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Physiological measurements and emotional experiences of drawing and clay forming

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ABSTRACT

Experimental research on the psychophysiological effects of different art materials and tasks is still scarce. This mixed methods research focused on physiological changes and emotional experiences in drawing and clay forming during the tasks of copying, creating novel designs and free improvisation within fast and slow timeframes. It combined an experimental setting and analysis of 29 participants' physiology with a qualitative content analysis of 18 participants' stimulated recall interviews. The main findings indicate that fast drawing was mentally the most relaxing. This physiological and qualitative evidence supports the therapeutic use of the fast scribbling tasks commonly used in the warm-up phase of art therapy. Furthermore, compared to drawing, clay forming demanded higher mental and physical effort in both timeframes. Interestingly, while physiology did not significantly differ between the tasks, the qualitative analysis revealed that nondirective clay forming stimulated participants' creative ideation and evoked the most positive emotions. This supports the use of nondirective clay tasks to aid in reaching therapeutic goals. The qualitative results also shed light on the unique and contradictory nature of emotional processes that different art materials, tasks and timing can evoke, highlighting the importance of therapists' skills to sensitively tailor matching interventions for different clients.

Introduction

The use of different art and craft materials is at the core of the art therapeutic relationship, and cognitive, sensory motor, emotional and social aspects are all included in the creative process during the handling of art and craft materials (Groth, Mäkelä, & Seitamaa-Hakkarainen, 2013; Huotilainen, Rankanen, Groth, Seitamaa-Hakkarainen, & Mäkelä, 2018; Lusebrink, 1990; Rankanen, 2011). However, there is only little prior empirical research related to the psychophysical and emotional effects of different art materials and tasks (Czamanski-Cohen, Galili, & Allen, 2020). Furthermore, the body and mind have often been researched separately, since simultaneous body–mind study requires new kinds of transdisciplinary approaches and combination of multiple research methods (Czamanski-Cohen & Weihs, 2016; Seitamaa-Hakkarainen, Huotilainen, Mäkelä, Groth, & Hakkarainen, 2016). In cognitive sciences the study of body–mind interaction has lately become a particular focus of interest (Hari & Kujala, 2009; Wilson, 2002). The theory of embodied cognition includes the perceiving body in sense making and can also enhance understanding of the processes of arts therapies (Koch & Fuchs, 2011).

Art and craft making are multimodal processes that require complex problem-solving processes (Seitamaa-Hakkarainen, Huotilainen, Mäkelä, Groth, & Hakkarainen, 2014) and decision making (Groth, 2015) as well as hand-eye coordination. They are based on the extensive

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use of various interrelated senses (Gallace & Spence, 2008) and senso-motoric operations that can also evoke emotions. Studies in neuroscience have shown that our physical experiences, emotions and decision-making processes interact with each other (Damasio, 1994). Measuring different physiological signals such as electrocardiogram, skin conductance, movement or brain activations in experimental setups holds great promise for a deeper understanding of these embodied actions. The neural mechanisms involved in the perception of general motor activities have already been studied for decades using a variety of neurophysiological and neuroimaging methods (for a review, see Rizzolatti & Craighero, 2004). These studies have revealed that sensorimotor areas of the brain activate as a response to seeing other people working (Borghia & Cimattic, 2010), to seeing hand-held tools (Witt, Kemmerer, Linkenauger, & Culham, 2010) or even to seeing abstract works of visual art (Umilta, Berchio, Sestito, Freedberg, & Gallese, 2012).

Art therapy takes place in triangular relationship where both the human relationship and the relationship to art form the therapeutic working alliance. Since extensive amount of psychotherapy studies have focused on the psychotherapy alliance from the perspective of the human relationship and the common therapeutic factors, it is also important to focus research at the art therapy specific factors of working alliance: the art makers emotional experiences of art making and materials (the bond element) as well as artistic tasks and goals.

This mixed methods study focuses on the psychophysiological and emotional experiences that took place during the handling two different art materials in a strict experimental setting that enabled comparison of three different tasks and two different timings. The analysis of both quantitative and qualitative data aims to construct a more comprehensive picture of how different creative tasks and materials affect art makers' embodied and emotional processes. Of particular interest is how drawing and clay forming differ during copying, creating novel designs and free improvisation tasks. Psychophysiological experiment and related stimulated recall interviews were used to explore the possible quantitative and qualitative differences of embodied and emotional aspects during reproduction and creative processes. This article is based on a multidisciplinary Handling Mind research project.

The effect of drawing and clay forming on emotional experiences

There is some previous empirical research that studies the effect of either drawing or clay forming on mood and emotion regulation by utilising different self-rating questionnaires (DePetrillo & Winner, 2005; Drake & Winner, 2012; Drake, Coleman, & Winner, 2011; Kimport & Hartzell, 2015; Kimport & Robbins, 2012). Most of the studies have tested the effect of varying drawing or clay forming tasks on participants' mood and emotional regulation after first inducting a negative mood. In general, the drawing studies testing short term effects on mood improvement have focused on comparing different drawing tasks that are designed to work as opposing emotion regulation strategies producing either venting or distraction (DePetrillo & Winner, 2005; Drake & Winner, 2012, 2013; Drake et al., 2011). These studies suggest that distraction reduces negative mood more effectively than venting as a short-term emotion regulation strategy. Furthermore, some of them show evidence that copying is not as effective a task as more imaginative and self-expressive tasks (DePetrillo & Winner, 2005; Drake & Winner, 2013). Similarly, one randomised controlled trial (RCT) study that compared the effect of clay forming and handling of stress balls on reducing negative mood showed greater mood enhancement following five minutes of clay handling than ball handling (Kimport & Robbins, 2012). It suggested that both non-directive clay forming and pinch pot shaping are effective in reducing negative mood states.

Other empirical studies have focused more specifically on the effect of art making on anxiety reduction (Bell & Robbins, 2007; Kimport & Hartzell, 2015). Kimport and Hartzell (2015) studied the effect of creating clay pinch pots on psychiatric in-patient's anxiety levels with pre- and post-test in a single intervention. In their research, participants could use two different clay materials to form pinch pots, and they found a statistically significant reduction of anxiety after clay forming regardless of the quality of the clay. Bell and Robbins (2007) instead compared in their RCT the effect of active art making to the effect of sorting and grouping of prints of famous paintings on healthy adult participants. They used non-directive drawing with a choice of crayons, coloured pencils, charcoal pencils, or oil pastels as the active art making condition. The participants of the study showed a greater reduction in negative mood and anxiety scores in the art production group when compared to the art viewing group.

Furthermore, multiple research works study more specifically subjectively evaluated anxiety reduction after colouring mandalas and compare the effect to different kinds of tasks, such as free colouring, copying or other kind of drawing tasks (Ashlock, Miller-Perrin, & Krumrei-Mancuso, 2018; Babouchkina & Robbins, 2015; Campenni & Hartman, 2020; Curry & Kasser, 2005; Duong, Stargell, & Mauk, 2018; Eaton & Tieber, 2017; Flett et al., 2017; van der Vennet & Serice, 2012). Results from these studies consistently show that drawing mandalas reduces anxiety. However, their results are contradictory when comparing the effect of structured mandala drawing to more unstructured or free drawing tasks. Part of the studies show that both structured colouring of mandalas as well as more free drawing are equivalently effective for reducing anxiety (Ashlock et al., 2018; Campenni & Hartman, 2020; Duong et al., 2018; Mantzios & Giannou, 2018). On the other hand, some studies found that structured mandala colouring led to greater anxiety reduction or mood improvement than other kinds of drawing tasks (Babouchkina & Robbins, 2015; Curry & Kasser, 2005; van der Vennet & Serice, 2012).

These previous studies suggest that both clay forming and drawing have therapeutic effects and that the effects might depend upon the given tasks. However, these previous studies have focused on the effect of art material and task on mood and anxiety by only using questionnaires. They have not measured physiology or recorded qualitative interview data on how the participants experienced the art making task and art material. Analysis of both physiological data and participants' descriptions might offer more detailed knowledge of their emotional processes and increase understanding of the therapeutic mechanisms related to different art materials and tasks. Furthermore, qualitative analysis can shed light upon those aspects' that participants might experience as aiding or challenging the creative process (Rankanen, 2014). In addition to documenting and analysing participants' qualitative descriptions, the tracking of participants' physiological measurements during art making can construct a more comprehensive picture of the body-mind process related to different materials and tasks in the clinical practice of art therapy.

