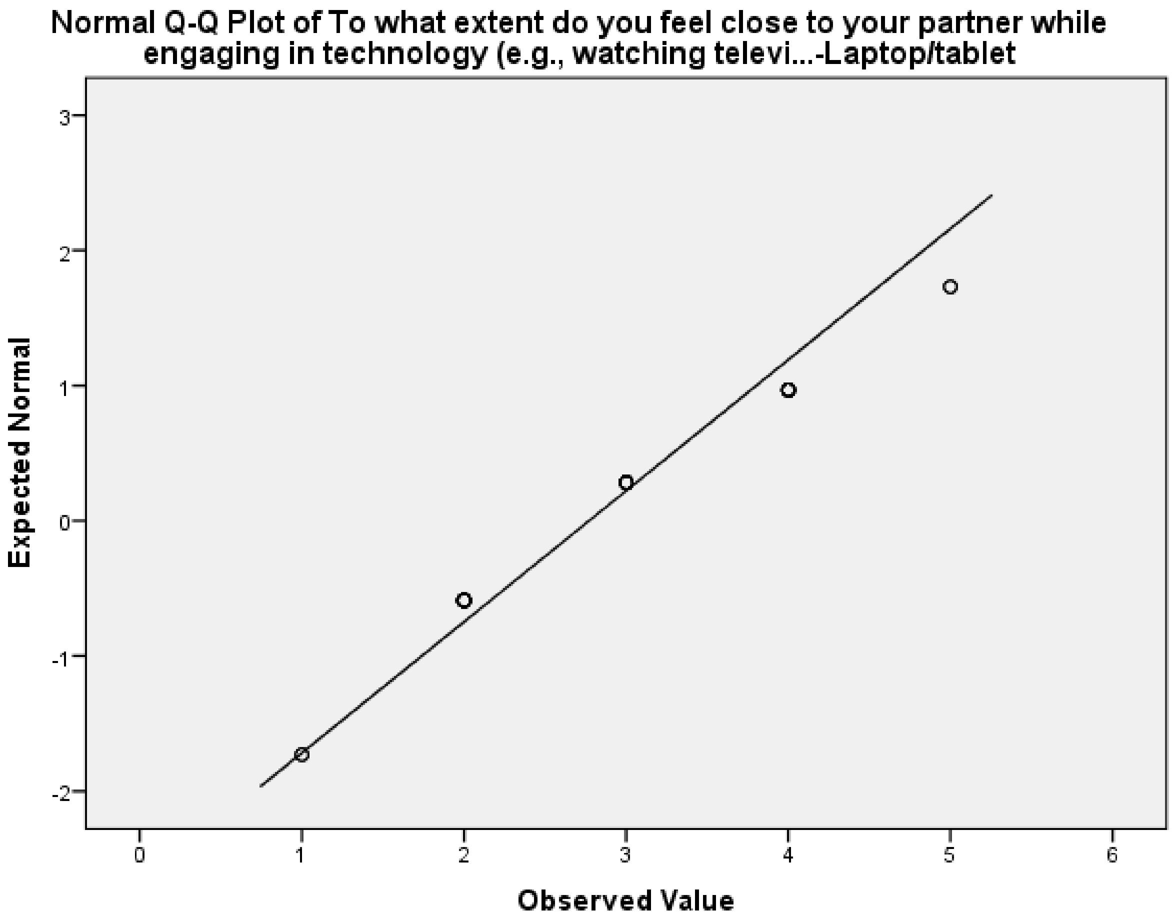
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Computer

