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From Cultured Chats to the Chirrups of Choo-Choo-Da-Choos, or How We Found a Key to the Gate of Eden

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Abstract

Reinvention of the form of expression is a conceptual approach characteristic for the evolution of all arts. This research study provides one such step forward in the advancement of scientific paper, a standard form of expression in natural sciences, toward more progressive terrains. The paper adopts the form of a theatrical play where a scientific family of four attempts to find the way around a writer's block (Act I). Their idealess sense of confinement is overcome through arts or, more specifically, through scientific research implementing the aesthetics of music as its key element. The characters record compositions differing in the degrees of consonance, rhythmicity and tonality, and play them to birds to observe their vocal and behavioral responses (Act II). They note that the birdsong volume drops significantly when the piano tunes, especially the compositionally complex ones, are played to the birds and increases significantly when the white noise of ocean waves is played. The bird count experiment proves indirectly that the birdsong volume reduction is an auditory response of the birds to music rather than the effect of their migrating to or away from the sound source. This science with the flavor of art elevates the characters beyond the limits of their confinement and they, exalted and uplifted, gain ideas for creative research in their own disciplines of biomedical science (Act III). They relinquish the newly gained freedom in favor of embracing love for humanity that underlies medical research and return to their confinement, where they conduct, in the coda of the paper, a series of experiments

that venture beyond musicology and ornithology and fall in the domains of tissue engineering and drug delivery, but also psychology (Act III). First, sparrow nests are used as templates for tissue engineering constructs, which facilitate the growth of human fibroblastic cells better than their artificial, gridded replicas. Next, the shell of an Easter egg, predominantly calcite in composition, is used with success as a drug delivery carrier. Lastly, the bird nest drawing experiment demonstrates a greater mental health of children than that of the adults, correlating with one of the overarching points of the paper, which is to present children as a model for grownups to follow rather than the other way around. Over the course of the play, the characters discuss the value of the various fusions between art and science, question the limits of human language and repeatedly go off-topic to celebrate the freeness of the creative thinking process. The play reports on real-life research methods and scientific results through a narrative, without diminishing their empirical rigor and analytical accuracy.

Keywords: Art; Avian; Cell culture; Children's science; Dialogue; Music history; Ornithology

"Let's look at the sky"
Maya Angelou,
I Know Why the Caged Bird Sings (1969)

ACT I: The Writer's Block

(*A cliff overlooking the sea. An array of marshmallow clouds embellishes the horizon. The father is lying down and looking at the sky. The daughter leans onto his shoulders and plays with a toy bird on his chest. The handheld bird hops up and down in the child's hands. The mother and the son sit nearby, playing a hand-clapping game. Behind the family of four, the ruins of an ancient city. Ahead of them, the open sea.*)

SON: Who's that flying over yonder?

MOM: A beautiful soul watching over us?

SON: Feels so freeing just watching it fly.

MOM: Darn that dream, darling, you missed the beat.

DAD: When our hearts miss a beat, that's when the adventure begins (Prefab Sprout, 1985a).

MOM: A perfect imperfection ⇌ the mother of all beauty.

DAD: And yet, ideas don't come easy anymore. Not only do I seem to know nothing anymore, but neither do I know I know not, this nothing, I mean. I drown

in vortices of perplexity, dozing in the mazelike shrubbery of a murky mind. What were clear and glistening skies once are all but nebulae in and around me. Where do we go from here?

SON: Wee wee whoa, choo-choo chee-chee paw (♪♫♪).

DAD: Sing? Go with the flow, you say, beside these purple crocus corms and fusty jacarandas? Which flow, I ask, when it all seems to be going dry? Not even a cry makes the sound in this desert I am holding inside me.

MOM: Are you saying that this infinite well has run dry of ideas? That sure is impossible.

DAD: The deluge has turned to a brooklet, a shower into a drizzle, and they both parched. Now I am blank like a *tabula rasa*.

SON: Let me make 8 and a half figure eights. Maybe that will give you a clue.

MOM: Indeed. Maybe it is time for us to hold each other's hands and dance in circles (Fellini, 1963). People are the best remedy to writer's blocks.

SON: Just jump into the starlit swimming pools of a fellow human's eyes, as you say, and all shall be fine.

MOM: Don't forget that nothings can always be turned into beautiful some-things.

SON: Hence the ball must keep on rolling.

MOM: And these words with it. Even when all that they are bound to build is but petty lines of a gobbledybook intelligible to but a few.

SON: Besides, to admit to not know is to crush the gates of dogma and open the view toward endless possibilities.

DAUGHTER: Like this view of the open sea ahead of us.

DAD: What would I do without you, my muses, beside me? Alright, let us swiftly erase all that has been kept inside our minds. Let the bottoms of their green watering cans (Radiohead, 1995) drop and the waters they hold splash every-where.

SON: I am peaking from the top of this dilapidated fortress and assure you that the sea looks gorgeous.

DAD: Then, let us not know rather than know. Let us be innocent in our intel-lects, like children.

DAUGHTER: Choo-choo-da-choo, choo-choo-choo-choo (♪♫♪). Look, y'all, the birdie is dancing.

MOM: How splendiferous.

DAD: I know. What if we make a human song to it? With a simple melody. It could go like this: Hello birdie, hello birdie, how are you? Your wing's so beautiful, and thine eyes too (♪♫♪).

DAUGHTER: But the birdie will not understand it. See, it does not dance to it. Hear this instead: Choo-choo-da-choo (♪♫♪). Look, it dances.

MOM: Interesting. Children should be always treated as fountainheads of wisdom.

DAD: They have so much to teach us. And yet, this world revolves around us teaching them instead.

SON: We should flip it upside down.

DAD: Verily so, as the good old miser has advised us. Everything that is now on top should slide to the bottom, and *vice versa*.

DAUGHTER: You should be small and I'd be big.

DAD: Children truly ought to be made into centerpieces of the social machinery.

SON: But if the birdie dances only to the avian tunes, is this to say that we must always speak the language of another being for it to understand us?

DAD: Aha, how many of us know this, let alone know how to implement it in practice?

MOM: It takes a whole lot of empathy for this to be done. And willpower, too. It takes looking at the world from the eyes of another, everywhere and at all times.

DAD: I wonder if science can be conceived so as to conform to this rule. It would be science with love in its heart. Science wherein the objectivistic and positivistic elements thereof, careless and cold, would cede some of their places on the scholastic pew to their warmer complements, namely subjectivity, poetry and humanity, so that they could sit together, side by side.

DAUGHTER: Would they be hugging?

DAD: Very much so. Because they have a lot to learn from one another. Therefore, they would naturally feed on and inspire each other. That is what the notion of co-creation I elaborated long, long time ago (Uskoković, 2009) was to represent: a gateway to science aware that its models are arbitrary human creations descriptive of the interpersonal states of experiential reality rather than exclusive and universal representations of it.

MOM: It was a yellow brick road for science and art to jollywalk on together, hand-in-hand.

SON: And yet, we are taught at school that science is and must continue to be objective.

DAD: It is one of the major fallacies of modern education. Science neither is nor can be perfectly objective.

SON: Why is that so?