Physiological measuring of drawing and forming process

Some neuroscientific studies related to art therapy have already been published that compare physiological measuring of brain activity during drawing and sculpting (Kurk, Aravich, Deaver, & DeBeus, 2014) or analyse the effects of drawing on alpha activity (Belkofer, Vaughan Van Hecke, & Konopka, 2014). These studies used EEG to examine the brain activity frequency patterns of participants engaging in art making. In general, non-event-locked physiological and brain activity is represented in patterns related to cognitive processes and in response to environmental stimuli. Theta activity is shown to be related to imaginative states and creative processes. Alpha activity is most prominent in relaxed and normal conscious awareness. Beta activity is observed during active thought and alert states. Gamma band activity is quite consistently correlated with cross-modal stimulus integration, synthesis, and information-rich processing (Luck, 2005). Results from the study by Kurk et al. (2014) showed that both clay forming and drawing increased gamma activity in the right medial parietal lobe compared to general movements. Further, sculpting clay decreased right medial frontal

gamma power and elevated theta activity. In addition, a study by Belkofer et al. (2014) indicated that alpha activity may play an important role in drawing. In other words, drawing and clay forming appear to be information-rich tasks requiring simultaneous cognitive processing. Based on these preliminary studies it could be hypothesised that drawing may provide a more relaxed state and clay forming could enhance the imaginative creative state.

Another possible physiological method of measuring mental and emotional reactions during handling art materials is the use of heart rate variability (HRV) (Czamanski-Cohen et al., 2020; Haiblum-Itskovitch, Czamanski-Cohen, & Galili, 2018). HRV is the natural fluctuation in the beat-to-beat intervals of the heart. It reflects the balance between the sympathetic and parasympathetic activations of the autonomous nervous system. Increased mental stress, meaning decreased HRV, leads to the activation of the sympathetic nervous system and an almost simultaneous withdrawal of the parasympathetic nervous system. This often results in a higher heart rate, more muscular tension, faster breathing, and feeling tense, irritated and/or restless. Generally, short-term increases in HRV are associated with relaxation, openness and positive mental effort, while long-term high levels of HRV are related to good health.

Previous studies (Cinaz, Arnrich, La Marca, & Tröster, 2013) have shown that several time- and frequency-domain related HRV metrics are relevant measures to track the interaction between cognitive and physiological processes. The underlying hypothesis in such studies is that cardiac activity reveals detailed reactions to any mental or physical activity: therefore, also during the creative process. Similarly, in their study measuring emotional arousal, Dunn et al. (2010) showed that cognitive-affective processing relates significantly to bodily responses. During the study, they presented affective images and recorded participants' heart rate (HR) to measure their bodily response to the images. Herbert, Pollatos, Flor, Enck, and Schandry (2010) applied the same method, and pointed out that cardiac activity is closely related to the arousal level of emotional experiences and that the sensitivity of cardiac signals can easily be measured.

However, while the levels of arousal and stress can be detected via these physiological measurements, they cannot reveal the positive or negative valence of the art maker's emotional experiences. For example, the activation of the sympathetic nervous system and high arousal can be related to either negative or positive emotions, such as anxiety or excitement, respectively, and parasympathetic activation similarly to either bored states or pleasurable relaxation. Furthermore, emotional experiences within the context of art therapy have a complicated nature that also contains contradictory experiences, which are crucial in aiding or hindering therapeutic change process (Rankanen, 2014). In other words, subjective qualitative information from research participants is also needed to provide a more comprehensive picture of the effects of different art materials and tasks.

This mixed methods study focused on exploring the physiological and emotional differences between handling the 2D and 3D materials. The research question was: How do drawing and forming clay differ in measures of physical and mental stress, and experiences of positive and negative emotions, during tasks of copying, creating novel design or free improvisation with respect to different timings? We chose to limit the time that the participants had for the tasks since many physiological processes are very time-dependent. At the time of conducting the experiment there were no prior studies with similar physiological comparisons and we wanted to make sure that the time is long enough to see the differences between the tasks but also short enough to make sure that the participants spend all of the allocated time completely absorbed in the task. Since colours are both important and complex component effecting on emotional experiences, we chose art materials and stimulus photographs without colours.

We created an experimental setting for measuring the physiological effects of different art materials and tasks that was followed by simulated recall interviews. Participants' physiology and arousal level was measured via HRV, and their transcribed descriptions of emotional experiences were analysed using qualitative content analysis. Triangulation of quantitative and qualitative data and methods provided more comprehensive and trustworthy information on the participants' physiological activity and emotional experiences during drawing and forming activities.

However, creating the experimental setting became ever more complicated and challenging, since it was planned that the same setting would be repeated later in another separate pilot study focusing on neuroscientific measurements. This meant that participants had to be able to fix their gaze and body between the art making tasks, because these fixation moments enable the recording of good quality EEG data. Naturally, this need to control participants moving at regular intervals makes the creative setting quite rigid but measuring a creative process in an experimental setting always demands a compromise between either allowing natural flow or enabling the gathering of good quality comparable physiological data. This article focuses on analysing the physiological and qualitative data from the first experimental research study, but its replicable experimental setting creates a basis for future neuroscientific investigations since it affords a full comparison of two materials, three tasks and two timings without excessive noise on the EEG data.

Methods

Participants

Thirty healthy art and design students and professionals were recruited through a mailing list and wall poster advertisements on the campus of Aalto University. Participants gave their informed written consent prior to the experiment and the study protocol had the ethical approval of the Institute of Behavioral Sciences of the University of Helsinki. Finally, only 29 participants' physiological data was used for the statistical analysis due to technical difficulties with the data of one participant. After inductive macro level analysis of qualitative data, 18 participants' descriptions were chosen for qualitative content analysis at the micro level.

Protocol

The study design begun with experimental part that was followed by stimulated recall interviews (Fig. 1). The experimental setting lasted approximately 3 h and the written instructions for each task was given on a screen using "Presentation" (Neurobehavioral Systems). The instruction would state the material (drawing, forming), the task (copy, design, improvise) and timing (fast, slow). During performing the task, participants physiology was continuously and automatically tracked with a HRV sensor capable of recording full electrocardiogram and heart rate variability. Participants also had an accelerometer on both wrists for hand movement detection. These sensors collected the data at a sampling rate of 1000 Hz.

In addition, participants evaluated their subjective sleepiness and the experienced task load five times during the research. Sleepiness was evaluated using the 9-point questionnaire (1 = extremely alert; 9 = very sleepy, great effort to keep alert, fighting sleep) of the Karolinska Sleepiness Scale (KSS) (Åkerstedt & Gillbert, 1990). The mental, physical, temporal, effort, performance and frustration load was evaluated on a scale of 0–100 using the NASA-TLX assessment tool (Hart & Staveland, 1988). Participants also evaluated their mood state before and after the experimental setting using Finnish version of the shortened Profile of Mood States questionnaire (POMS) (Hänninen, 1989; McNaire, Lorr, & Droppleman, 1981). This questionnaire contains 38 items, measuring eight mood state scales: tension, depression, inefficiency, vigour, fatigue, bewilderment, irritability and forgetfulness.

A stimulated recall interview followed the experimental task. The interviewer selected parts of the video-recorded experimental setting