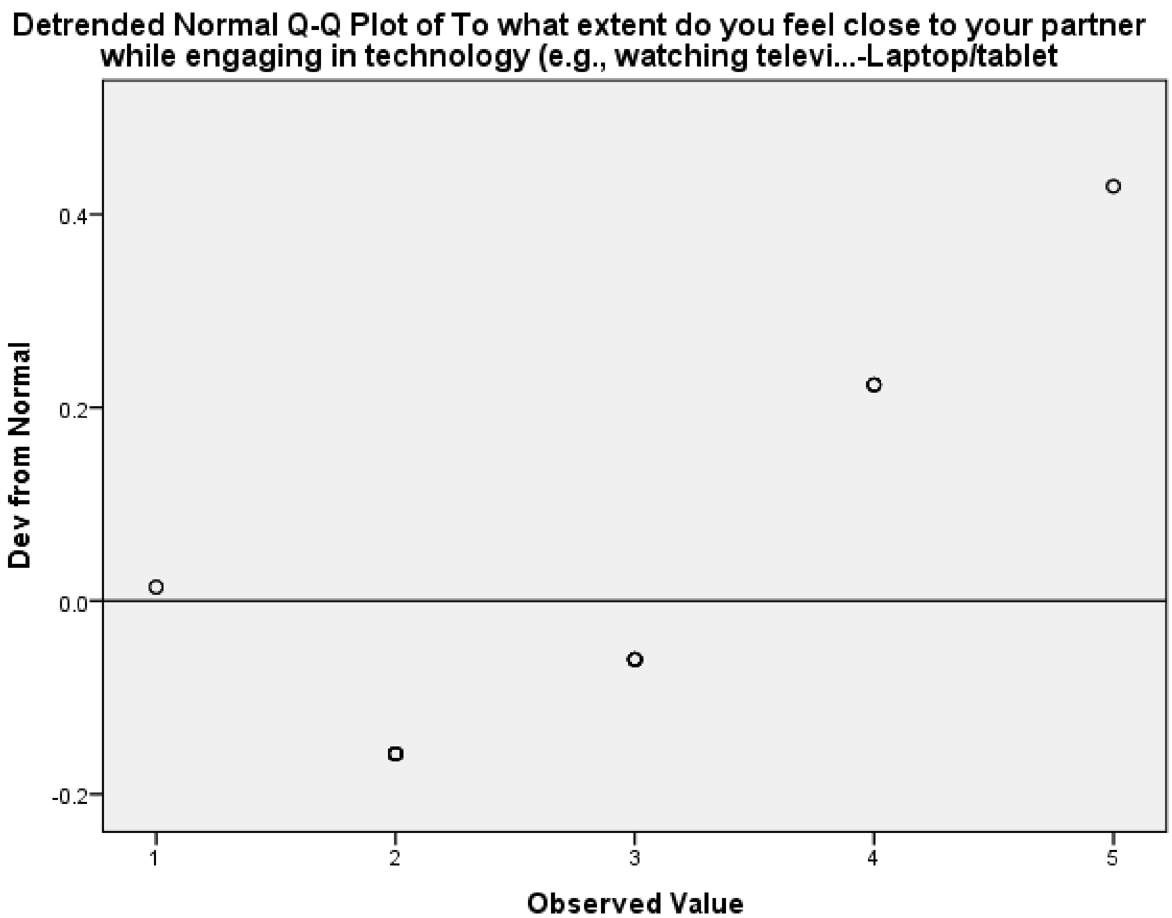


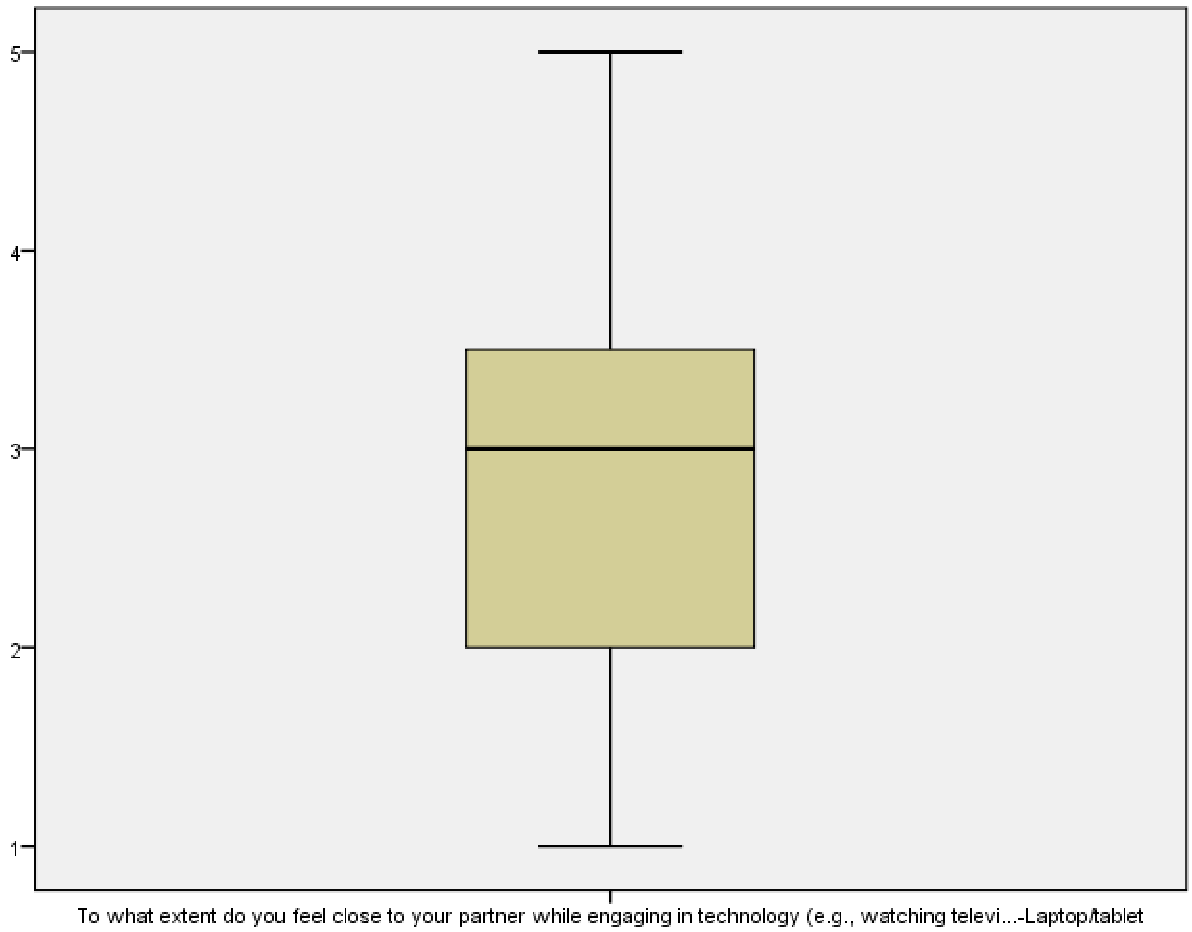

Detrended Normal Q-Q Plot of To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Computer
Dev from Normal
0.8
0.6
0.4
0.2
0.0
-0.2
1
2
3
4
5
Observed Value


22
5
4
3
2
1
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Computer

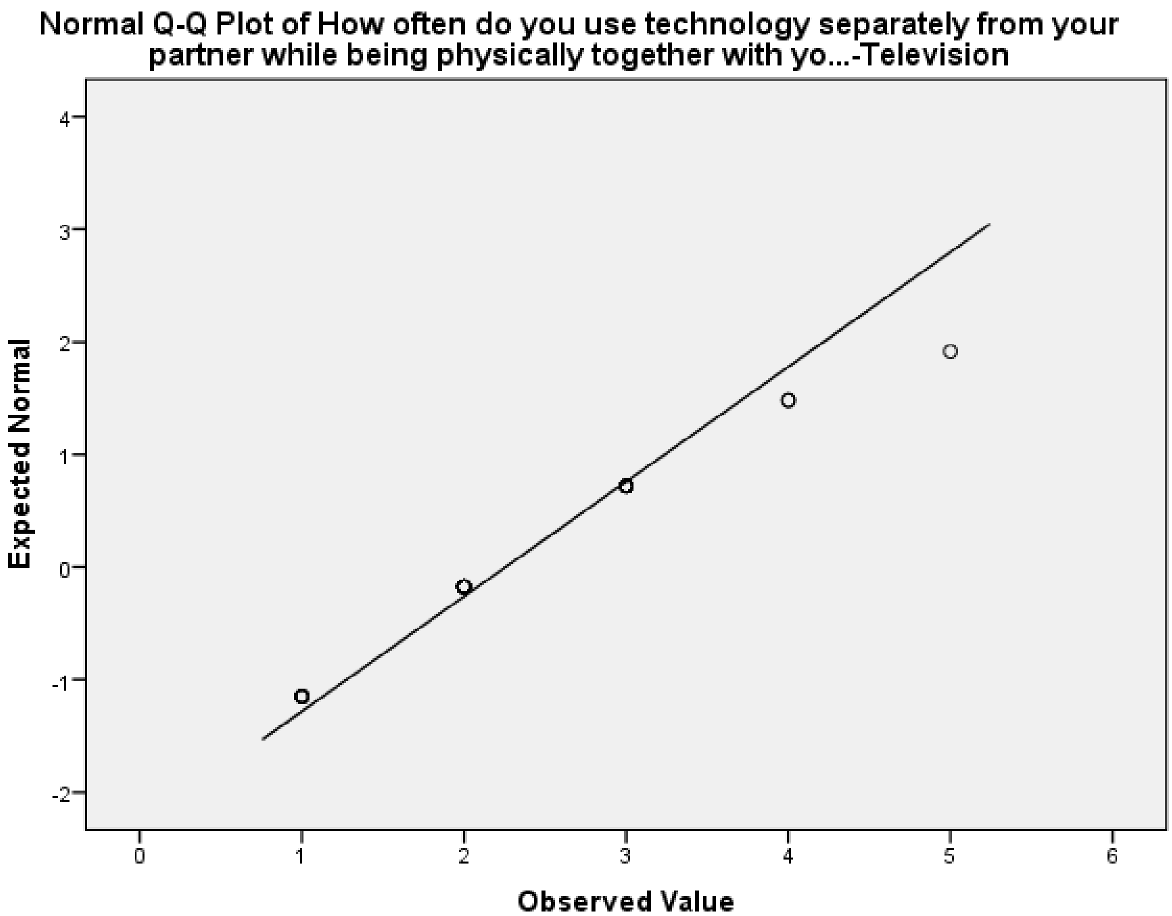
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Laptop/tablet