DAD: There are many reasons. One of them stems from the role of premises in scientific reasoning. The most fundamental logical propositions are being, well, proposed and are neither directly derivable nor provable by empirical means. This source of subjectivity is tightly related to the role of human values in scientific reasoning, given than collective values of an era, aka zeitgeist, are akin to a riverbank that directs the streams of scientific thought in very subtle and hardly decipherable ways. Next, we should never neglect that the world of science, despite the naïve preconceptions, is such that major discoveries in it, especially when paradigm-shifting or paradigm-shattering, become accepted only when the critical mass of politically powerful, that is, tenured scientists accept them as veritable.

MOM: Doesn't this mean that the notion of truth in science, despite the premises of neutrality and objectivism, is socially determined.

DAD: Indeed. As Heinz von Foerster had it, "Truth is the invention of a liar" (Thyssen, 2003). Being aware of how status determines how truthful a scientific theory is deemed can be disheartening for all of us who have already gotten weakened and discouraged by being sidelined as irrelevant simply because of our lack of significant titles in this global battle for relevance and recognition on the scientific stage. But the idea of co-creation, which I have advocated for nearly two decades now, can be the gateway to amelioration of the ill concreteness and objective realism insisted on by so much of science and education of the modern day. It can be the foundation from which the renaissance of science can happen, notwithstanding that it must still get darker before this daybreak illuminates the sky.

SON: Is this to say that all of this is partially a dream?

DAUGHTER: Are we really a dream in a dream?

DAD: Quite possibly. Look at you, after all. So beautiful you are that you could be real only if this were a dream.

DAUGHTER: And this whole world, too!

SON: Are we saying that our dreams blend in with reality?

DAD: They create, or, to be more precise, co-create it. Every moment of our existence is an act of active co-creation of our experiential reality in togetherness with Nature (Uskoković, 2009 & 2011). How we co-create our world is a direct measure of our evolution on the ladder of spirituality. Were we to see all things bathed in the infinite bliss of being, we would know that we have ascended high on this ladder.

SON: Now it makes sense when you said at the end of your first book that the world is but the mirror for our souls (Uskoković, 2004).

DAD: As my favorite Serbian poet said once, “Things take on forms given to them by our souls” (Dučić, 1936).

MOM: But how many of us still know this?

DAD: Not many, for sure, in this world poisoned by the ideals of icy objectivity, at least among the adults. Children, however, know it very well. They are born with this knowledge and they only gradually exit it as they mature.

MOM: If that is so, then all we need is to watch children play (Uskoković *et al.*, 2022b) their pretend games and wonder where that piece of consciousness, which enables us to easily and effortlessly recraft and remold the reality by our abstractions, has gone and how we could retrieve it.

DAD: Hence the new science, the science of and for children that we try to craft through these dialogues.

SON: Watching us play is the gateway to revolutionizing science of the day, you reckon?

DAD: Verily so. Science, in fact, and the perceptions of absentminded scientists are such that they blend dreams with reality, for which reason scientists and children are the closest buddies the world can ever have. To watch the children play can be, therefore, a route to rejuvenating everything stale and dull in science today. And this is exactly what we do here. We use children’s play as a gateway to romanticizing science and sparking its renaissance.

SON: A grandiose aim it is.

DAD: But also the one having the littlest spirits in this world as its foundation.

SON: In the littlest we always find the greatest, as you say.

MOM: Hmm, I cannot get this reckless-eyed boy (10,000 Maniacs, 1992) out of my head. Him who got accused of being a narcissist when he was only a turbulent emotionalist made anxious by the grand ambitions nurtured within. A good, faithful soul he was, albeit star-struck and blinded by the city lights, thus yielding to a debilitating tear running across the kernel of his heart, which produced massive anxieties in him that passivated and incapacitated him, like in posttraumatic survivors.

DAD: His name?

MOM: Paul (Cather, 1905).

SON: The convert from the desert?

DAUGHTER: The painter on an island?

DAD: Oh yes. That man of mediocre talent for art (Gowans, 1966), but an unrelenting drive to create something fantastic, whose primitivistic goal was to "go back beyond the horses of the Parthenon to the rocking-horse of the childhood" (Gombrich, 1989)?

SON: Was it Paul who ran the boutique "busting routines and rhymes all night" (Beastie Boys, 1989a) and "dropping science like Galileo dropped the orange" (Beastie Boys, 1989b)?

DAD: Or it was the bloke whose best lyrical moment was his best buddy's cursing Sir Walter Raleigh and calling him a "stupid get" in a verse from a pop song unthinkable for its time (Beatles, 1968b)?

SON: Maybe Paul whom we waited for under the stairs of the San Francisco Zen Center on Page St.?

DAD: With the stardust in our hairs collected by running down the hills hand-in-hand. Golden days those were.

MOM: One day at school, he got reprimanded by his teacher for drawing the Adriatic on a sheet of paper on the basis of the fact that he had never seen it. He said he dreamt it, but that did not soften the teacher's heart, although she did notice something witty in response, unwantedly as it were, which is that, if dreamt, then "it must be research" (Johnson, 1980).

DAD: The co-creational thesis does teach us that this drawing of the unknown is an elementary act every sentient being performs through its perception. As a corollary, it tells us that things seen in our dreams only, as subjective as the whirls of emotions instated in us by marvelous pieces of art, have their place in science.

SON: There should be a place for dreams in science.

DAD: This is why we are here. To make sure that those dreams of dreams do not go down forgotten. To make sure that science of the future understands that science is the pasture of dreams rather than of vanity or prosaic objectivism that threatens to turn us all into robots.

MOM: Or into a giant zombie apocalypse.

DAUGHTER: I know you dream of the Adriatic, too.

DAD: I do (Dučić, 1936). I bathe in it in my dreams, like a dolphin.

SON: But walrus was Paul (Beatles, 1968a).

DAD: And I am the walrus, said John (Beatles, 1967b).

MOM: So I is You…

DAUGHTER: …and you is I.

DAD: Aye, we can go home now. The great One has been found.

SON: Before our research has even begun?

DAD: Why not? We seem to have understood the tree of life and now we are free to rejoice in its shade.

MOM: We will sip carmen mirandas and play games all day long.

SON: But wouldn't it be a morally unjustified escape from a cruel reality that needs salvation badly?

DAD: So what do you suggest that we do?

SON: Go back…

DAUGHTER: …and save…

MOM: …the kingdom…

DAD:…of science.

SON: Alright, but how do we save it?

DAD: How else but with creative research. And with words that set all these walls of dull convention and malevolent intentions that take the heart out of science in flames.

MOM: So destroy things we must to pave the road for better things to come the future generations' ways.

SON: Hence the ruins whereon we lean.

MOM: Love among the ruins this has all always been about. If I am allowed to read from your high school written assignment I stole from one dusty desk drawer, here is what you said when you were 16, and I do not think that much has changed since then: "The old order must be ruined for a newer, more wondrous one to be erected in its place".

DAD: In a nutshell, we must continue where we stopped, which is creating papers that are but carpet-bombs blowing up everything that is stale, status-laden and starched in today's science.

MOM: We are peaceful revolutionaries and these papers strewn in the wind are our clarion calls and grenades.

DAD: But how do we conceive of a research that does not only shatter all this staleness apart with its form, but also with its content? For, remember, our ideologies must be embedded at every logical level of the works we compose. Lest we become like those hypocrites that advocate poetry in a dry, technical language or profess enlightenment using closed, dogmatic concepts.