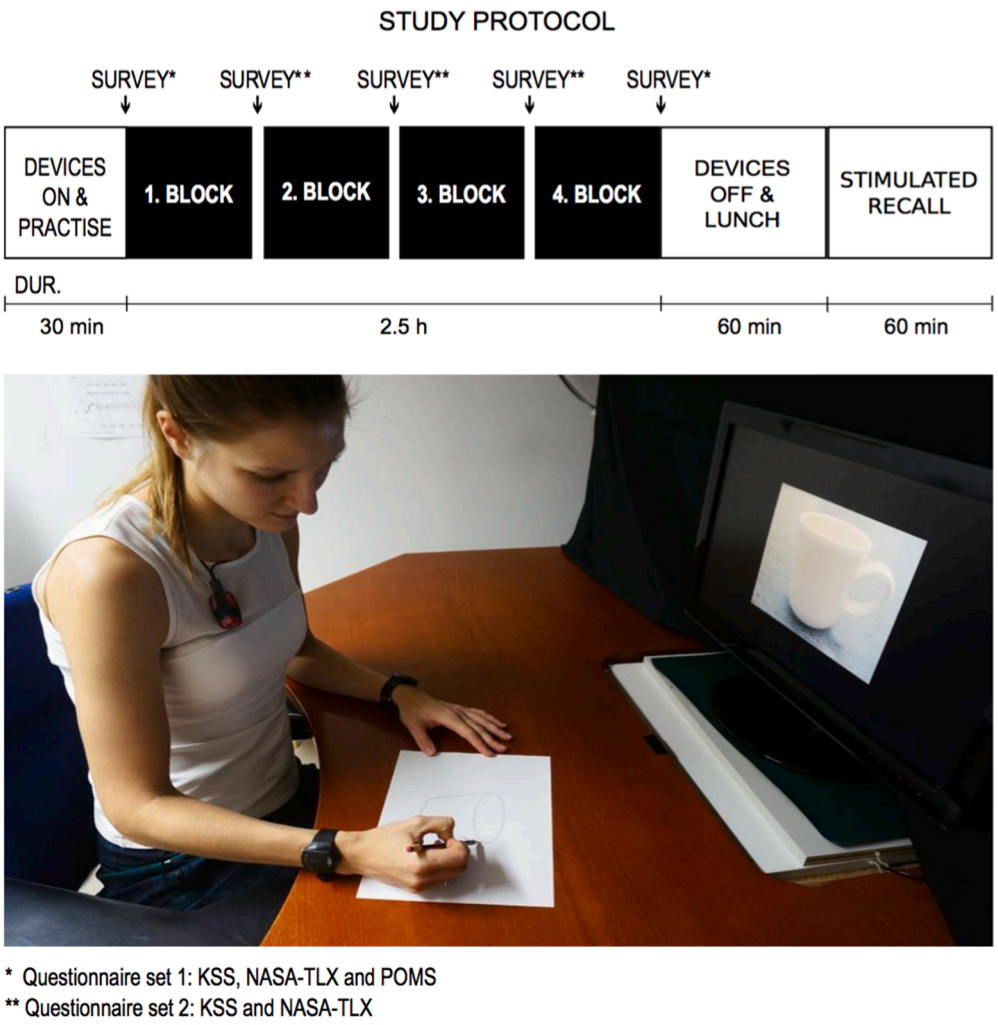

Fig. 1. Study design. Before the experiment participants signed an informed consent and study design was described to them by research assistant. The experimental protocol comprised of four blocks (fast drawing, slow drawing, fast clay forming, slow clay forming) that were completed in front of a computer. The interview followed experimental part.

and then watched these privately with each participant during the interview. The participants had the opportunity to reflect and comment upon their embodied and emotional experiences of the art making processes, different tasks and materials. These hour-long interview sessions were video recorded and transcribed for analysis.

Fig. 2. The cups presented as stimuli in the study.

Measurement blocks

The three creative tasks in the experiment were: (a) a copying task – drawing/forming a copy of a cup on the basis of a photograph, (b) a design task – creating a new design for a cup, and (c) a free improvisation task – a nondirective creative work. These three task instructions were chosen to present varying amount of structure and creative freedom.

The participants had either a shorter 45-second time period ("fast") or a longer 3-minute time period ("slow") to perform the given copying, designing or improvising task. First, they saw a written instruction of the upcoming task. Thereafter, they looked at a photo of a white ceramic cup (5 s) and an empty screen with a fixation cross (10 s). Ten cups with different surface patterning and shapes were shown before all tasks and used as a starting point in the copying task (Fig. 2).

In order to have a duration sufficient for gathering physiological data (Task Force, 1996), participants performed each task five times in a row in a fast block (5 min 25 s) and repeated this. This means that the fast block consisted of 30 tasks, ten copying, designing and improvising tasks following each other in a forced-pace manner. Conversely, in the slow block, each task was repeated twice (6 min 40 s). Each participant performed four blocks in total: (a) fast drawing, (b) slow drawing, (c) fast clay forming, (d) slow clay forming (Fig. 3). The order of blocks and tasks was randomised across participants to minimise the effects of novelty (first blocks) and fatigue (last blocks). At the end of the study, each participant had made 42 drawings and 42 clay pieces in total (Figs. 4 and 5).

Fig. 4. Clay objects made according to the mixed copying, designing and improvisation tasks.

Quantitative and qualitative analysis of the data

HRV data

The (a) time-domain, (b) frequency-domain, and (c) non-parametric

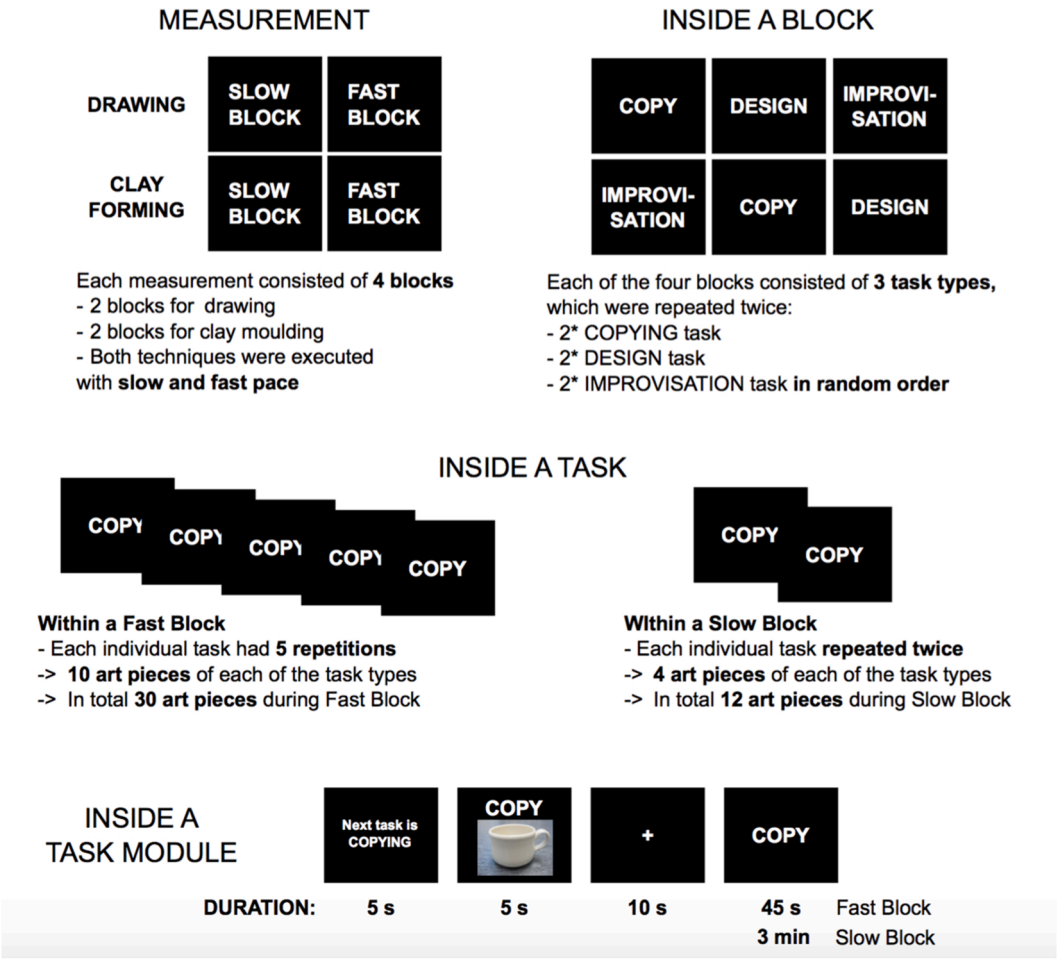

Fig. 3. The experiment had four randomised measurement blocks: a) fast drawing, b) slow drawing, c) fast clay forming, d) slow clay forming. Inside each of the four blocks, participant repeated three different tasks: a) copying, b) design, c) improvisation. The amount of repetition differed between five fast tasks and two slow tasks. Between each task participants saw the instruction, stimulus cup and fixation cross on a screen.

Fig. 5. Shelves filling up with clay objects. Each of the 30 participants created 42 clay objects, resulting in a total of 1260 objects.

parameters from the HRV electrocardiogram signal were analysed, and the data was cleaned before analysis (Xu & Schuckers, 2001). The time-domain analysis included mean heart rate (HR), standard deviation of R-R intervals (SDNN), root mean square of the successive R-R differences (rMSSD) and the portion of the successive, consecutive R-R differences which differed by more than 50 ms (pNN50). The high frequency (0.15–0.4 Hz, HF) power, the low frequency (0.04–0.15 Hz, LF) power, and their LF/HF ratio from the frequency domain were analysed. The Poincaré plot indices (SD1 and SD2) were calculated from the non-parametric parameters. In these measured parameters, the increase in SDNN, rMSSD, pNN50, HF, SD1 and SD2 indicate higher parasympathetic activation.