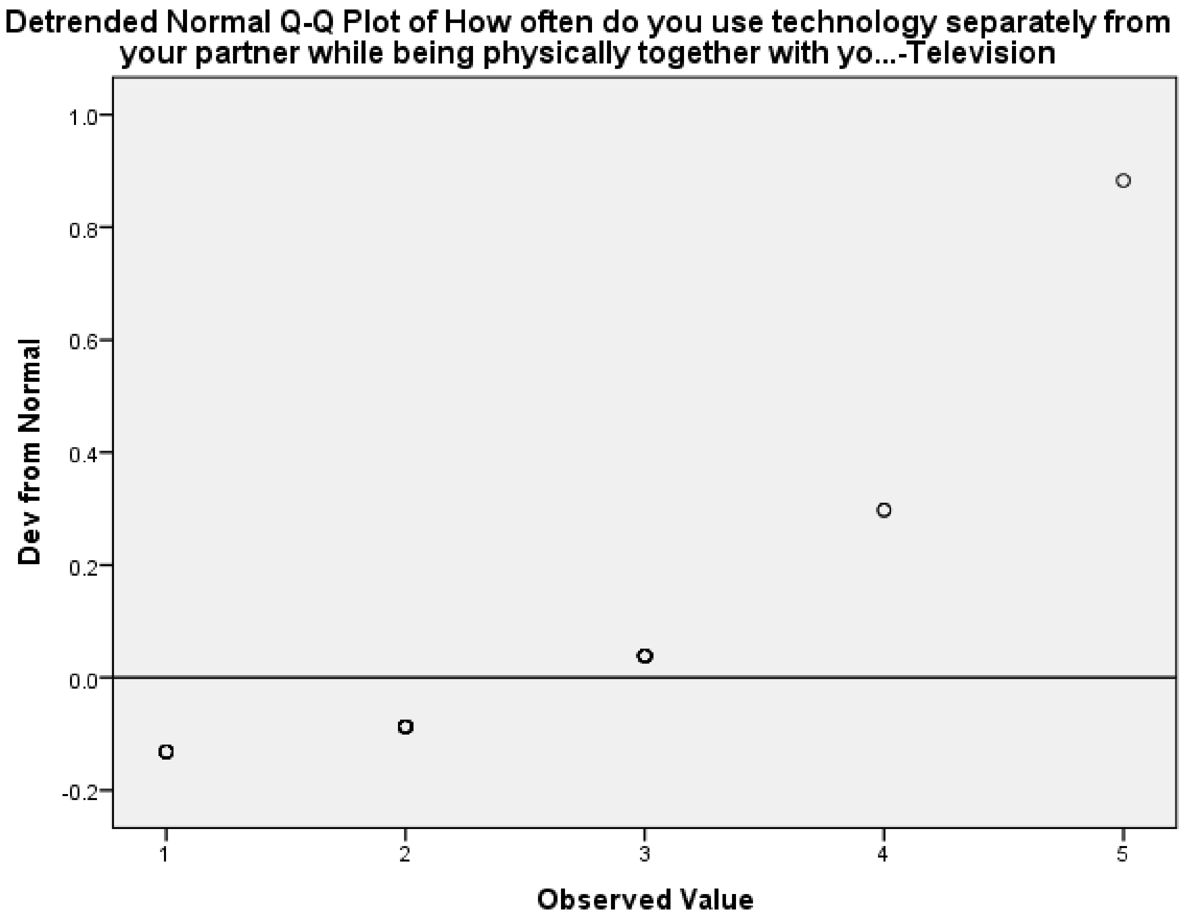




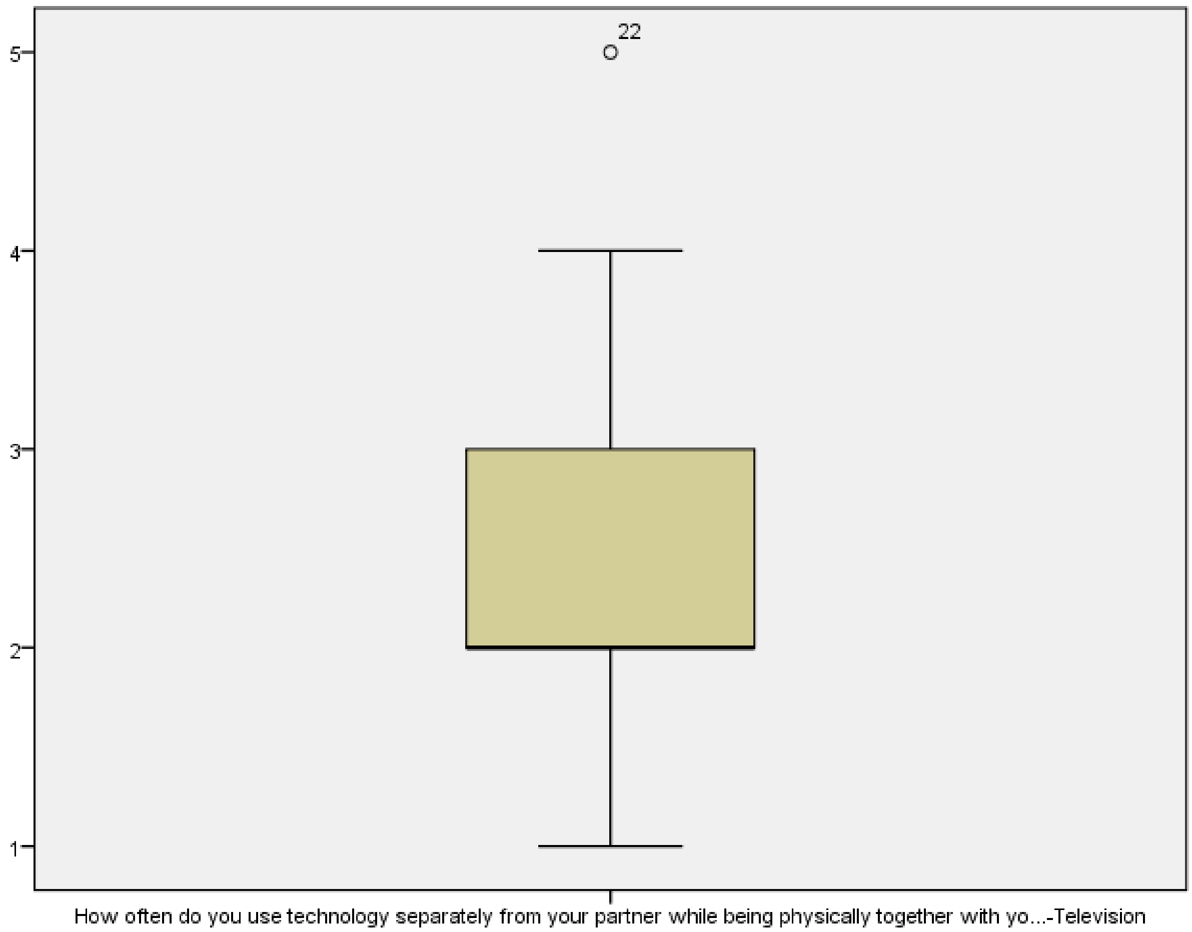


How often do you use technology separately from your partner while being physically together with yo...-Television