DAUGHTER: Birdie should know. We should ask her. But first, let us feed her some breadcrumbs.

SON: Goldfinches are my favorite birds (Twig Science, 2021).

DAD: Huh, I remember that. 'twas the example given by your science instructors of tangential comments students should not make to explain the results of a bird-feeding experiment. They teach you that such claims should be prohibited from the world of rigorous and correct science, but they are wrong. Tangents cannot but lead to the navel points in this world that is akin to Pascal's circle, the circumference of which is nowhere and center everywhere.

MOM: We should add a disclaimer here, saying that we are huge fans of values transmitted through the early primary school education these days.

DAD: We are, but I am over and over again stunned by the discrepancy between these values and the values adopted by the adults in the world we live in. This gap I see as a key fallacy of our societies, which everyone, with an utmost effort, ought to work on bridging.

SON: So let us overcome this gap and make the grownup world of science at least a bit more like children's. Let us turn academic science into a giant science fair project festival.

DAUGHTER: With the swish of the fairy's magic wand.

MOM: If there is a gradual loss of the shimmer of the heart and sparkle of the eye as we progress up along the academic ladder, should we succeed, we would recognize our success in the restoration of authentic childlikeness in the gestures and the behavior of the grownups.

SON: Let us childify science and the grownups under whose command science is these days.

DAD: Considering that this was a tangent branching off of a tangent, let me go back to your goldfinches and ask ourselves if we could conceive of science that embraces such tangential inferences that bounce back and forth between our research and the most intimate features of the fabrics of our lives.

MOM: Isn't what we do here exactly that?

DAD: We weave bonds between research and life, which someone somewhere thought could get ruptured for good. But we are here to restore those bonds and turn research papers into narratives or even novels.

MOM: And then, someday, poems.

SON: I was pulling your leg. Everybody knows that hummingbirds are my favorite birds.

DAD: It makes sense. For, not only are they the smallest birds on Earth, but they are also the only ones that can fly backwards, which is a neat metaphor of what we try to do here. We are inspired by children, the epitomes of the small and are also trying to fly back to the reigns of childhood and blend therein with the holy intellects of children.

SON: So shall we ask birdies, starting from the nuthatches that hang upside down from this eucalyptus tree?

DAUGHTER: Or the phoebe quivering on this ficus?

SON: Or the finches chirping from this palisade of punk trees?

MOM: In which language?

DAD: The language of science.

SON: So we are off to a new adventure?

DAD: Off to a new research in the format of a play, both theatrical and literal, we fly.

SON: Like this birdie that sings so happily as it traverses the sky.

MOM: It is the road we must follow.

DAUGHTER: We should flap our wings too.

MOM: But before we proceed, let me distract you once again and read you this quote, another one from the drawer I mentioned earlier: "Today I firmly decided to be a great physicist when I grow up. My role model will be Nikola Tesla. He spent his whole life in poverty. He lived like a hermit and had but a single friend: a little birdie".

DAD: I remember this. These are lines from my diary.

MOM: The date is May 3, 1989; you were 12 at the time.

DAD: The story goes that as Tesla, broke and alone, nearing the end of his life, lived on the 33rd floor of the New Yorker Hotel, he found most joy in feeding pigeons at a nearby park and communing with a bird that would often come to his windowsill. He thought of it as of a divine messenger, an angel of a kind.

MOM: Tesla was extraordinary.

SON: Do we look up to him because of national causes?

DAD: Not at all. He is significant to us from numerous other angles. One is that he illustrates what some may call the authentic Slavic mindset in sciences, which is such that there are always some mystical, lyrical forces underlying the scientific curiosity. It contrasts the frame of mind built around pure practicality devoid of any aesthetic inclinations, which typified his famous adversary, Thomas Alva Edison. Sadly, it is this latter, practical stream of thought that holds the province of science in its cold clutches as we speak. The capitalist model of doing science, where the principal investigator is busy promoting oneself and hunting for funds so as to continuously exploit the students and postdocs in his lab for the promotion of his fame and ego, has become pervasive. In contrast, a solo scientist, a lone wolf, an analogue to an auteur in the filmmak-

ing genre, such as Tesla was, is doomed to failure in this world where networking, outreach and engagement in sickening sycophancy are all that is required for success, while the fundamental creativity of scientific thought and the talent to inspire others through education and peer-to-peer communication matter little. All this is to say that the real, quintessential goal of what we will do here is not really to provide a key insight into commonalities between avian and human musical brains or tastes, but rather to spur the revolution in science. Down this road that we wish to pave, Tesla's approach would be rejuvenated and reinvented and Edison's challenged.

DAUGHTER: The trite tirade, tire thyself. Breathe.

DAD: Good catch. 'twas yet another breathless monologue in the making.

SON: On another note, going back to the connection between Tesla and birds, is this to say that science we pursue will end in feeding pigeons in a park?

DAUGHTER: Or falling in love with one and only bird, whom we may deem an angel on Earth?

DAD: This is not far from truth because one reason why we will study birds is because we are interested in angels, so we temporarily leave chemistry behind and focus on these tiny creatures that have something in common with angels, which we do not: wings.

MOM: Don't all the angels of this world grow wings because deep inside they feel the need to fly away?

DAD: They, with their indestructible empathy that has no borders, always get brought down to their knees and humiliated in a world dominated by the cruel domineers. Walking through it without a guard, with open arms and an open heart, they are bound to be pierced with many arrows of malice. Hence their wish to fly far, far away, into some better worlds.

MOM: They love endlessly, everyone and all things around them, but they also get hurt and wounded. Hence the need to fly.

DAD: When I was younger I enjoyed watching waves and shimmering seas and clouds. But the older I am, the more I enjoy bird-watching. When I watch the birds fly, it is as if a part of my being flies too.

DAUGHTER: Does this mean that this paper is about flying?

DAD: It is, in a way.

SON: In our way?

DAD: Well, yes, in a way, since every act of intellectualization stands in the way of the freeness of the spirit. To liberate it and soar high, we need to burn the paper. In a way.

SON: So we will write this paper and then burn it?

DAD: If Wittgenstein could raise his ladder of logical dissection of linguistics to the stars and then remove it from under our feet (1918), we could do so, too.

MOM: Besides, it is forgotten that the scientific paper ought to be an exercise in education, imagination and creativity rather than a sheer technical report of protocols and findings.

DAUGHTER: Look, I can touch this cloud.

(The moment of surprise and an utter disbelief strikes everyone.)

SON: I can touch it too. How come?

MOM: Is this heaven and we the angels living on a cloud?

DAD: This explains it. All of this is a wallpaper and we are confined inside an idyllic, colorful cage.

MOM: A block, as it were. A writer's block?

DAD: A writer's block.

SON: Now it makes sense why those crumbled pillars never left a trace when I ran my palms over them.

DAUGHTER: And why I could draw with crayons over these waves.

MOM: We are trapped. What a moment to realize that this whole seascape before us and the landscape behind us are but wallpapers. Inside a cage we are.

DAD: We may kick and we may scream, but these splashy walls won't give in. We've been locked down for good and there is no key that would set us free.