Statistical testing

All statistical tests were carried out in an R environment and a linear mixed-effects analysis (Bates, Maechler, Bolker, & Walker, 2015) of the relationship between material, timing and task was performed separately on all HRV indices. Material, timing and task were treated as fixed effects and the interaction term was added. As a random effect, we had intercepts for subject as well as a by-subject random slope crossed to material and timing. Homoscedasticity and normality were inspected visually from the residual plots. The impact of fixed effects was tested using likelihood ratio tests through comparing the full model with the effect in question against a model without that effect. The p-values from the Chi-Square tests are reported. When significant simple effects or interactions were found, post-hoc multiple pairwise comparison tests with Bonferroni-adjustment were applied (Lenth, 2016). KSS and NASA-TLX results were similarly compared to HRV indices, but using the combination of material and timing (for example, fast drawing) as a fixed effect and the subject as a random effect. The repeated measures Student's t-tests were conducted in order to test the significance of POMS-results at the beginning and end of the experimental setting. In all of the tests, the level of significance was set at $p < 0.05$. Second author conducted all quantitative analyses.

Qualitative content analysis of stimulated recall interviews

For the qualitative part of the study, the video-recorded stimulated recall interviews of 30 participants were first inductively macro analysed. Based on the macroanalysis, 18 participants' data was chosen for microanalysis. The interviews were transcribed and then analysed using systematic qualitative content analysis (Hsieh & Shannon, 2005). The categories from the quantitative analysis were used as a pre-set categorisation matrix for analysing the positive and negative emotional qualities in the participants' descriptions. The qualitative data was also analysed in two separate rounds focusing on (a) material and time, (b) task. This approach was chosen to match the qualitative analysis with the quantitative analysis and to enable making comparison between qualitative and quantitative findings.

The transcribed material was first coded according to the time (fast or slow) and the material modality used (drawing or clay) and grouped under four categories: fast clay forming, fast drawing, slow clay forming or slow drawing. The emotional quality of the participants descriptions in these categories was then inductively analysed according the positive, negative or ambivalent emotional content related to the interplay of different material modalities and timings.

Another separate coding and content analysis process was conducted to categorise the data according to the task (copying, designing or improvisation) to match with the statistical analysis. The emotional quality of the descriptions for nondirective improvising clay forming and drawing was analysed separately. The participants' descriptions of their emotional experiences during the copying and design tasks were instead analysed without specifying the art material used. The participants' descriptions positive, negative and ambivalent emotional qualities were analysed within the categories of: (a) improvisation by clay forming, (b) improvisation by drawing, (c) copying by drawing and clay forming, and (d) designing by drawing and clay forming. Analysis was conducted by the first author and dialogue among colleagues was conducted to increase the credibility of qualitative analysis and its trustworthiness is enhanced by presenting excerpts from the data in the result tables.

Quantitative results

Questionnaires

The subjective sleepiness values (KSS) did not change dramatically across the experiment, and there were no significant differences between drawing and clay forming or fast and slow tasks (Fig. 6). The experienced task load values (NASA-TLX) differed significantly within the subscales of physical, $X^2(3)= 19.21$, $p < 0.001$, and temporal load, $X^2(3)= 46.41$, $p < 0.001$, as well as effort, $X^2(3)= 20.16$, $p < 0.001$ (Fig. 6). Fast clay forming (M 62.59, SD 20.5) required the most effort compared to the other tasks, and the difference was significant over both slow clay forming ($M = 51.28$, $SD = 21.1$; $p = 0.005$) and slow drawing ($M = 47.93$, $SD = 18.2$; $p < 0.001$).

The most prominent differences were seen in the subscale of temporal load. In temporal load, the participant was asked to answer the question: "How hurried or rushed was the pace of the task?", where the higher score represents very high, and the lower very low. Participants ranked fast clay forming ($M = 74.07$, $SD = 22.4$) as the most temporally demanding. Both slow blocks, clay forming ($M = 54.66$, $SD = 19.6$, $p < 0.001$) and drawing ($M = 42.59$, $SD = 25.4$, $p < 0.001$) were significantly less demanding temporally compared to fast clay forming. Slow drawing was ranked the least temporally demanding task of the four. It was significantly lower compared to fast drawing ($M = 62.72$, $SD = 22.5$; $p < 0.001$).

The physical demands strongly highlighted the effect of material on physical action. Clay forming, in both fast and slow settings, was experienced as more physically demanding than drawing. The physical load was significantly higher for slow clay forming ($M = 38.41$, $SD = 24.0$) than for slow drawing ($M = 25.55$, $SD = 20.7$; $p = 0.006$). In addition, slow drawing was significantly lower compared to fast clay forming ($M = 40.31$, $SD = 27.4$; $p = 0.001$). The general factors of POMS mental states (only 26 participants had both the prior and after answers recorded) were found to differ significantly only in the vigour scale, yielding higher values in the beginning ($M = 13.3$, $SD = 3.9$) compared to the end ($M = 11.4$, $SD = 3.4$; $t25 = 2.8$, $p < 0.05$).

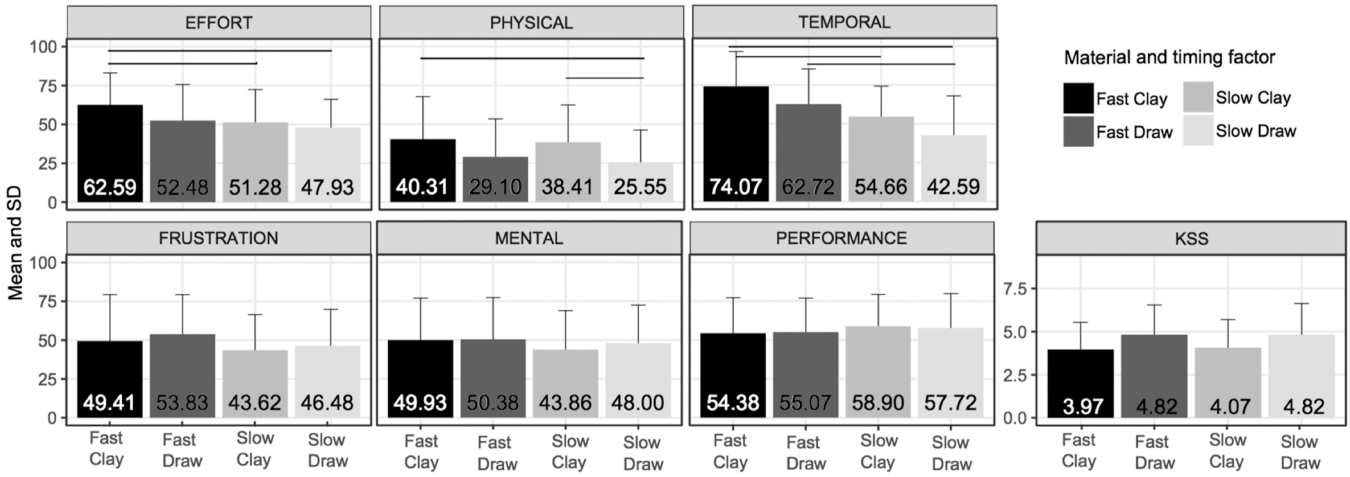

Fig. 6. Experienced Task load, NASA-TLX, and subjective sleepiness, KSS values during the study for fast and slow clay forming and fast and slow drawing. In the NASA-TLX, a score of 100 represents high general effort, physical, temporal, and mental load, high frustration, and good performance. In KSS, a smaller value indicates a more alert state. The mean and standard deviation values are marked on the graph. The upper row indicates the subscales which were significant. At the Bonferroni-adjusted alpha level of p = 0.008, significant comparisons are denoted with lines.

Physiology

A mixed-models analysis with fixed effects of material modality (drawing, clay forming), timing (fast, slow) and task (copy, design, improvisation) was conducted on each HRV metric separately, using the subject as a random effect. The simple effect of material was significant on mean HR, rMSSD, pNN50, LF, HF, LF/HF and SD1 (Table 1). Mixed-model results indicate that forming of clay (M = 76.9, SD = 10.20) demanded more physical effort, which was seen as a significantly higher mean HR compared to drawing (M = 72.3, SD = 9.8). In addition to physical effort, mental demands, highlighted as a lower rMSSD, pNN50, SD1 and HF as well as higher LF/HF, were significantly higher when forming clay than when drawing (Table 1).

As Table 2 shows, the timing of the task had a simple effect on the time-domain metrics of rMSSD and pNN50, both Poincaré indices, SD1 and SD2, as well as frequency-domain metrics of LF and the ratio, LF/HF. The high frequency, HF was marginally significant ($X^2(1) = 3.78$, p = 0.052). All significant parameters showed higher values in the fast setting compared to the slow setting. The results are not straightforward to interpret. The results are consistent with more parasympathetic activation in fast timing compared to slow timing, when the parameters rMSSD, pNN50, SD1, SD2 and HF are being investigated, but in contrast, there is more sympathetic activation according to LF and LF/HF for fast timing compared to slow timing. Interestingly, bodily effort was not found to differ statistically significantly in the simple timing factor as the mean HR was 74.5 bpm (10.4) and 74.7 bpm (9.9), in fast and slow settings, respectively.