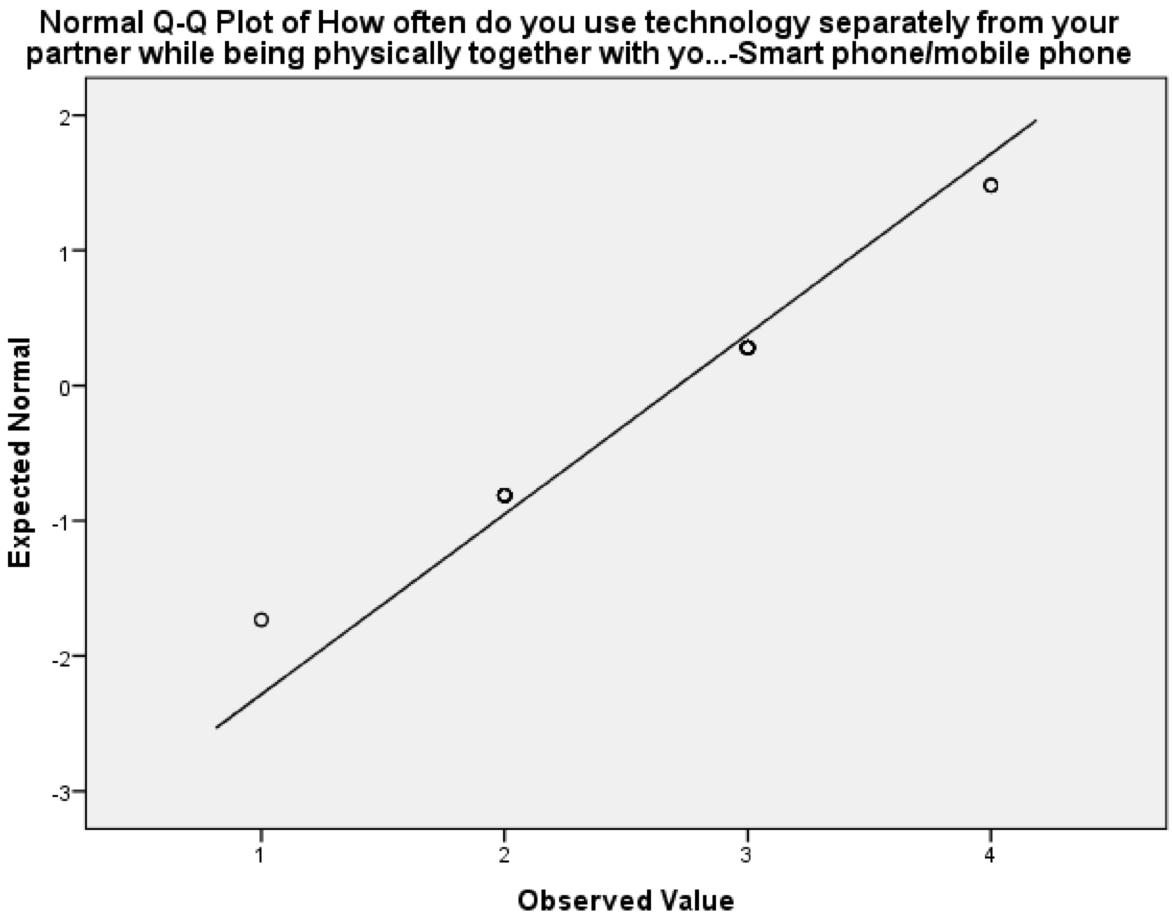


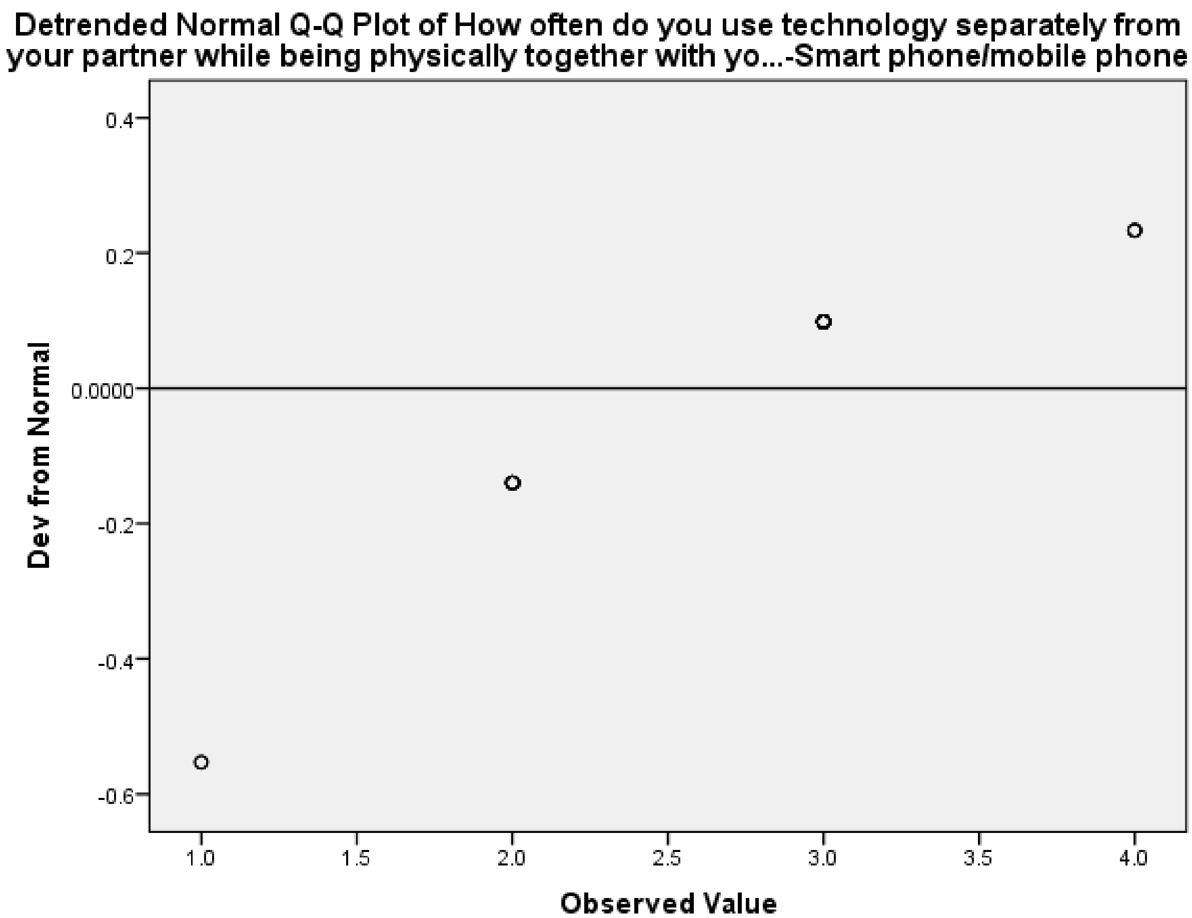
Detrended Normal Q-Q Plot of How often do you use technology separately from your partner while being physically together with yo...-Television
Dev from Normal
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
1
2
3
4
5
Observed Value

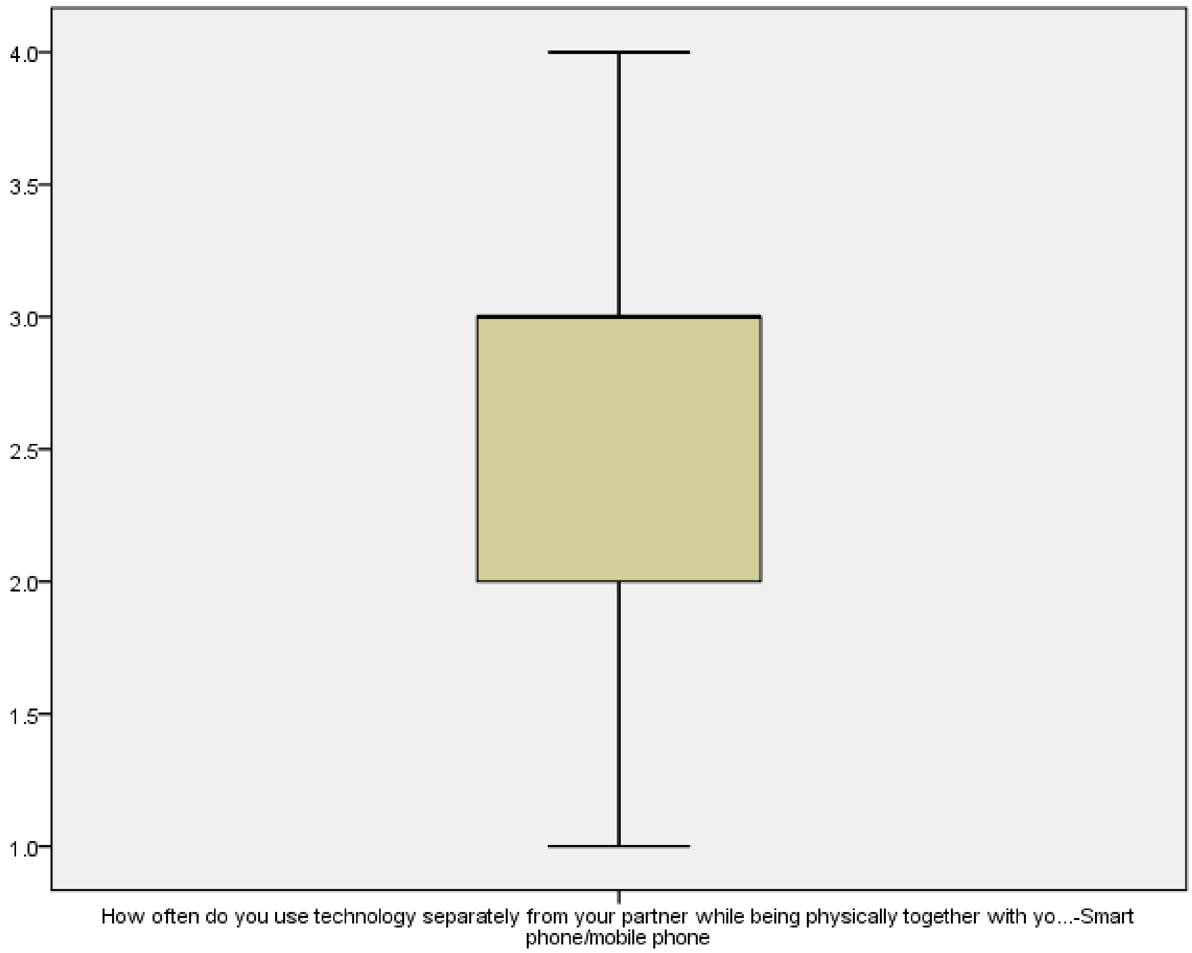


22
5
4
3
2
1
How often do you use technology separately from your partner while being physically together with yo...-Television