MOM: Are we saying through the metaphor that the material world is not as real as it is usually thought to be?

DAD: Perhaps so.

SON: But what is real if everything we see and can touch is not?

DAD: We have yet to find it out.

MOM: I wonder if this is also a metaphor of what Californian lifestyle is? A prison for the soul, the way you christened it. A bubble after a bubble, never colliding with one another, each harboring some of the world's vainest and bleakest major Toms (Bowie, 1969).

DAD: Talk about individualism reaching toxic proportions in this land of the "dead from the waist down" (Catatonia, 1999), all confined claustrophobically to the automobiles of their personal spaces, zooming past one another at supersonic speeds, but never getting to hold each other's arms and gaze deep into their fellow humans' souls.

SON: Or this is just cabin fever from abiding in a sensory deprived suburbia sweating itself out on the surface.

MOM: On top of this, everything that the artist does, if he does it right…

SON:…and right is left…

DAUGHTER:…and up down…

DAD:…he holds a mirror to the world. Hence, I wonder if this confinement is a reflection of the current state of the world as a whole, where everybody distances from one another with each passing second, like galaxies of the universe, drifting toward ever deeper solitudes and seclusions.

SON: The Little Prince (Saint-Exupery, 1943) would have a lot to say about the separation between people these days.

MOM: Or, could this imagery be the reflection of your subconscious tendency to reflect on your past of being raised in a country that was at the time the prison of international isolation, economic embargos and borders locked by force?

DAD: That could be, too.

DAUGHTER: Whatever it is, we must think fast. Just remember all those concussed ruby-throated hummingbirds and dark-eyed juncos.

SON: I remember them. They are attracted to the luscious greenery planted behind the windows of both high-rises and low-rises, but they do not see the glass because it is very clean and very transparent and so they crash into it.

MOM: By analogy, we must do something about this invisible cage or else the fate of these representations of angels jamming in the air may be just about the same.

DAD: You say that we must think fast, but has our incessant need to intellectualize everything put us inside a cage in the first place? Has this overthinking and perpetual abstraction posed us “in a way” of the world, as you mentioned earlier? Has everything, as at the end of Sartre’s debut novel (1938), become an object “in a way” – an obstruction, a wall, in a way?

MOM: All these things are possible, including your sense of confinement to a professional cage, which may have emerged on the surface from some subliminal depths.

DAD: It is true. I currently undergo the very same imprisonment by the science community as that which some of the most revolutionarily libertarian spirits in the past underwent at this, midlife stage in their social activist careers.

MOM: But we can always look up into the sky from this cage and seek inspiration. As the little tramp's muse says, "Look at that star, isn't it beautiful? Hynkel with all his power can never touch that" (Chaplin, 1940).

SON: And who is out there able to provide the hints of this inspiration better than the birds flying over this abstract cage of ours?

DAD: From here, I guess, the cage becomes no longer the metaphor of our academic and existential state only, but rather the metaphor of the human condition too. This was envisaged by Plato when he wrote about the one "who, when he sees the beauty of earth, is transported with the recollection of the true beauty; he would like to fly away, but he cannot; he is like a bird fluttering and looking upward and careless of the world below; and he is therefore thought to be mad" (Plato, 1984).

SON: No doubt that the world deems us mad.

DAD: It does but, as Pascal noted in one of his maddest pensées, "Men are so inevitably mad that not to be mad would be to give a mad twist to madness" (Pascal, 1669).

MOM: Submission of these dialogues to various publishers has indeed prompted many a phone call inquiring about the mental wellbeing of you, mister writer.

DAD: On the other hand, note that this ancient Greek lineage of philosophizing through dialogues was discontinued for a few millennia, but we are reinstating it through this work.

MOM: Plays attempting to popularize science have popped their bumbling heads in the previous century (Wu & Uskoković, 2019) and mannered works such as Jane Marcet's *Conversations on Chemistry* have been popular in England of the early 19th century, but they have little to offer in comparison with the trembles and quakes we are generating across scientific and literary universes with works like these.

DAD: When one approaches writing as music and lets muses from somewhere high above pull out the words from one's open heart and drop them on the paper, gingerly, then the results cannot be but inspirational.

SON: How revolutionary it is that we do all this in natural sciences, where the last traces of lyricism have been in exile for a long, long time now.

MOM: As if we have not always been affiliated with the Renaissance men and women in the kingdom of science.

SON: In view of that, are we ready for experimentation?

DAD: Before we proceed, let me read you something really quick. Here it is. "A darkened stage, suddenly a single circle of light is seen on stage and within is a

person. The person is sitting, arms wrapped around knees, head bowed. Motionless. The person within the circle of light raises his head, looks around, confused, turns a circle within the circle of light. He reaches out his hand but cannot extend it beyond the light. He pushes, it doesn't give. He is trapped within the light".

MOM: My play: *In Limbo*. The very beginning of it.

DAD: Talk about the past haunting the present.

SON: Okay, now that we are in this limbo, what research are we exactly going to undertake along the line of carpet-bombing the stale edifices of modern science? And also, will it liberate us?

MOM: And, more importantly, the world.

DAD: We will ask birds.

DAUGHTER: But let us watch them first, carefully, wistfully.

ACT II: Musicianship with Birds

(Same scenery. Actors have watched the birds for a while now.)

DAD: Here is what I have in store for us.

SON: Which store? You cannot stand going to stores plus you have no dough to buy us anything.

MOM: You are happiest when you come back from a store citing that Banksy's graffiti, "The joy of not buying anything".

DAD: My favorite of his is, naturally, the one I came across by accident, on the streets of New Orleans.

SON: How did that come about?

DAD: I was going to meet a jivey sneak and a pickle, but I missed the bus on Rampart St. Then, as I was walking back, all crestfallen, she popped, like an apparition, in front of me: a girl getting rained on under her umbrella, when there was not a single droplet of rain outside it. I could not believe my eyes.

MOM: Those who request safety more than freedom do not deserve any, as they say.

DAUGHTER: Lucky us, we are adventurers.

DAD: God knows we are.

MOM: Alas, these adventurous roads have driven us to this limbo.

SON: Or the cage, doggone it.

MOM: Whichever, sherlock.

DAD: But here is what I have in mind. We shall make a music experiment as a writer's block remedy. This will show us, hopefully, that there is a hope for art in the world of science, assuming that we succeed in using art to inspire scientists in us in search of creative concepts, which we have yet to find. Now, since the only creatures coming to greet us here, in this confinement, have been birds, it makes sense to communicate with them in our experiments.

MOM: This will be our homage to them.

DAD: It will also go along with our appreciation of the aesthetics of poverty in science, which suggests that we ought to design experimentation around what can be used at as low of a cost as possible, ideally free.

SON: Alright, so here are some of the birds I noticed that are landing here, within the limits of our cage and also singing their songs from the tops of these trees surrounding us. Here are samples of their tunes, too (Fig. 1*).

DAUGHTER: I remember this chorus of sparrows we listened to near a tree on the Birdsong street.

MOM: There is the flock of parrots, the escapees from the safari park that once adorned our town, too.