Table 1
The effect of material on different HRV metrics. The simple effect was significant on Mean HR, rMSSD, pNN50, LF, HF, LF/HF and SD1.

	Material modality Mean (SD)		Maximum likelihood ratio test results		
	Drawing	Clay forming	Chi-square value	Df	p-value
Mean HR	72.3 (9.8)	76.9 (10.0)	22.33	1	< 0.001
rMSSD	39.9 (22.9)	34.0 (16.8)	12.14	1	< 0.001
pNN50	18.8 (17.2)	14.2 (14.4)	14.17	1	< 0.001
SD1	28.2 (32.1)	24.1 (11.9)	12.14	1	< 0.001
LF	1519.5 (1642.6)	1080.0 (857.2)	8.75	1	0.003
HF	793.8 (977.9)	508.6 (527.7)	8.50	1	0.004
LF/HF	2.8 (1.6)	3.2 (2.1)	6.93	1	0.008

Table 2
The effect of timing on different HRV metrics. The simple effect was significant on rMSSD, pNN50, LF, HF (marginally), LF/HF and Poincaré indices, SD1 and SD2.

	Timing Mean (SD)		Maximum likelihood ratio test results		
	Fast	Slow	Chi-square value	Df	p-value
rMSSD	38.5 (22.2)	35.3 (18.1)	4.10	1	0.043
pNN50	17.4 (16.4)	15.6 (15.6)	10.18	1	0.001
SD1	27.3 (15.7)	25.0 (12.8)	4.10	1	0.043
SD2	83.9 (30.2)	75.8 (26.5)	10.58	1	0.001
LF	1502.7 (1539.6)	1096.9 (1038.7)	13.14	1	< 0.001
LF/HF	3.2 (2.0)	2.8 (1.8)	7.39	1	0.007

Significant interaction between material and timing was found in the mean HR, rMSSD, SDNN, pNN50, LF, HF and SD1. Table 3 and Fig. 7 present the means and standard deviations as well as the Chi-square test results with p-values for this interaction. Further post-hoc comparisons at the alpha level of p = 0.008 revealed that fast drawing differed significantly from the others. We found strong evidence (p < 0.001) of the differences between material modalities in the fast setting. Clay forming yielded a higher physical effort (mean HR) compared to drawing. Additionally, rMSSD, pNN50, HF and SD1 were higher in drawing compared to clay forming, indicating less mental effort for drawing as can be seen in Fig. 7. Importantly, we also found that fast drawing was significantly higher in rMSSD (p = 0.001), SDNN (p < 0.001), HF (p = 0.003), SD1 (p = 0.001) and SD2 (p < 0.001) than slow drawing. This could be interpreted as indicating that in drawing, the slow setting was mentally more demanding compared to the fast setting. Physical effort was similar (p = 0.071) between different timings in drawing. In both the above-mentioned comparisons, LF also showed strong significance (p < 0.001), but in the opposite direction compared to the other HRV metrics.

Thirdly, the comparison between fast drawing and slow clay forming showed significant differences in mental effort metrics of rMSSD (p = 0.003), pNN50 (p = 0.001), and SD1 (p = 0.003), yielding higher values for drawing compared to the clay forming. The comparison of mean HR (p < 0.001) was also significant, indicating greater physical effort in slow clay forming than in fast drawing. Again, low frequency, LF (p = 0.003), was not in accordance with the other metrics. In addition, slow drawing differed from fast clay forming in mean HR

Table 3
Material to timing interaction results from Chi-Square tests.

		Mean (SD)		Maximum likelihood ratio test results		
		Fast	Slow	Chi-square value	Df	p-value
Mean HR	Drawing	71.4 (9.8)	73.4 (9.9)	39.72	3	< 0.001
	Clay forming	77.8 (10.1)	76.0 (9.7)			
rMSSD	Drawing	43.4 (26.6)	36.2 (17.9)	17.32	3	< 0.001
	Clay forming	33.5 (15.0)	34.5 (18.2)			
SDNN	Drawing	65.6 (28.0)	56.9 (20.0)	8.17	3	0.043
	Clay forming	59.6 (16.7)	56.5 (19.5)			
pNN50	Drawing	20.9 (18.4)	16.7 (15.7)	11.94	3	0.008
	Clay forming	13.8 (13.0)	14.7 (15.5)			
SD1	Drawing	30.7 (18.8)	25.7 (12.7)	17.33	3	0.001
	Clay forming	23.7 (10.6)	24.4 (12.9)			
LF	Drawing	1856.2 (1928.3)	1177.2 (1000.2)	12.60	3	0.006
	Clay forming	1143.1 (726.5)	1018.4 (918.5)			
HF	Drawing	967.1 (1207.8)	623.3 (577.5)	12.08	3	0.007
	Clay forming	490.3 (464.3)	528.0 (520.9)			

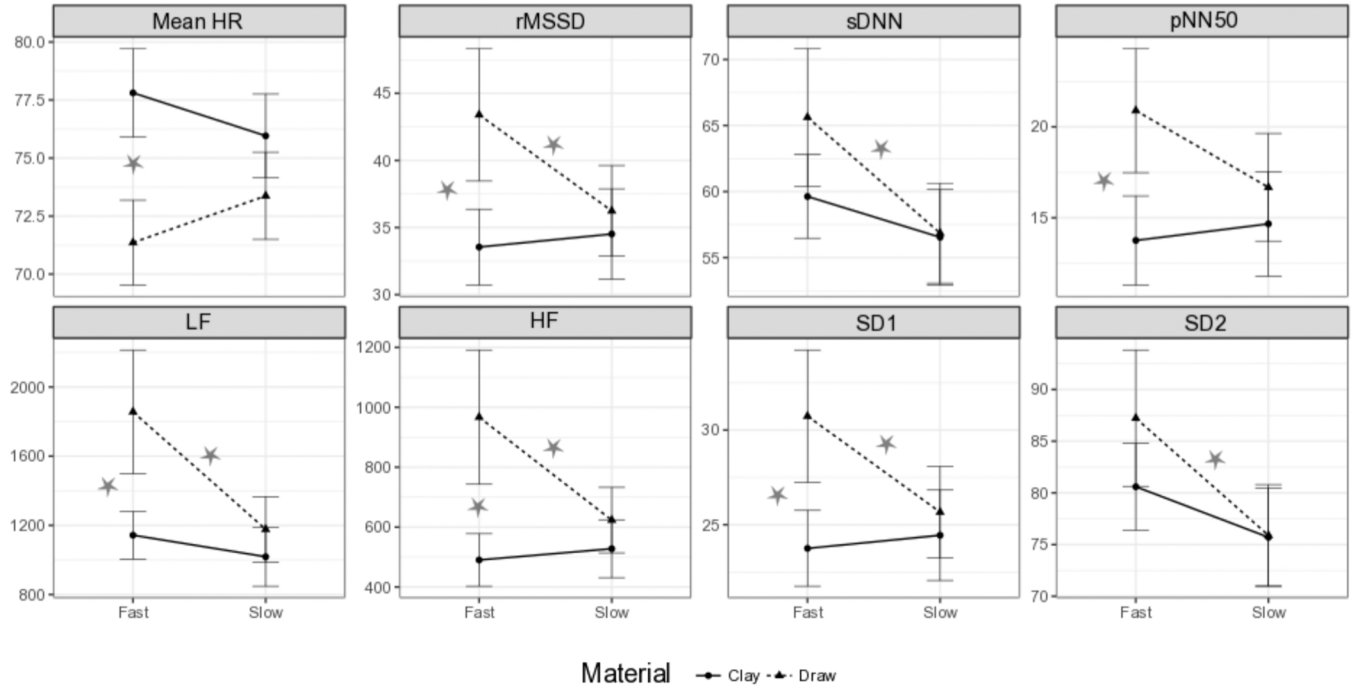

Fig. 7. The significant interactions of material modality (drawing or clay forming) and timing (fast and slow) on time-domain (upper row), frequency-domain (bottom row: two furthest left) and non-parametric (bottom row: two right) HRV metrics. The graphs are mean values with standard error of mean. Significant interactions are denoted with a star shape. The level of significance is p = 0.008.

(p = 0.004), supporting the previous results which indicate that clay forming demands more physical effort compared to drawing regardless of the time participants have for the different tasks. In the pairwise comparisons, none of the HRV metrics showed significant difference between slow and fast clay forming. The closest to significance was mean HR, but it was also far from being significant (p = 0.120). From the mental-effort-related HRV metrics, rMSSD was closest, but it showed only a p-value of 0.600. Therefore, clay forming was physically and mentally equal within the different timeframes.