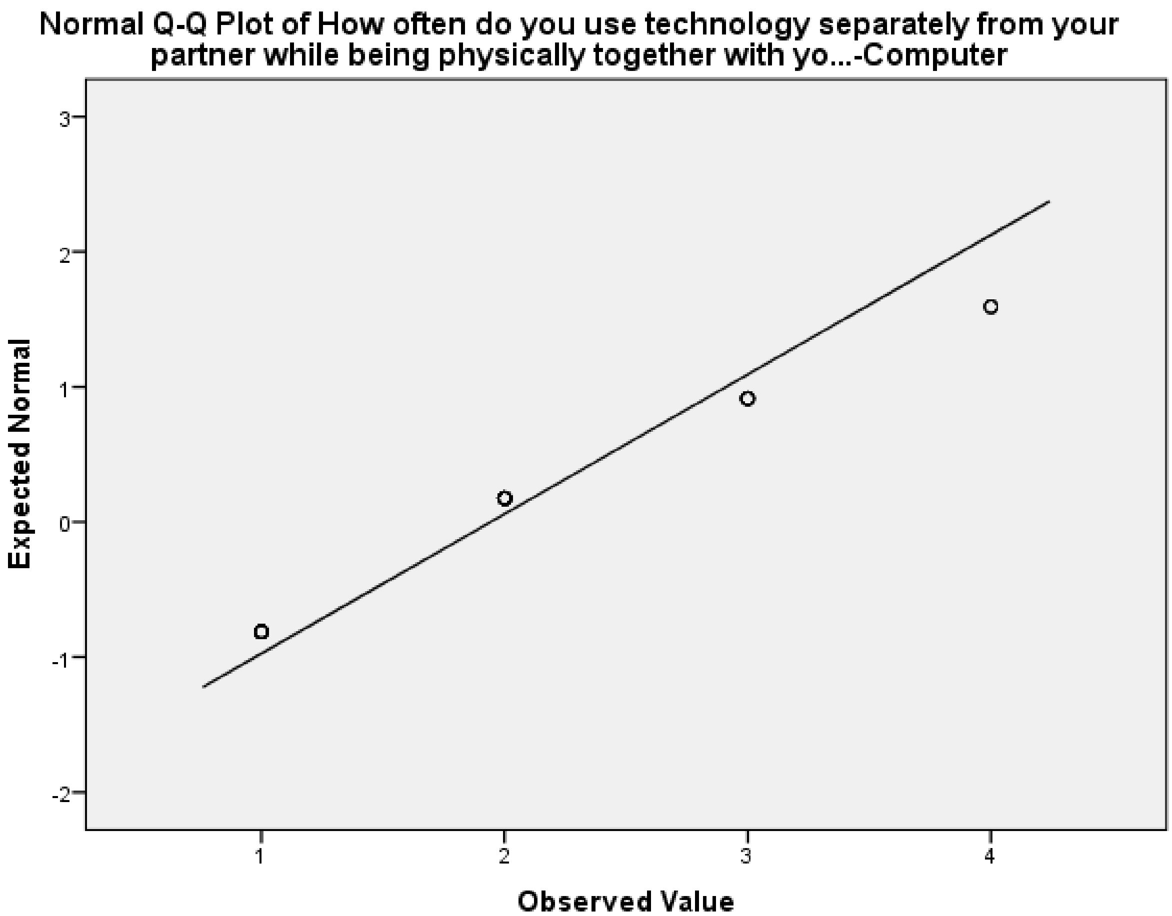
How often do you use technology separately from your partner while being physically together with yo...-Smart phone/mobile phone