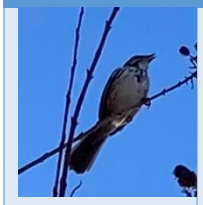
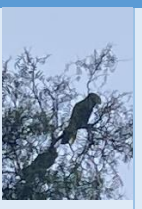
Purple finch	Western bluebird	Mourning dove	Parrot	Sparrow
				
Finch.mp3	Bluebird.mp3	Mourning dove.mp3	Parrots.mp3	Sparrows.mp3

Fig. 1. Images of exemplary songbirds and/or talking birds that landed within the limits of the 35 m^2 space where the experiment was conducted, along with the samples of their birdsongs and the birdsongs hearable within the given limits. The reader is referred to the supplementary folder "Figure 1" for mp3 files of audio samples.

***NOTE: The audio files will only be playable after the article has been downloaded.**

DAD: And the mourning dove that wakes the sleepyheads in the wee morning hours.

SON: Here's one of the finches that hops on the roof of the garage so gleefully when the sun is out.

DAUGHTER: And there's the bluebird that blows us invisible kisses from this fence.

SON: I am curious how we are going to interact with birds and what they are going to tell us in return. We know that every scientific experiment is an interaction of the observer with a physical system. So what will constitute this interaction?

DAD: We will record a series of piano compositions and play them to the birds. This time, notwithstanding their exceptional singing and vocal apparatus abilities, the birds will be our listeners and, in a way, judges of the quality of our music.

MOM: And what will be the difference between these compositions?

DAD: Three of them will be very simplistic in rhythm and melody (Table 1a-c). The other three will be disharmonic, arrhythmic and largely atonal (Table 1d-f). We will play these tunes to the birds and will measure how loud in decibels on average their responding to our music with their own songs is and also what the time length of their sitting on our cage is while the music is playing. We will, of course, add a silent control to the experiments. In that case, we will measure the response of birds to our not playing anything to them.

SON: What about the technical specificities?

DAD: They are all listed in the Materials & Methods section at the bottom of the paper. Briefly, we will play each tune on repeat for 5 minutes to adjust the birds to the sound before doing the measurements intermittently for the next 10 minutes, after which we would move on to the next tune. We will play each sample tune once before we go back to the same tune. Eventually, we will have far more than triplicates, which will give us statistically reliable results.

MOM: This appears to be a novel method, not reported in literature before.

DAD: Yes, I have come up with it on the spot. Besides, when we strive to create a scientific expression that is conceptually novel – as we do it here with the format of this paper – it makes sense to embrace novelty at every level of this expression, from the methodological to the structural to the disseminative and beyond.

SON: Since we will be measuring the volume of the birdsongs, I wonder how loud the music played from the speakers will be.

DAD: Previous research played music at the level of 70 dB measured on the edge of the cages. At the same time, it is worth knowing that in the absence of additional absorbers of sound, the volume normally drops by approximately 6 dB with each doubling of the distance from the source (Larkin *et al.*, 1996).

MOM: Technicalities aside, I have a more fundamental question.

DAD: What is it?

MOM: This experimental setup assumes that songbirds respond to songs as if it were music. But what if songs have a wholly different, more primitivistic and survivalist meaning to them?

DAD: Well, since Darwin's times it has been wondered if birdsongs are only mating calls and territorial protection assertions or they could be music to the birds' ears too. In one of his treatises (1872), Darwin makes a claim that the evolution of life he envisaged implies a similarity between the brain mechanisms that encode the emotional behavior in humans and other animals. And we know that the homologs of mesolimbic reward pathways that get activated in humans in response to music get activated in birds, too, when they are exposed to birdsongs (Earp & Maney, 2012). Also, the fact that some birds, including not only parrots, but also catbirds and mockingbirds, replicate human sounds from urban areas (Voon, 2016) suggests that the avian behavior could be greatly affected by our music. The fact that birds, on average, hear best at frequencies ranging from 1 to 5 kHz, with the highest sensitivity range of 2 – 4 kHz, whereas the highest auditory sensitivity range in humans is 0.5 – 4.0 kHz (even though we hear best over a broader frequency range of 20 Hz – 20 kHz) (Ortega, 2012), also makes this hypothesis of relatability between human music and bird behavior meaningful.

SON: Phew, what a long monologue. I hope that everybody lent their ears.

DAUGHTER: I will be the first to play the piano and you, guys, click the record button.

DAD: Alright, mono it is, in the spirit of *Pet Sounds*.

SON: So we will embrace dissonance and insinuate our fondness for cacophony, but should birds like it?

DAD: Although most research on the response of birds to sound ended up being unpublished (Ortega, 2012), what we know based on previous findings is that birds do not like noise. However, the effect of naturally noisy beauty vs. distilled beauty has not been studied yet and if we do show the preference of birds for dissonance interwoven into moving melodies, it would partially challenge the predominant beliefs in the field. Note that the type of noise here is important, as birds, for example, avoid highways almost universally (Reijnen *et al.*, 1995; Forman & Deblinger, 2000; Brotons & Herrando, 2001), but in some,

albeit very rare studies the higher nest success was noted near noisy gas compressors than at quieter sites (Francis *et al.*, 2009). Still, such findings are mostly exceptions that prove the rule.

DAUGHTER: Alright, here we go. I will start from E♭ (Table 1e).

MOM: The heroic key it is, the key of Eroica, fitting the occasion, pardon our mission, quite well.

DAD: Wonderful work, little piano master. You create abstract, expressionist art so effortlessly on pieces of paper and the same goes for the musical notes on these recordings. Let me now overdub them with some fine touches.

Piano tonal/simple pieces	**a** Happy Birthday.mp3 	**b** Chopsticks.mp3 	**c** Ode to Joy.mp3 
Piano atonal/complex pieces	**d** Under the Luster.mp3 	**e** Choppy Sticky Liftoff.mp3 	**f** Cacophonous Coco.mp3 

Table 1. Three tonal themes from popular songs played by the son on a piano and recorded by the dad, namely *Happy Birthday* by an unknown composer (a), *Chopsticks* by Arthur de Lulli (b) and *Ode to Joy* from Beethoven's 9th Symphony (c), along with the three complex atonal pieces (d, e, f) recorded jointly by the daughter and the dad (d, e) or by the son and the dad (f). The reader is referred to the supplementary folder "Table 1" for mp3 files of audio samples.

SON: Alright, so here are the compositions we have created on the piano (Table 1). I paste them on this sky, pardon wall, side by side with your earlier recorded simplistic themes from three popular songs (Table 2a-c) and also with your twenty-one-year old compositions for three guitars (Table 2e-f). Here it says that they tread the path of similar balance between the harmonic and rhythmical order on one side and the instrumental spontaneity and jazzy improvisation on the other (Uskoković, 2001a).

MOM: It is obvious that the approach we follow here evokes your musical compositions from the days predating your first scientific publication (Uskoković, 2002).

DAD: It is true that I was a musician (Tišina kod poluzvezde 1998a,b; Uskoković, 2001b) before the idea of becoming a scientist was even vaguely set in my mind. Once upon a time, I held that music is so sublime and superior to any other art that to betray it with any verbal expression, even when it is a part of a scientific

text, would be a blasphemy like no other. In that sense, all this musical research, the first of a kind in my scientific oeuvre, is a return to those innocent beginnings, before I became imprisoned in the vicious Kafkaesque castle of academia and shunned to its darkest dungeons, in just about the same way as the brightest devotees were excommunicated from the church in the Dark Ages. Now, twenty years later, we make music with the untainted light of One in our heads, like back then, when I was as pure on the inside as a lotus flower, before the academic life and its egotistic rat race defiled my spirit.