The task showed a significant simple effect only on mean HR ($X^2(1) = 9.00$, p = 0.011), and further post-hoc tests revealed a significant difference between copying (M = 75.2, SD =10.3) and improvisation (M = 74.2, SD = 9.9; p = 0.006). This result suggests that copying demanded more physical effort from the participants compared to the improvisation task. However, the metrics indicating parasympathetic activation did not react or showed only a minimal increasing tendency for the improvisation and design tasks. Thus, these quantitative results are inadequate to make full conclusions on the differences in the mental requirements of the creative process of the three tasks.

Qualitative results

Stimulated recall interviews

The qualitative content analysis focused on analysing the participants' emotional experiences recounted in the stimulated recall interviews. The four sets of results from the first round of coding and analysis of the interview data are presented first. Next are presented the results of the second round of analysis of the participants' emotional experiences that were related to the copying, designing and free improvisation tasks with clay forming and drawing. Since the experiment took altogether three hours, the quality of the data was rich and the same person could experience a variety of emotional qualities during different times of the experiment and emotions could also be ambivalent. The themes are exemplified by tables with quotations.

Fast clay forming

In the fast clay forming tasks in general, 15 of the 18 participants described the short timing as distressing, irritating and frustrating (Table 4). These negative emotions related to their experience of clay as a "slow" material to form. The hurried clay forming and unfinished products felt unsatisfactory and decreased their motivation. In contrast, three of the participants described the emotional arousal caused by the time limit as an exciting challenge that created positive emotions in them.

Fast drawing

The fast drawing tasks were described as positively stimulating and as meaningful experiences by 13 participants (Table 5). However, five participants mentioned being negatively affected by the stressful time limit. The negative emotions were connected to their experience of the demands of pressure for ideation, irritation linked to half-finished drawings or repetition of the tasks. For those describing positive emotions, the short timing was instead experienced as particularly aiding their spontaneous and relaxed approach to the drawing tasks.

Slow clay forming

In the stimulated recall interviews, not every participant separately mentioned how they experienced the slow time in clay forming, but of the ten participants who did nine described it as emotionally more satisfying and easier than fast clay forming (Table 6). One participant did not feel that there was such a big difference between the different timings, except in the copying task, where it enabled a more detailed forming of the clay. Thus, for the greater part, the descriptions of the slow clay forming tasks in general indicated positive emotions.

Slow drawing

In the same vein, only eleven participants distinctly described their experiences related to the slow timing of drawing tasks and these descriptions had clearly contradictory emotional features (Table 7). Seven of the participants said that they felt emotionally calmer and less strained during these tasks. However, although the three slow drawing

Table 4
The qualitative coding matrix for fast clay forming and examples of the emotional qualities that participants described in the data.

Coding category	Fast clay forming
Negative emotional qualities	– "It was quite difficult to work fast. Frustrating, that I could not make it." 003 – "It was frustrating when it changed so fast that you could not express your vision. It was demanding because the time was too short. Working was hasty and I got stressed feeling." 008 – "It was quite frustrating to do the fast clay works, when it felt that I just spoiled the material, and I did not have time to make anything right. It was more demanding, when I wanted to get something done, but the time was shorter. I began working straight away and did not plan, what it will be." 022 – "In the end I got very frustrated when there were so many ugly and unfinished pieces that had no sense. I gave up trying, which made it mentally easier, but performing was bad I minutes felt stuck." 026 – "Rapid rhythm made me nervous, absolutely. Somehow it irritated, that I was not allowed to finish the things." 027
Positive emotional qualities	– "I had to keep it very simple, and the little stress was continuous. It was exciting and kept me present in each moment." 006 – "In the short time there was no time to think. I am quite impulsive, like impulsive working and trust my instincts. I'm not afraid of mistakes, because failing is always a new chance. I am not that kind of a person, who would ruminate with problems. It was an interesting challenge." 009 – "I wanted to show to myself that I can do this, so it was a kind of challenge for myself." 017

Table 5
The qualitative coding matrix for fast drawing and examples of the emotional qualities that participants described in the data.

	Fast drawing
Positive emotional qualities	– "I found the rapid rhythm meaningful. If I should have drawn a certain picture for ten minutes, I would have been pretty bored. I liked it when it was fast." 002 – "The short time was too short in a good way. It might even have helped that the ideas begun overlap in an interesting way. I did not have time for too conscious thinking." 007 – "It maintained a certain level of alertness, when it just kept changing fast and I felt that I want to find something new each time. So that even if I was tired, I stayed awake." 008 – "The fast tempo was even better. One could not stop to think so much." 011 – "Often I don't think very far ahead what to do. It is my characteristics and personality to just begin doing. The rhythm was a little slow for me. Generally spoken, I am really fast." 014 – " The experiment was really hurried, and I especially liked the hurry with the pencil." 021 – "The fast tasks were more permissive when you knew you cannot do anything finished, but just draw really fast." 022 – "The short time made it somehow simultaneously relieving and heavy. There was a pressure to immediately invent something, but at the same time you could forgive yourself the bad ideas because of the short time. You allow the drawing to become bad or strange. Somehow it was stress-free. I knew the drawings would be unfinished and took it as a challenge, not as a problem." 026
Negative emotional qualities	– "It was maybe most frustrating and stressing to try to do something creative just in a one minute. When you have just waked up, are a little stunned and try to think what you can make, the time has already gone, and you have just drawn some mess on the paper. You had to lower your own expectations and think that no one will grade the picture." 015 – "I was a little bored or frustrated with the limited time. I noticed I was not so ambitious, but just made something. I did not experience it difficult or demanding, but it was just a little irritating." 017

Table 6
The qualitative coding matrix for slow clay forming and examples of the emotional qualities that participants described in the data.

Coding category	Slow clay forming
Positive emotional qualities	– "It felt good and soothing to handle and form the clay." 003 – "I worked by touching and experimenting with the material. It felt wonderful, cold, and soft. Clay was flexible, shaped the way I wanted and adapted to the touch. My forming skills are not too good, but it was easy to handle." 006 – "It was really therapeutic to work with the clay. When I handled it, I felt my mind was resting and I could think through and deal with things. 008 – "Clay felt nice, even if I cannot form. But I think it felt nice just because I needed not to think if I can or not. And I like it as a material, so it was fun." 010 – "Clay felt really good because it was so soft. Somehow it is very grounding and soothing. It just makes you feel good." 014 – "Clay work was really fun, because I have sometimes used it, but it is not very familiar material. Especially within the longer time it was really nice. Clay felt good and soft, and it was nice to form. When you had three minutes you knew you could also get something done." 026
Ambivalent emotional qualities	– "I felt that both times were a little too short. I did not experience the longer time much better." 007

Table 7
The qualitative coding matrix for slow drawing and examples of the emotional qualities that participants described in the data.

	Slow drawing
Positive emotional qualities	– "When there was more time, I drew all different kinds of things I had in mind and planned things. The pace was suitable and peaceful". 002 – "I noticed I took the pencil at hand in a different was and begun draw more freely. There was more variety in the drawing." 011 – "I was less demanding to myself, and I did not bother if it was not any skilful drawing. But pencil is much faster, so it was more easy and less frustrating." 025 – "Drawing was easy and felt quite effortless in all of these drawings." 026
Negative emotional qualities	– "I got frustrated many times during the three minutes – it felt long to just use the time to shade the drawing." 009 – "Sometimes the timing felt too long for me, but I did not mind because I didn't get panic or stress about that." 014 – "It has been a long time since I have been drawing and I was stiff and felt a little embarrassed." 022 – "I got tired and bored. I did not feel challenged. I felt there was too much time, and I just filled the paper." 028

tasks were described as being easier tasks, six participants mentioned that the time for these tasks was overly long and caused demotivation, boredom and even frustrating emotions.

Nondirective improvising with clay

The second separate qualitative analysis of the emotional effects of materials and tasks revealed that all 18 participants described pleasurable experiences connected to handling and sensing the material during the free improvisation task of forming clay (Table 8). Nondirective clay handling was pleasant regardless of the fact that nine of the participants did not have much previous experience of forming clay and clearly found it more difficult than drawing. Furthermore, all 18 participants noted that the creative ideation process during clay handling was mostly felt to be smooth and naturally flowing. They explained that the combination of a nondirective task and a flexible material enabled a spontaneous approach where random action or flaws could turn into surprising, inspiring and rewarding outcomes. Participants described how trying out different hand movements shaped the form or texture of the clay and that the perception of the three-dimensional shape offered them creative ideas. Free improvisation with clay evoked positive emotions and joy in the participants, and only two participants said they had some moments where they experienced difficulties in finding ideas.