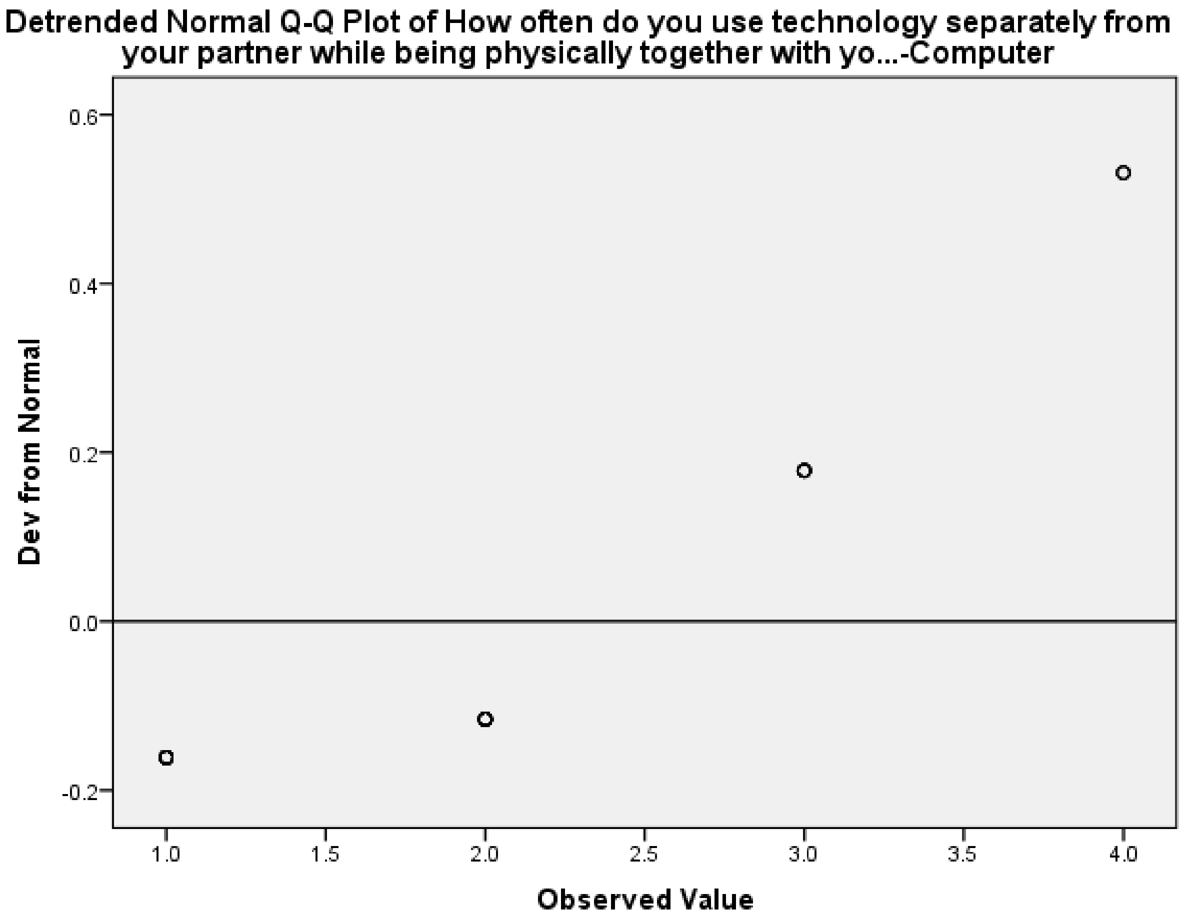


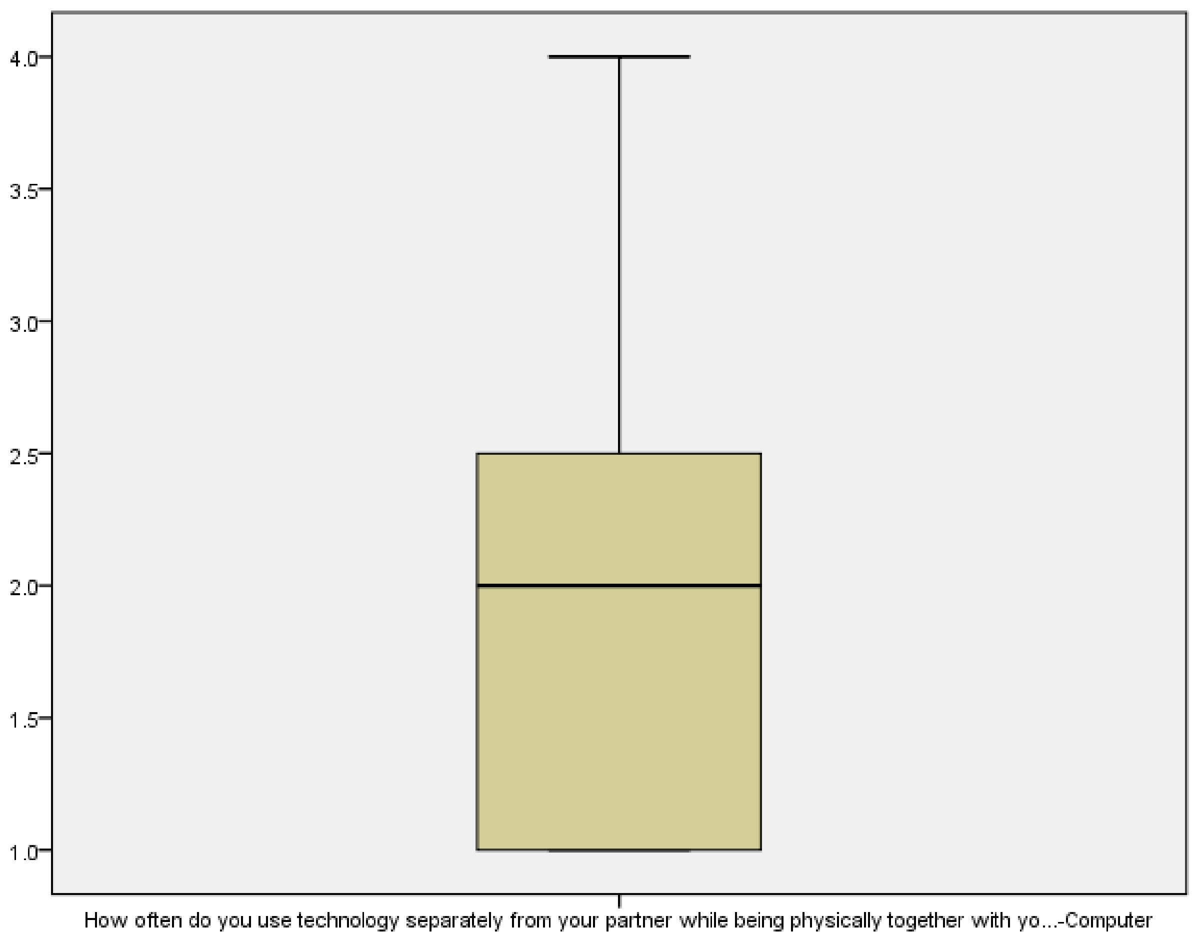




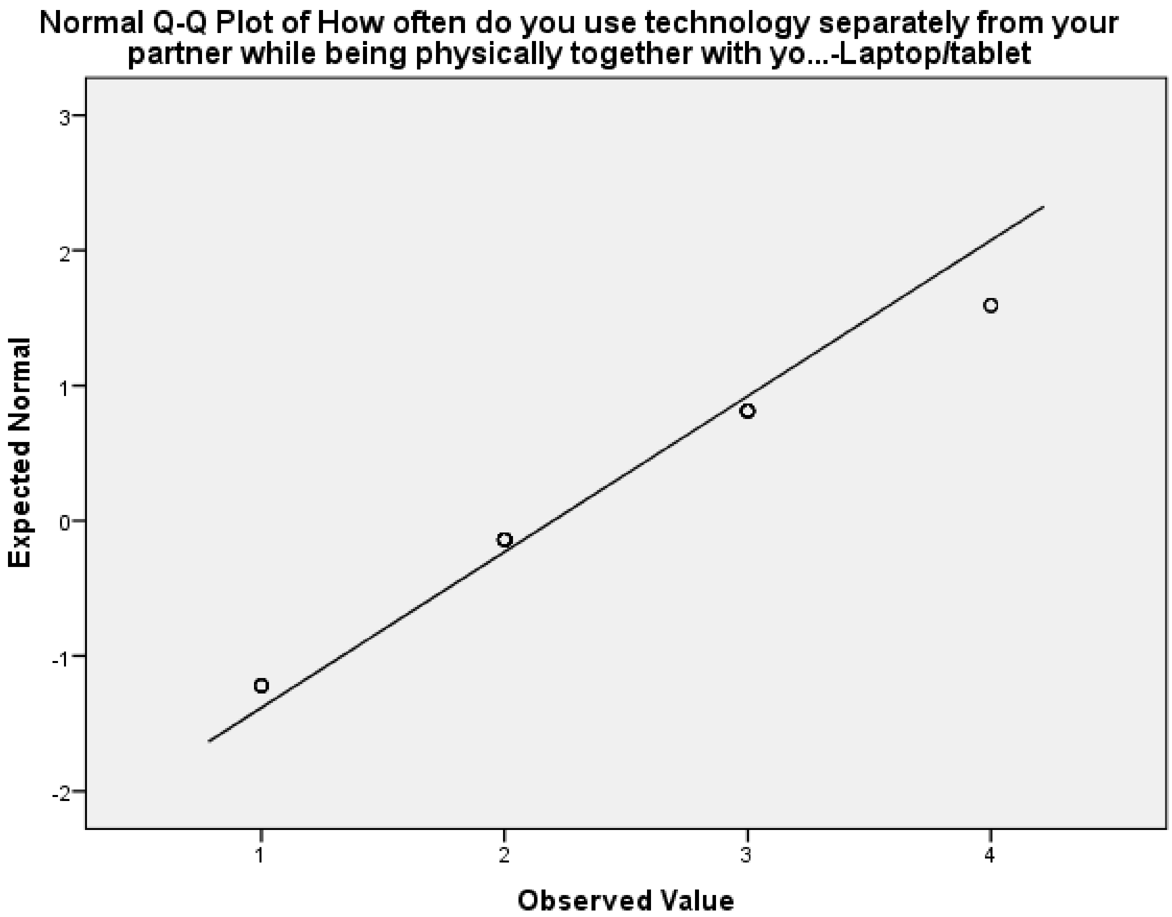
How often do you use technology separately from your partner while being physically together with yo...-Computer