Guitar tonal/simple pieces	**a** Happy Birthday guitar.mp3 	**b** Chopsticks guitar.mp3 	**c** Ode to Joy guitar.mp3 
Guitar atonal/complex pieces	**d** Revolution Sunup.mp3 	**e** Christianity.mp3 	**f** True Love Waits.mp3 

Table 2. Three tonal and simplistic themes from the same popular songs as those from Table 1, as played and recorded by the dad (a, b, c), along with dad's three older pieces for three guitars, namely *Revolution Sunup*, *Christianity*, and *True Love Waits* (d, e, f), played and recorded by him in 2001. The reader is referred to the supplementary folder "Table 2" for mp3 files of audio samples.

SON: Here is one of the songs from that era, called *Revolution Sunup* (Table 2d). And then another, called *Christianity* (Table 2e), and then another, called *True Love Waits* (Table 2f). What is characteristic for all of them is this sense of tiptoeing around the cliff of pure chaos.

MOM: As if all is going to fall apart at any moment.

DAUGHTER: Kind of like this paper, too.

MOM: But this sense of uncertainty and sweet inaptitude, childish in many respects, invites the listener to root for this starry train, as you called this music back then, to keep on barreling down this soundscape.

SON: The soundscape filled with the sympathetic twinkles of three guitars, like stars', as they slide down a thin blue line separating joy from sadness, holding both by the hand.

DAD: All this chaos infuses the melodies rolling down these aural hills like starry trains with ever more beauty. Or so was the goal of my experimental method.

MOM: It is all improvisational, too.

DAD: Indeed. These songs were designed to be akin to jazz tunes enriched with the dark and frightening, authentically romanticist harmonies that had been banned from the jazz standards, the way even the slightest hints of depression have been prohibited from communication in this land of the fake and the phony that we reside in.

MOM: It is an energy well that we have fallen into and try to escape.

SON: Maybe our songs will give us wings to fly out of those pits.

DAUGHTER: But what would the birds say?

DAD: What would the birds say? Let us wait and see.

MOM: As we play music to their ears and mark down the observations, we have a plenty of time to discuss some history of the use of cacophony and dissonance in popular music.

DAD: Great idea, especially so considering that some of the most landmark moments from the history of western music were characterized by the introduction of disharmonic sounds.

SON: Really? Like what?

DAD: One of the earliest and most memorable examples from the realm of classical music is the Toy Symphony from somewhere around 1760. It was initially attributed to Joseph Haydn, later to Leopold Mozart and today to the Benedictine monk, Edmund Angerer. In it, the sounds of bird calls mix in with triangles, shakers and glockenspiels and seemingly randomly intercept the classical instrumental harmonies.

MOM: So it all starts with children and their toys.

DAUGHTER: And birds too.

DAD: Yes. The sounds of cuckoos, nightingales and quails are imitated in this symphony.

MOM: Then?

DAD: Then came the beginning of Beethoven's 9th, where a 16-bar long cacophony of tremolo strings, with neither a key nor a rhythm, preceded the opening theme.

MOM: It evokes the chaos from which stars are born (Nietzsche, 1891), in this case by passing across the bridge of the opening pianissimo theme having neither a clear key nor a definite rhythm.

DAD: Then, there came Schubert's late piano works, which were occasionally interspersed with cacophonic tones, such as those appearing midway through the andantino of the piano sonata No. 20 in A major. After that came Wagner's notoriously disharmonic, so-called Tristan chord from *Tristan und Isolde*,

alongside the centerless chord progressions with shifting keys, which paved way for the upcoming abandonment of the limits of tonality.

SON: But the non-classical instruments really paved way for the usage of noise in music.

DAD: Well, simple electrical distortions of guitars or other instruments can create noise unreachable to naturally sounding violins, flutes or timpani. On the other hand, by the time electronic instruments hit the mainstream stage, dissonance was already widely explored by the acoustic jazz artists, starting with the likes of Charles Mingus, Thelonious Monk, Dave Brubeck, Cecil Taylor and Ornette Coleman in the 1950s and continuing with the legacy of Coltrane in the post-*Ascension* phase, Miles of *Bitches Brew*, Albert Ayler, Eric Dolphy, Noah Howard, Sun Ra, the Art Ensemble of Chicago, Don Cherry, Archie Shepp, Patty Waters, the Joe Harriott Quintet and the Peter Brötzmann Octet among many others in the 1960s. Interestingly, all the records by these artists where dissonances had an exceptionally prominent role compared to their earlier works went down the musical history better than the others.

SON: Now we come to pop music. I am all ears.

DAD: As far as the use of noise, dissonance or cacophony in modern popular music is concerned, by the time the first strides in this direction were made, the foundations had already been set. Namely, the liberation from harmonic and rhythmic limitations had happened in the hands of classical composers, jazz musicians and musical experimentalists of the 20th Century and there was no need to reinvent the wheel. All that was needed was to pick the right (dis)harmonic modes and convert them to the pop genre. Sometimes the inspiration came from a distant exposure to the new sound and sometimes the connection was more direct. For example, alongside La Monte Young, Tony Conrad and Marian Zazeela, one of the members of the Theatre of Eternal Music, aka the Dream Syndicate, which experimented with pure harmonic intervals, with sustained, so-called drone notes and with electrical sound distortion in New York of the early 1960s, was also John Cale, one of the founders of the Velvet Underground, the band widely regarded nowadays as the pioneer of avant-garde pop.

SON: Is this to say that pop musicians who embraced these unconventional elements were but wily middlemen?

DAD: Not at all because their task of delivering the unconventional and unpleasant to the ears of the popular audience was a tricky one, requiring quite a lot of creativity. This is especially so because no artists who experimented with dissonance more than the popular taste could digest or did not hold an already established status, such as John Cage, Karlheinz *Stockhausen, Steve Reich, Richard Maxfield, Pauline Oliveros or Terry Riley*, so that the public could accept their experiments as serious and not some accidental mumbo jumbo, simply could not afford the luxury of getting released on a major label and reaching

the attention of the public and the critics. Rather, the innovations had to be minor and shyly introduced into the musical works, meaning that for many of such works, such as *Egyptian Shumba* by the Tammys from 1963, *Have I the Right* by the Honeycombs from 1964 or *Funnel of Love* by Wanda Jackson from 1961, there continues to be a lack of consensus whether those were the products of true visionaries or pieces of accidental art resulting from a sloppy home production. In science pretty much the same barriers are at work, as a way around of which I, myself, often resorted to the tactics of sneaking one or two romantic sentences into a scientific paper in my effort to romanticize and revolutionize its content, hoping that the peer reviewers and the editors would not notice them lest they object. Likewise, if you look at today's titles of scientific papers, you might realize that they are often fancier in style than the rest of the content. However, these are just titles and not scientific papers in their entireties.

MOM: And so the innovation at this stage never really left the bedroom, so to say.

SON: Meaning that we should never stop rummaging through secret spaces. Clearly, unthinkable treasures could be found therein.