Nondirective improvising drawing

Interestingly, the emotional experiences described regarding the free improvisation task during drawing were not as consistently positive, even if the task and technique were more familiar to the participants than clay forming (Table 9). This familiarity could also decrease motivation and interest in the task by making it too easy and unchallenging. Eleven participants described nondirective drawing as intuitive and spontaneous. However, five described difficulties in finding ideas. Nine of the participants said that they aimed to be creative and constantly find new ideas. This self-set goal could either be experienced as an emotionally positive challenge or as a negative demand, which also explains part of the contradictory emotional experiences during the nondirective drawing task.

Copying task

Ten participants described positive emotions related to copying (Table 10). The clearly framed task made working manageable and easy, and the challenge of remembering visual shapes and details made it interesting. However, six of the participants instead found the framing of the task to be too simple and its repetitive nature also made it boring.

Table 8
The qualitative coding matrix for nondirective improvising clay forming and examples of the emotional qualities that participants described in the data.

Coding category	Nondirective improvising clay forming
Positive emotional qualities	– "It was easier to find ideas when you could handle the material. The material gave inspiration, and it was fun to form." 002 – "It was easier to work with clay, when you could do what you wanted without instructions or limits." 003 – "When I just turned my hands, the clay formed itself before I had any idea what to do." 005 – "The free work was most pleasurable, when you could just be with the material and do what you wanted. You did not have time to think, but your hands were just working, and the clay turned into some form. You could just experiment and reform it without any thought. It was fun." 006 – "The clay was resisting to form according to my will. I played with it and experimented what shape it wants to take. It surprised me and I needed to accept it." 007 – "The creative task was most pleasurable when you were free to do anything. You could let go and experiment and suddenly it just matched with the feeling you had." 008 – "In a way you discussed with the clay, hand in hand. It is less controllable than drawing. You could tear it and see how cool it looked and get excited." 009 – "These tasks were relaxing and fun. You did not need to concentrate; you could just let your mind wonder." 010 – "Clay is not so familiar material, and it is more difficult, but it was still fun. I liked it more than drawing. It was more flexible and easier to form. It felt nice in hands, and I was glad. I don't remember I would have been frustrated and I was more motivated than with drawing." 011 – "It was fun to do creative tasks with clay. I had lower expectations and I did not stress how it turned out. It was less demanding somehow. The clay felt nice, and it was therapeutic." 015 – "I did let go of self-criticism quite fast and just begun handling clay to see what comes out of it." 022 – "It was most easy to absorb with the free creative tasks. I got excited and inspired when I got the chance to form clay. It was fun and I forgot the time limits." 026 – "I was attached to the material and enjoyed how it felt. It felt charming because it is not so familiar to me. It was soft and easy to form. I could just experiment and form it according to my feelings. I did not set any demands to myself and there was no stress." 027
Ambivalent emotional qualities	– "Towards the end of the experiment my ideas begun to run out or maybe I got tired. I just tried to form whatever first came to my mind. I also tried to think of new ways to handle it such as pinching." 011

Design task

The participants' descriptions of the design task were the most ambivalent, and five participants experienced positive and five negative emotions (Table 11). In addition, four mentioned that it was motivating and satisfying at the beginning but became frustrating and boring towards the end of the experiment when they ran out of novel ideas. In other words, their emotional valence changed during the experiment from positive to negative. For those who described this task as unpleasant and frustrating, they found it overly demanding compared to their skills or the time limits. On the other hand, those describing it as pleasant and fun were motivated to invent new designs and consciously chose to approach the task with a more spontaneous and freer attitude.

Discussion

Our mixed methods research studied the interplay of the material, the task and two different timings by combining an experimental setting and stimulated recall interviews. It contributes to the understanding gained from previous studies that have explored the effects of different

Table 9
The qualitative coding matrix for nondirective improvising drawing and examples of the emotional qualities that participants described in the data.

	Nondirective improvising drawing
Positive emotional qualities	– "Drawing is more familiar to me than clay forming, which makes it also more demanding - or I set more goals for myself. Drawing was very intuitive, and I was interested in what kind of mars the pencil is leaving on the paper. I did not plan what I drew, but just experimented." 006 – "When I got into the task, I just begun follow the flow of thoughts. Somehow it was quite fun to draw. It was like meditation or entertainment." 022 – "Drawing was easy, it felt effortless, and I continued my ideas in the next papers." 026 – "It was free, easy and relaxed. I played with lines and drew free associations. These creative tasks were best." 027
Negative emotional qualities	– "Especially the creative drawing was more difficult or boring than clay forming. In a way it was frustrating, because creating something by drawing is most demanding. It is frustrating when you can do whatever you want. Because I am not used to draw, it did not feel very pleasant." 002 – "A creative person should continuously have ideas what to draw. It felt stupid when I did not have. But then one just needs to try coming up with some ideas. I just tried to draw something. "003 – "It was more difficult to do the free task with drawing than clay. It was more difficult to not to think and let go. At some points, when I just let the pencil go, there became some accidental forms and that was fun." 009 – "The free drawing was most demanding and frustrating when I felt I cannot just keep on doing the same all the time. It was stressing and tiring. It was demanding to all the time think, what to do." 015

Table 10
The qualitative coding matrix for copying task (both drawing and clay forming) and examples of the emotional qualities that participants described in the data.

Coding category	Copying task (both drawing and forming clay)
Positive emotional qualities	– "And then again, copying was maybe most easy. You did not have to think anything, just look, remember, and then do something. I tried to draw fast as long as I remembered. So, I was happy to draw what I had seen." 002 – "Copying was meaningful, when I noticed I had to actively try to remember the picture and really to concentrate on what I had seen. I was really concentrated because it was difficult. The working was meaningful and quite fun. The task was challenging since you had to concentrate so much and actively remember." 006 – "Beforehand I expected that copying would have been most boring, but since the challenge was so simple, it was actually fun to follow the process when the same objects came so many times. I began to recognise the cups in the end and learned to look at them more closely. So, it was not so boring." 007 – "Copying was not too challenging for me. I think they were almost the most relaxing tasks during the experiment. They were somehow relieving. I thought, aa, now comes again this nice copying task, I don't have to think so much, just to remember how it looked alike, but nothing else. I had no difficulties and enjoyed drawing." 015 – "The copying was easy and pleasant, because you knew what the task was." 021
Ambivalent emotional qualities	– "Copying was a little boring." 003 – "Copying task was most burdensome. When you had so limited time you got a little anxious of not being able to do the same on paper and even less with the clay." 008 – "The copying tasks were at times a little boring" 010 – "Because there was so many of these tasks, I was thinking, why do these same pictures come all the time, I cannot do anything different. I was not so motivated since there was no challenge." 011 – "Copying was most boring." 017

art tasks on emotional regulation and anxiety reduction (Ashlock et al., 2018; Babouchkina & Robbins, 2015; Campenni & Hartman, 2020; Curry & Kasser, 2005; DePetrillo & Winner, 2005; Drake & Winner, 2012; Drake et al., 2011; Duong et al., 2018; Eaton & Tieber, 2017; Flett et al., 2017; van der Vennet & Serice, 2012). It also complements the understanding that has been gained from a study of changes on HRV and emotions after nondirective drawing and painting task with three different materials (Czamanski-Cohen et al., 2020; Haiblum-Itskovitch et al., 2018). However, these previous studies have not tested the physiological effects and emotional experiences of different timings in drawing and forming tasks. Timing of the tasks, it's effects and interplay with the different art materials can be crucial aspect in the limited time of clinical art therapy sessions. Our study gave preliminary indications of the physiological and emotional effects of the interplay of timing and materials and can be a base for further studies as well as more informed clinical choices.

Timing and material modality

In physiological measurements, comparison of fast or slow art making generated interesting results, signifying the therapeutic value of fast drawing tasks as the mentally most relaxing. The strong correlation between parasympathetic activity and HF is well known, and several studies have shown the relationship between high mental effort and decrease in different vagal parameters (Cinaz et al., 2013; Taelman, Vandeput, Spaepen, & Van Huffel, 2008). The parasympathetic predominance, also described as vagal tone, reflects the lowest amount of attentive effort and highest amount of free cognitive resources. The majority of the HRV metrics reflecting vagal tone were higher within the drawing task, indicating a more relaxed state. Moreover, fast drawing was the most mentally relaxing, not only when compared to both clay forming tasks, but also when compared to the slow-paced drawing task. These HRV results indicate that fast drawing seems to be an effective way to enhance mental relaxation and different fast drawing tasks could be used to reduce stress and to aid the art therapeutic process.