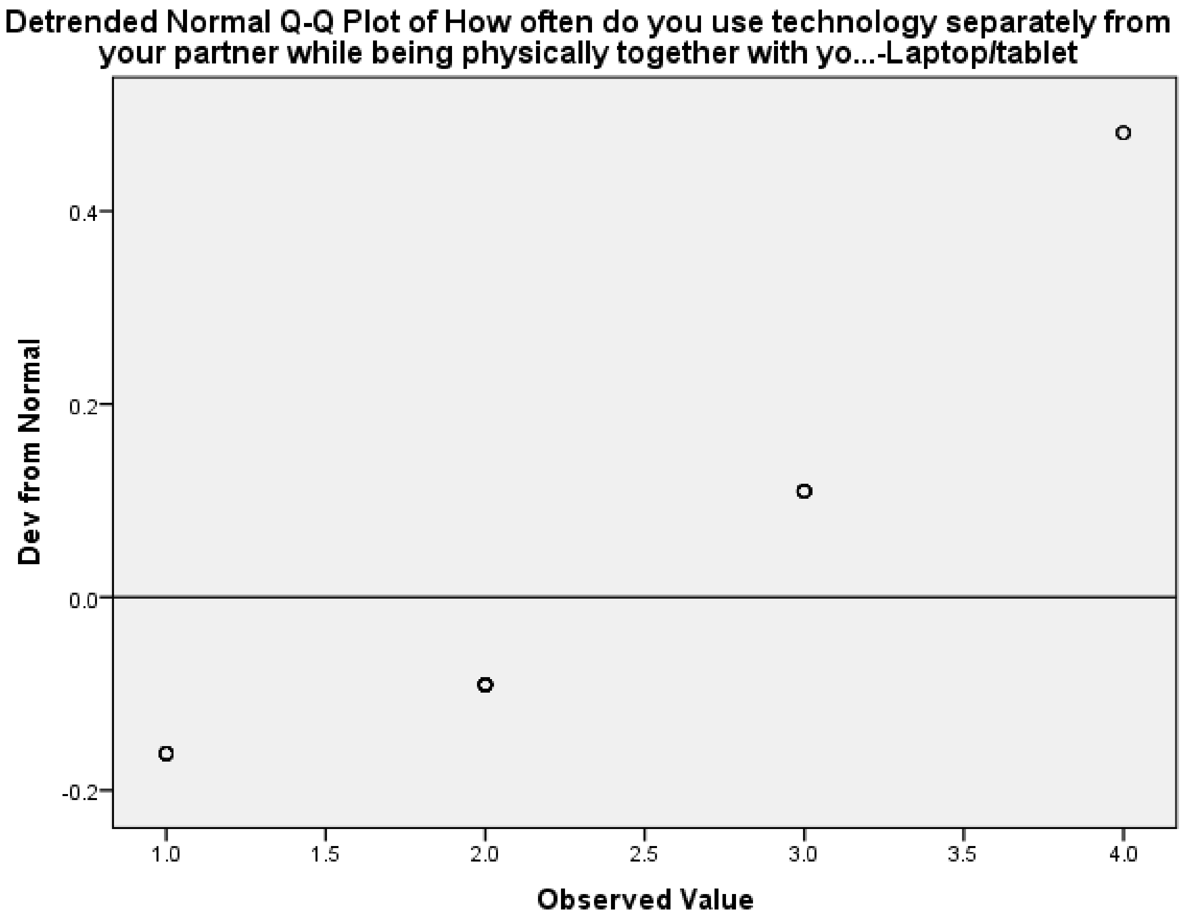


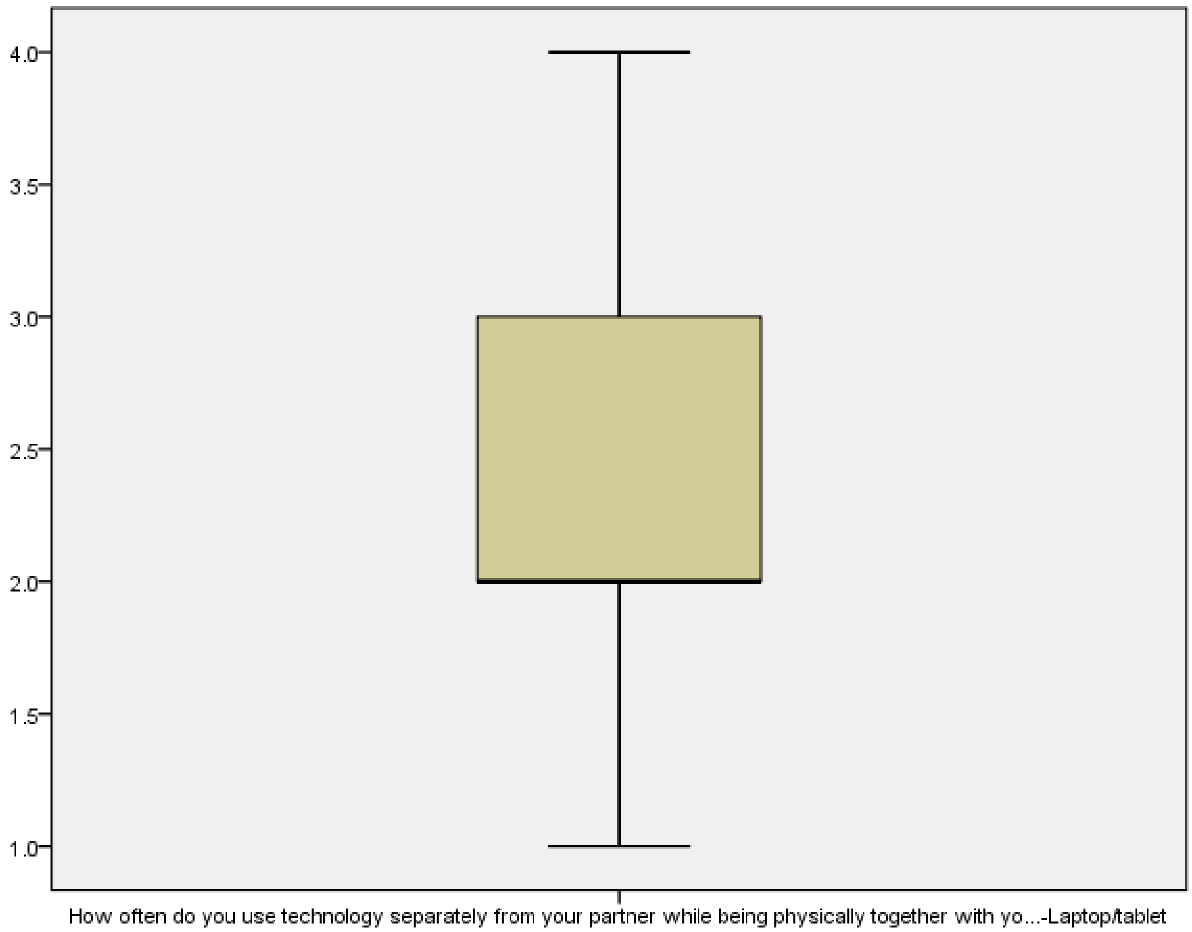

Detrended Normal Q-Q Plot of How often do you use technology separately from your partner while being physically together with yo...-Computer
Dev from Normal
Observed Value
0.6
0.4
0.2
0.0
-0.2
1.0
1.5
2.0
2.5
3.0
3.5
4.0


4.0
3.5
3.0
2.5
2.0
1.5
1.0
How often do you use technology separately from your partner while being physically together with yo...-Computer

How often do you use technology separately from your partner while being physically together with yo...-Laptop/tablet







Frequencies

[DataSet1] C:\Users\Stina\Desktop\Psychology\Thesis\Results and Stats\thesis working db v5.sav

Statistics

		How long have you been with your partner?	Which of the following do YOU use?-Television	Which of the following do YOU use?-Smart phone/ mobile phone	Which of the following do YOU use?-Computer	Which of the following do YOU use?-Laptop/ tablet	Which of the following does YOUR PARTNER use?-Television	Which of the following does YOUR PARTNER use?-Smart phone/ mobile phone	Which of the following does YOUR PARTNER use?-Computer	Which of the following does YOUR PARTNER use?-Laptop/ tablet
N	Valid	42	42	42	42	42	42	42	42	42
	Missing	0	0	0	0	0	0	0	0	0
Mean		6.29	3.36	4.69	3.79	3.90	3.14	4.43	3.38	3.69
Std. Error of Mean		.469	.198	.080	.203	.159	.203	.133	.196	.182
Median		6.00	4.00	5.00	4.00	4.00	3.00	5.00	3.50	4.00
Mode		3	4	5	5	4	4	5	3[a]	5
Std. Deviation		3.039	1.284	.517	1.317	1.031	1.317	.859	1.268	1.179
Variance		9.233	1.650	.268	1.733	1.064	1.735	.739	1.607	1.390
Skewness		.059	-.573	-1.398	-.728	-1.202	-.410	-1.462	-.473	-.576
Std. Error of Skewness		.365	.365	.365	.365	.365	.365	.365	.365	.365
Kurtosis		-1.201	-.574	1.078	-.661	1.507	-.868	1.391	-.620	-.510
Std. Error of Kurtosis		.717	.717	.717	.717	.717	.717	.717	.717	.717
Range		10	4	2	4	4	4	3	4	4
Minimum		1	1	3	1	1	1	2	1	1
Maximum		11	5	5	5	5	5	5	5	5
Sum		264	141	197	159	164	132	186	142	155
Percentiles	25	3.00	3.00	4.00	3.00	3.75	2.00	4.00	3.00	3.00
	50	6.00	4.00	5.00	4.00	4.00	3.00	5.00	3.50	4.00
	75	9.00	4.00	5.00	5.00	5.00	4.00	5.00	4.00	5.00

a. Multiple modes exist. The smallest value is shown

Frequency Table

How long have you been with your partner?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-1 years	2	4.8	4.8	4.8
	2-3 years	10	23.8	23.8	28.6
	3-4 years	4	9.5	9.5	38.1
	4-5 years	1	2.4	2.4	40.5
	5-6 years	5	11.9	11.9	52.4
	6-7 years	2	4.8	4.8	57.1
	7-8 years	7	16.7	16.7	73.8
	8-9 years	5	11.9	11.9	85.7
	10 years or more	6	14.3	14.3	100.0
	Total	42	100.0	100.0	

Which of the following do YOU use?-Television

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Seldom	6	14.3	14.3	14.3
	Rarely	3	7.1	7.1	21.4
	Some times	11	26.2	26.2	47.6
	Often	14	33.3	33.3	81.0
	Very Often	8	19.0	19.0	100.0
	Total	42	100.0	100.0	

Which of the following do YOU use?-Smart phone/mobile phone

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Some times	1	2.4	2.4	2.4
	Often	11	26.2	26.2	28.6
	Very Often	30	71.4	71.4	100.0
	Total	42	100.0	100.0	

Which of the following do YOU use?-Computer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Seldom	3	7.1	7.1	7.1
	Rarely	5	11.9	11.9	19.0
	Some times	8	19.0	19.0	38.1
	Often	8	19.0	19.0	57.1
	Very Often	18	42.9	42.9	100.0
	Total	42	100.0	100.0	

Which of the following do YOU use?-Laptop/tablet

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Seldom	2	4.8	4.8	4.8
	Rarely	2	4.8	4.8	9.5
	Some times	6	14.3	14.3	23.8
	Often	20	47.6	47.6	71.4
	Very Often	12	28.6	28.6	100.0
	Total	42	100.0	100.0	

Which of the following does YOUR PARTNER use?-Television

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Seldom	8	19.0	19.0	19.0
	Rarely	3	7.1	7.1	26.2
	Some times	12	28.6	28.6	54.8
	Often	13	31.0	31.0	85.7
	Very Often	6	14.3	14.3	100.0
	Total	42	100.0	100.0	

Which of the following does YOUR PARTNER use?-Smart phone/mobile phone

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Rarely	2	4.8	4.8	4.8
	Some times	4	9.5	9.5	14.3
	Often	10	23.8	23.8	38.1
	Very Often	26	61.9	61.9	100.0
	Total	42	100.0	100.0	

Which of the following does YOUR PARTNER use?-Computer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Seldom	5	11.9	11.9	11.9
	Rarely	4	9.5	9.5	21.4
	Some times	12	28.6	28.6	50.0
	Often	12	28.6	28.6	78.6
	Very Often	9	21.4	21.4	100.0
	Total	42	100.0	100.0	