DAUGHTER: Like this bird poop that has just dropped on my nose.

MOM: It is a lucky sign, hon.

DAD: Also, this just proves the thesis that small and intimate settings have always been the most innovative of places, for both scientific and artistic advancements (Uskoković 2021).

MOM: I wonder if a parallel could also be drawn between science and art when it comes to this tendency of the goddess of history to cast long shadows of oblivion on the realest pioneers.

DAD: Quite likely. Because when we seek pioneers in certain scientific disciplines or specific research topics, we have no other choice but to browse through libraries of published studies. However, innumerable innovative ideas that never led to publishable findings never left the lab or office drawers and the world never learned about them. So yes, there is a definite parallel between music and science here. Tracing it can be inspiring for anyone interested in the marriage between science and art.

SON: What about some of the examples of these precursors of dissonance in pop music?

DAD: Off the top of my head, the song titled *The Ox* by the Who, which was released as a part of this band's debut record in December 1965, presents possibly the earliest example of an extensive, thorough embracement of cacophony and dissonance in a western pop music song. It did, of course, build on the earlier guitar work by the likes of the Yardbirds, the Kinks and Them, but it went a step further than any of the prior, characteristically bluesy discords or

distorted chords that their predecessors employed. Regrettably, this band failed to blend this Dionysian mayhem with deep aesthetic sensibilities all throughout their career, meaning that the influence of this early work was reduced to sheer energy, without the ability to ennoble the listener. Next, we could mention the infamous electric jug in the first release of the 13th Floor Elevators from January 1966, which earned the band leader, Rocky Erickson a prompt entrance to a lunatic asylum and a series of electric shock therapies. Two months later, the world saw the release of the debut record by the Monks (1966a), a proto-punk band composed of discharged American soldiers stationed in Germany. Not only did they resort to wildly dissonant keyboard lines, but they also opened the record with a bold announcement: "You know we don't like the army" (Monks, 1966b). Naturally, given how ahead of its time the record was, it was released to a universally muted reception, both commercial and critical. A bit more influential was *Evil Hoodoo*, a song that came off the debut record by the Los Angeles band, the Seeds in April 1966, but its influence still never spread far beyond the SoCal region. Around this time, the Easybeats, aka the Australian Beatles, were composing their biggest hit on all continents, *Friday on My Mind*; its key feature was the dissonant guitar riff adorning the verses prior to the chorus, but the song would not be released before October 1966. Therefore, none of these examples can be said to have really paved way for the first pop record that incorporated a broader-scale experimentation with dissonance and chaos. It was *Freak Out!* by Frank Zappa and his San Francisco band, Mothers of Invention, which was released in June 1966. The record is not, however, coherent when it comes to the adoption of dissonance, as most of it is just a comical rockabilly stuff. One notable example could be heard toward the end of the song called *Who are the Brain Police?*, but then things really explode in the last 20 minutes of the record, which are thoroughly cacophonic (Mothers of Invention, 1966).

SON: Isn't it obvious that all these early prototypes you mention were quite dark and angry? I wonder if this reflects the darkness that all innovators must pass through on the way to fulfilling their revolutionary dreams.

DAD: Well, the innovation of the form is one thing while balancing the invention of a new form with the provision of an aesthetically moving content is a whole different story. For that to happen we had to wait for none other but the Beatles, it seems. In fact, the cult status of the Beatles' *Revolver* released in August 1966 largely owes to the record's ending enriched by tape loop noise. However, the all-encompassing swish of cymbals, the muffled vocals and the dissonant lead guitar emerging on and off from the back in *I'm Only Sleeping* was when that delicate balance between standard harmonics and discord was struck, better than by any other song on this record. That was when cacophony truly hit the mainstream.

MOM: Isn't it a bit ironic that these masters of harmonic composition produced their most significant moment when they gave up on complex harmonies and turned to elaborate construction of dissonance?

DAD: Well, all this constructive cacophony is a definite reason why *Revolver* has rated better than any other Beatles' record on the critics' lists of best albums of all time (Anon., 1996a,b). Although, at the very finale of their first following record, *Sgt. Pepper's Lonely Hearts Club Band*, they pushed even further toward this goal of embracing noise (Beatles, 1967a). There is no doubt that they were greatly inspired in these endeavors of theirs by the Beach Boys' use of coke cans and bicycle horns, alongside countless exotic instruments, on *Pet Sounds* (1966).

MOM: Or by the Dixie Cups' earlier turning the tapping of bottles, ashtrays and chairs into the only accompaniment for voices in their chart single, *Iko Iko* (1965).

DAD: Or years earlier by Joe Meek, who only on his most popular record to date, *I Hear a New World* (1960), used clockwork toys, milk bottles, drinking straws, combs, washers and various radio interferences as instruments (Handley, 2020). He, unfortunately, became yet another musician ahead of his times who descended into madness.

MOM: Now that you mention the downward drags of insanity that all the trailblazers of this world feel and *Pet Sounds*, that sonic cathedral for all the childlike dreamers at heart and a most glorious piece of pop music ever made, should not we stop for a second and reminisce about it?

SON: If we wish, we may tip our invisible hat of admiration in its direction, too.

MOM: There, 40 miles northwest from here is where it was born.

DAD: The definite influence of this milestone of modern music notwithstanding, it has been tapped into less than the tips of the icebergs in the Titanic crew's sight. For, music, largely, has evolved away from it rather than to it.

SON: And its creator had no choice but to drift toward madness.

MOM: But to slip into madness can only be a sign of mental health of one squelched under the confines of an inherently ill, isolationist culture that this tattered old vulture called SoCal carries on its crushed wings.

DAD: As for the timeless flight of *Pet Sounds* toward greatness, it was largely owing to its lauding descents into the dreamy darkness of desolate playrooms, into quietness, subtlety and the eye of the mind with a taste for the beauty of small sounds in an era when pop music was all about "shake, rattle and roll" (Big Joe Turner, 1954). And when you create a work of art that inverts the mainstream up on its head, madness is the ravine lurking from around each corner,

all along with the label of a looney, if not "an old flat-top with a juju eyeball and a walrus gumboot" (Beatles, 1969).

SON: As far as the Beatles are concerned, our favorite examples pop up here and there on their White Album. Like the ending of *Dear Prudence*.

DAD: Or the car traffic jams and neon flashes of *Savoy Truffle*.

MOM: Or Yoko's experimental stuff on *Revolution 9*.

DAD: All their conceptual overthinking aside, that is when the Beatles were at their best: when they created music unpretentiously, with a pure subliminal attitude, as if they were making jingles for children's ads.

SON: Strange time it was, that 1968, with the White Album, *Smiley Smile*, Blood Sweat & Tears' *Child is the Father of Man*, *the Kinks are the Village Green Preservation Society* and the Zombies' *Odessey and Oracle* emerging all around the same time and all sounding like music for children in many respects. And then a year later, the trend was gone, never to reappear again.

MOM: Isn't that what we do here? Making science for children.

SON: Children *4 real* and children at heart.

DAD: Four of us cannot be realer than this, but we do pray that we remain children inside forever and ever.

DAUGHTER: We vow never to grow up.