These physiological results are in line with Belkofer et al. (2014), who utilised EEG instead of cardiac activity measurement and found that drawing has a lower mental loading than clay forming. Newer studies, such as Loudon and Deininger (2017), have also indicated towards the relaxing effects of drawing by utilising both HRV metrics and subjective information of the physiology. Also, those previous studies that focused on mandala drawings and their self-rated effects on anxiety reduction support the idea of the relaxing impact of drawing and concomitant reduction in negative feelings (Ashlock et al., 2018; Babouchkina & Robbins, 2015; Campenni & Hartman, 2020; Curry & Kasser, 2005; Duong et al., 2018; Eaton & Tieber, 2017; Flett et al., 2017; van der Vennet & Serice, 2012).

The analysis of mean HR pointed towards higher physical effort and stress during clay forming, especially in fast clay forming compared to both fast and slow drawing. However, no significant difference in bodily effort within the timing factor was observed either in drawing or clay forming. The subjective questionnaire of the NASA-TLX highlighted this result, and participants ranked the clay forming tasks as physically more demanding than the drawing throughout the study. Interestingly the mental stress parameters were also somewhat in parallel with the physical effort, showing higher mental demands in clay forming.

The physiological results were supplemented with the findings from the qualitative analysis of participants' emotional experiences from the stimulated recall interviews. It is interesting that their qualitative descriptions of the differences in creative processes during fast or slow drawing and forming revealed that individual emotional valence connected with physiological or mental effort and stress level could be experienced as either positive or negative. The challenge experienced

Table 11
The qualitative coding matrix for design task (both drawing and clay forming) and examples of the emotional qualities that participants described in the data.

	Design task (both drawing and forming clay)
Positive emotional qualities	– "I quite liked the design tasks. In the beginning I clearly tried to do the task somehow correctly but towards the end I thought more freely. In a way I gave myself freedom to do what I want." 017 – "I took quite similar approach to the design tasks and creative tasks. In a way I was amused by the task or maybe my own solutions. My thoughts went a little crazy, so it was actually fun, and I was laughing in my mind to all surprising outcomes. So, in the end these planning tasks were most fun. When I gave myself a permission to do all kinds of stupid things it was humoristic." 025
Ambivalent emotional qualities	– "In the beginning, it got better, and I even got some flow to the work, but then at some point I begun feeling bored and felt unmotivated." 007 – "Designing was ok, but it felt a little restricting to always have the cup there. But I was quite content with the outcome. The more I drew the more fun it felt – but then in the end the task begun feeling more burdensome." 008 – "I tried to keep it varying for not to become bored. When there was so many of these tasks, I tried to find new ideas all the time. I did not want to repeat doing same so it was challenging to do always a little different." 015
Negative emotional qualities	– "Most unpleasant was the design task with forming clay because the material is so unfamiliar to me, and it was very slow." 002 – "Design task was most difficult. I got frustrated many times and felt it stressing and demanding." 006 – "I think there was quite a many of those design tasks, so it made me a little bored, when there were no special demands. I was not very self-critical, and I felt it was quite an easy task." 010 – "Somehow the design task was always immediately stressing, there was a demand that this should turn out to be something." 026 – It was quite challenging, when I had the feeling that I should have been all the time inventing new ideas or doing something new, but then there was so much repetition it was difficult." 027

could make the task feel interesting, motivating and satisfying or overwhelmingly demanding. Participants also described their experiences of the fast and slow drawing tasks in somewhat opposite terms.

The main result from the physiological measurements, that fast drawing was mentally most relaxing, was contributed by the qualitative analysis. More participants felt the fast timing in drawing had a positive rather than a negative emotional impact on them. The positive emotions became evident in the participants' descriptions of their spontaneous and relaxed approach to the drawing, in contrast to those few for whom the time limit turned into a distressing and demanding pressure to produce new ideas.

In contrast, while slow drawing was also connected with a decrease in emotional arousal, its results concerning emotional valence were clearly more complex. The participants had a highly mixed response, and described more negative experiences than in fast drawing. The qualitative results related to the slow drawing tasks contain more contradictory emotions. Even if many participants felt these tasks were less demanding, they also described it as demotivating and emotionally boring or even frustrating. The temporal demand subscale in the NASA-TLX also reflected the difference described between the time pressures.

In accord with the measured effects between different timings and materials, the qualitative results revealed that fast clay forming tasks aroused more negative than positive emotions in the participants. Unfinished clay pieces irritated and demotivated them. The participants felt that the fast clay forming was strongly frustrating compared to the slower setting, which evoked more positive emotions. In contrast, the participants' found the experience of slow clay forming pleasant, and they described it as more satisfying and inspiring than fast clay forming. This irritation of the time limit was also clearly reflected in the temporal demands subscale in the NASA-TLX questionnaire as participants rated significantly higher scores for fast clay forming than under the slower setting.

Three different tasks

Analysis of the physiological differences between three different creative tasks revealed a significant difference in mean HR, which was lower on the free improvisation than in the copying task. This may reflect the mental pressure on visual memory related to the copying of a cup after seeing the photo. In addition, a slight non-significant tendency (e.g. according to rMSSD) indicated that the copying task may be mentally more challenging compared to the designing and free improvisation tasks, but more physiological studies are needed to confirm this as some metrics did not react at all. However, it is interesting to compare these indications to some previous self-rating studies, which have suggested that copying might not be as effective in reducing negative mood and working as a short-term mood regulation as more free and imaginative tasks (DePetrillo & Winner, 2005; Drake & Winner, 2013).

The qualitative results became especially relevant for different task types since physiological measures did not catch significant statistical differences between them. While material and time did show some significant effects on participants' physical and mental stress, the tasks of copying, designing and improvisation did not show similarly clear effects. However, the lower mean HR during free improvisation tasks was further supported by the qualitative findings, which revealed that the participants particularly experienced the non-directive clay forming as emotionally positive and creative without feeling emotional pressure. It is interesting that all the participants described positive emotional experiences related to nondirective forming, even if clay was simultaneously found to be physically more demanding to handle within the strictly limited time and task frames of our experimental setting. The nondirective drawing task was also felt to be spontaneous by many of the participants, but there were also contrasting experiences since others said that creative ideation during the free drawing task was more challenging than with graspable, three-dimensional and flexible clay.

Limitations of the study

There are potential limitations regarding participants of the study, since they represented healthy adults, who had interest in art or design. Replication studies with clinical population are needed to better understand of the possible differences in physiology and emotional qualities regarding the different tasks, timings and materials in relation to different diagnoses.

We are also aware of the potential limitations which arise from the material art making in the experimental study setting both with regard to the natural flow of creative process and to the physiological measurements. Participants could not follow the natural pace of the creative process in our strict experimental setting and its time frames. The diminished vigour scale in the POMS questionnaire during the study seems to reflect this limitation. On the other hand, all manner of excess movement or differences in timing are potential sources of noise in the data when recording of physiological signals. In addition, the rather different physical demands of drawing and clay forming may have created masking of results, because variations in physical demands have an effect on the autonomous nervous system which may mask the effect of mental loads (Garde, Laursen, Joergensen, & Jensen, 2002).

Conclusions

This mixed methods study using an experimental setting is the first to combine physiological measurements and the qualitative analysis of stimulated recall interviews regarding drawing and clay forming. It

constructs new evidence for art therapy practice concerning how emotions and physiological and mental efforts are interrelated with during different timings and tasks of drawing and clay forming. Combination of qualitative and quantitative findings indicates that the experience of emotional valence connected with the different art materials and tasks can differ individually even if physiological arousal level would be similar. This highlights the importance of sensitive therapeutic relationship, where art materials and tasks are tailored according to each unique patient.

The physiological results highlight that especially fast drawing seems to be the most effective manner to free up mental resources and yield a relaxed mental state. It also evoked positive emotions in many participants. Art therapists can utilise this knowledge in creating safe ground for art therapeutic relationship in the beginning of sessions before processing more difficult or emotionally painful issues. It could also be used within session to stabilise too high arousal level for example in treating trauma or anxiety.

Interestingly, even if the measured bodily efforts were clearly higher regarding clay forming compared to drawing, the qualitative analysis revealed that participants found nondirective clay forming to be the most inspiring, creativity enhancing and emotionally positive process. This supports the use of non-directive clay forming in clinical art therapy settings as a creative form of emotional processing. Finally, we wish to emphasize the value of the created experimental setting for further studies researching the processes and mental requirements of handling different art materials with either HRV or EEG.

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Declarations of interest

None.

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