Which of the following does YOUR PARTNER use?-Laptop/tablet

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Seldom	2	4.8	4.8	4.8
	Rarely	5	11.9	11.9	16.7
	Some times	10	23.8	23.8	40.5
	Often	12	28.6	28.6	69.0
	Very Often	13	31.0	31.0	100.0
	Total	42	100.0	100.0	

Correlations

[DataSet1] C:\Users\Stina\Desktop\Psychology\Thesis\Results and Stats\thesis working db v5.sav

Descriptive Statistics

	Mean	Std. Deviation	N
Extent of agreement with partner (average of 10 “agreement” questions)	5.9471	.53391	42
Perception of relationship (mean of 16 relationship feel andrelationship sat questions)	4.1667	.34994	42
When using technology together such as watching television, how often do you interact and engage wit...-Television	3.68	.722	41
When using technology together such as watching television, how often do you interact and engage wit...-Smart phone/mobile phone	3.12	.872	41
When using technology together such as watching television, how often do you interact and engage wit...-Computer	2.98	1.097	40
When using technology together such as watching television, how often do you interact and engage wit...-Laptop/tablet	3.03	.947	40
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Television	3.98	.689	41
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Smart phone/mobile phone	2.76	.994	41
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Computer	2.56	1.071	39
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Laptop/tablet	2.82	1.048	39
How often do you use technology separately from your partner while being physically together with yo...-Television	2.34	.938	41
How often do you use technology separately from your partner while being physically together with yo...-Smart phone/mobile phone	2.71	.742	42
How often do you use technology separately from your partner while being physically together with yo...-Computer	1.95	.947	41
How often do you use technology separately from your partner while being physically together with yo...-Laptop/tablet	2.24	.860	41

Correlations

		Extent of agreement with partner (average of 10 "agree ment" questions)	Perception of relationship (mean of 16 relationship feel and relationship sat questions)	When using technology together such as watching television, how often do you interact and engage wit...-Television	When using technology together such as watching television, how often do you interact and engage wit...-Smart phone/ mobile phone	When using technology together such as watching television, how often do you interact and engage wit...-Computer	When using technology together such as watching television, how often do you interact and engage wit...-Laptop/ tablet	To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Television	To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Smart phone/ mobile phone	To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Computer	To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Laptop/ tablet	How often do you use technology separately from your partner while being physically together with yo...-Television	How often do you use technology separately from your partner while being physically together with yo...-Smart phone/ mobile phone	How often do you use technology separately from your partner while being physically together with yo...-Computer	How often do you use technology separately from your partner while being physically together with yo...-Laptop/ tablet
Extent of agreement with partner (average of 10 "agreement" questions)	Pearson Correlation	1	.560**	.430**	.289	.376*	.341*	.366*	.331*	.302	.342*	-.117	-.205	-.021	-.137
	Sig. (2-tailed)		.000	.005	.067	.017	.031	.019	.034	.062	.033	.466	.192	.897	.393
	N	42	42	41	41	40	40	41	41	39	39	41	42	41	41
Perception of relationship (mean of 16 relationship feel andrelationship sat questions)	Pearson Correlation	.560**	1	.515**	.357*	.370*	.308	.633**	.360*	.498**	.426**	.137	.106	-.017	-.394*
	Sig. (2-tailed)	.000		.001	.022	.019	.053	.000	.021	.001	.007	.393	.505	.917	.011
	N	42	42	41	41	40	40	41	41	39	39	41	42	41	41
When using technology together such as watching television, how often do you interact and engage wit...-Television	Pearson Correlation	.430**	.515**	1	.420**	.507**	.464**	.336*	.203	.429**	.193	.237	-.008	.233	-.147
	Sig. (2-tailed)	.005	.001		.006	.001	.003	.032	.203	.006	.245	.135	.958	.143	.364
	N	41	41	41	41	40	39	41	41	39	38	41	41	41	40
When using technology together such as watching television, how often do you interact and engage wit...-Smart phone/mobile phone	Pearson Correlation	.289	.357*	.420**	1	.727**	.716**	.088	.583**	.403*	.560**	-.205	-.155	-.114	-.242
	Sig. (2-tailed)	.067	.022	.006		.000	.000	.583	.000	.011	.000	.198	.333	.479	.132
	N	41	41	41	41	40	39	41	41	39	38	41	41	41	40
When using technology together such as watching television, how often do you interact and engage wit...-Computer	Pearson Correlation	.376*	.370*	.507**	.727**	1	.597**	.066	.250	.536**	.406*	-.215	-.273	.197	-.265
	Sig. (2-tailed)	.017	.019	.001	.000		.000	.685	.120	.000	.013	.184	.089	.224	.103
	N	40	40	40	40	40	38	40	40	39	37	40	40	40	39
When using technology together such as watching television, how often do you interact and engage wit...-Laptop/tablet	Pearson Correlation	.341*	.308	.464**	.716**	.597**	1	.127	.413**	.281	.526**	-.038	-.311	-.141	-.258
	Sig. (2-tailed)	.031	.053	.003	.000	.000		.441	.009	.092	.001	.820	.051	.391	.107
	N	40	40	39	39	38	40	39	39	37	38	39	40	39	40
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Television	Pearson Correlation	.366*	.633**	.336*	.088	.066	.127	1	.429**	.437**	.353*	.245	.143	.075	-.196
	Sig. (2-tailed)	.019	.000	.032	.583	.685	.441		.005	.005	.030	.122	.372	.642	.226
	N	41	41	41	41	40	39	41	41	39	38	41	41	41	40
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Smart phone/mobile phone	Pearson Correlation	.331*	.360*	.203	.583**	.250	.413**	.429**	1	.536**	.828**	.038	.020	.014	-.103
	Sig. (2-tailed)	.034	.021	.203	.000	.120	.009	.005		.000	.000	.814	.900	.933	.529
	N	41	41	41	41	40	39	41	41	39	38	41	41	41	40
To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Computer	Pearson Correlation	.302	.498**	.429**	.403*	.536**	.281	.437**	.536**	1	.665**	.187	.022	.263	-.189
	Sig. (2-tailed)	.062	.001	.006	.011	.000	.092	.005	.000		.000	.254	.894	.105	.255
	N	39	39	39	39	39	37	39	39	39	36	39	39	39	38

To what extent do you feel close to your partner while engaging in technology (e.g., watching televi...-Laptop/tablet	Pearson Correlation	.342*	.426**	.193	.560**	.406*	.526**	.353*	.828**	.665**	1	.085	-.071	-.057	-.036
	Sig. (2-tailed)	.033	.007	.245	.000	.013	.001	.030	.000	.000		.612	.669	.733	.830
	N	39	39	38	38	37	38	38	38	36	39	38	39	38	39
How often do you use technology separately from your partner while being physically together with yo...-Television	Pearson Correlation	-.117	.137	.237	-.205	-.215	-.038	.245	.038	.187	.085	1	.435**	.300	.429**
	Sig. (2-tailed)	.466	.393	.135	.198	.184	.820	.122	.814	.254	.612		.004	.056	.006
	N	41	41	41	41	40	39	41	41	39	38	41	41	41	40
How often do you use technology separately from your partner while being physically together with yo...-Smart phone/mobile phone	Pearson Correlation	-.205	.106	-.008	-.155	-.273	-.311	.143	.020	.022	-.071	.435**	1	.397*	.463**
	Sig. (2-tailed)	.192	.505	.958	.333	.089	.051	.372	.900	.894	.669	.004		.010	.002
	N	42	42	41	41	40	40	41	41	39	39	41	42	41	41
How often do you use technology separately from your partner while being physically together with yo...-Computer	Pearson Correlation	-.021	-.017	.233	-.114	.197	-.141	.075	.014	.263	-.057	.300	.397*	1	.415**
	Sig. (2-tailed)	.897	.917	.143	.479	.224	.391	.642	.933	.105	.733	.056	.010		.008
	N	41	41	41	41	40	39	41	41	39	38	41	41	41	40
How often do you use technology separately from your partner while being physically together with yo...-Laptop/tablet	Pearson Correlation	-.137	-.394*	-.147	-.242	-.265	-.258	-.196	-.103	-.189	-.036	.429**	.463**	.415**	1
	Sig. (2-tailed)	.393	.011	.364	.132	.103	.107	.226	.529	.255	.830	.006	.002	.008	
	N	41	41	40	40	39	40	40	40	38	39	40	41	40	41

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).