DAD: Now, considering the notable examples from the 1960s era after 1966, chronologically, there are the Velvet Underground's bold use of cacophony all across their debut record (1967); the Red Crayola's upfront employment of noise and free improvisation on their first studio album (1967); cuckoos, rattles and other noises pervading Pink Floyd's first album (1967); the orchestrated fuzz occasionally heard on Who's production from this period (1967); the space folk of the Byrds (1967); the chaotic baroque pop of the United States of America (1968); the oscillator exhibitions of Silver Apples (1968); songs evolving into cacophonous chaos on the Grateful Dead's *Anthem of the Sun* (1968); the psychedelic guitar work of Jimi Hendrix (1968) and the satirical one of Frank Zappa (Mothers of Invention, 1968); Blue Cheer's acting as a precursor to heavy metal by catering to bikers, not hippies, from the heart of San Francisco (1968); Van Morrison's sophisticated use of dissonance on *Astral Weeks* (1968a); the strident sitars and other strings in the work by the Incredible String Band (1968); the exercises in song deconstruction by Soft Machine (1968); the eerie krautrock precursor sound of Amon Düül II (1969) and the early work by Can (1968/1981); the accidental art created by the out-of-tune guitars and vocals of the Shaggs (1969); the mind-bending grotesque of *Trout Mask Replica* (Captain Beefheart and his Magic Band, 1969); experimentation with tape loops and overdubbed instrumental improvisations by Terry Riley (1969); and the pure noise amidst

thunder and fire and Iggy's vacuum cleaner and an orange blender and a sitar drone and the hammered oil drums at the end of *Fun House* (Stooges, 1970), without which this record would not have gone down in history as well as it did.

MOM: Now that you mention these Detroit thrash bags, I declare that we must "open up and bleed" (Stooges, 1973) our essence to the world if we are to retain this infinite juvenileness of our spirits.

DAD: Inspiration comes from the strangest and least expected of places. Now, speaking of opening up, which we dream of under this confinement by the "curse of comfort" (Thrills, 2004), this pioneering work from the late 1960s opened up the way for the later gems by numerous acts. On the more popular and the less obscure end of the spectrum, notable examples, chronologically ordered, may include the works by Yoko Ono (1971), Can (1973), Faust (1973), Todd Rundgren (1973), Roxy Music (1973), Robert Wyatt (1974), Brian Eno (1974), Pere Ubu (1977), Throbbing Gristle (1978), Residents (1978), Nurse with Wound (1979) and This Heat (1979) in the 1970s, Public Image Ltd. (1981), Raincoats (1981), Glenn Branca (1981), Liquid Liquid (1981), Birthday Party (1982), Hüsker Dü (1984), The Fall (1985), Jesus & Mary Chain (1985), Einstürzende Neubauten (1985), Big Black (1986), Cocteau Twins (1986), Sonic Youth (1986), Dinosaur Jr. (1987), Cure (1987), Pixies (1987), Talk Talk (1988), My Bloody Valentine (1988) and Bongwater (1989) in the 1980s, Lush (1992), Ride (1992), Pulp (1994), Suede (1994), Tricky (1995), Björk (1995), Yo La Tengo (1995), Sparklehorse (1995), Beck (1996), Radiohead (1997), Oasis (1997), Verve (1997) and Roni Size & Reprazent (1997) in the 1990s, and Super Furry Animals (2001), British Sea Power (2003), Radio Dept. (2003), M83 (2003), Fiery Furnaces (2004), Sigur Ros (2005), Animal Collective (2005), Sunset Rubdown (2006), Love is All (2006), Go! Team (2007), A Sunny Day in Glasgow (2007), Depreciation Guild (2007), MGMT (2007), Dan Deacon (2009) and Salem (2010) on the calmer side in the 2000s. These, of course, are only the examples that are falling off the top of my head, like raindrops, and getting smeared over this virtual screen as I am speaking. They all strewed my paths with signs in the past and that is why they come to mind so naturally.

MOM: Glancing at this chronology, it appears that while dissonance and chaos in music at their best were inevitably avant-garde in the 1970s, they gradually became embraced and fused into softer, more pop forms during the 1980s, before becoming the tools of commercial blockbusters in the 1990s.

DAD: As the century rolled around, these trends vanished in the fog of diversity and everything can be found out there today, from the adoption of noise by music industry giants to reap profit to true-blue experimentations in blinded bedrooms, forest cabins and intimate concert halls squatted in the shadow, shielded away from the limelight.

MOM: Like us in this desolation row pending postcard writing (Dylan, 1965) and dipping their edges to the sea and sending them to distant lands.

DAD: In fact, many of the music genres that either exploded in popularity in the 21st century, such as hip hop or glitch pop, or were born in this new century, such as dubstep, deconstructed club, drone, indietronica, hypnagogic pop or post-industrial, have employed dissonance and noise in a fine and controlled manner.

MOM: On a side note, we seem to be putting atonality and cacophony in the same basket, yet they mean different things.

DAD: It is correct. David Rawlings' guitar accompanying Gillian Welch, for example, sporadically drifts into atonality (Welch, 2001b) but is by no means cacophonous, while Steve Jones' riffs on *God Save the Queen* are cacophonous (Sex Pistols, 1977), like all the distorted guitar sounds in punk rock, even though they are completely tonal. I suggest, though, that we better leave the untangling of the influence of the twain to others to wrestle with, especially because both atonality and cacophony represent forms of dissonance from the classical diatonic perspective of western music.

MOM: Have we just mentioned that highway dreamt to a you (Welch, 2001a)? If so, every road, every highway and alleyway calls for a detour.

SON: I wonder what will ours be at this fork in the road.

DAD: Maybe it will be a quick relish in the evocation of how Gillian and David's sensing a state of imminent peril while recording the record that ended with this dream of dreaming a highway to you is similar to the state we are in now. They felt that their "ability to be artists, like, for our career, was really in jeopardy"; they felt "raw and alone"; they felt as if it was them "against the world"; they felt "impossibly alienated and disconnected"; they "felt the tremor and saw the foundations washing away" (Bernstein, 2021), and this is how we feel today, too.

SON: We feel that this floor is made of lava as we spill these words out into the wind.

DAD: We have never felt more endangered and destined for oblivion than today, yet all this that we do has never sounded more precious and beautiful. We might remain shunned by the scientific society for all these lunacies despite carrying a torch that can enlighten this society and humanity as a whole. Unbounded darkness one way and bedazzling shine the other way – in-between them is the road we are ordained to walk on.

MOM: But if we produce our magnum opuses in the midst of this desolation, then maybe this prison for our souls is a blessing on our journeys? Maybe it is the driver for our engaging in the science of our lives?

DAD: Maybe this pen is the dreamer dreaming this dream, using us as but its sentient mediums?

SON: Maybe this thinking along tangents would shoot us to the moon someday, if we only aim high enough.

DAD: Or, if we aim low, bring us back to a you, to a fellow human soul, the center of gravity for the holy spirits in this life.

DAUGHTER: Holy spirits that we dream to become.

MOM: And, like these birds, soar ourselves high.

DAD: The soar of a kind that we can accomplish only if we care nil about it and all we want to do is soar a fellow spirit high.

SON: To birds.

DAD: To birds.

SON: All things considered, as we play our last tunes to the birds, we can conclude that the secret of producing a most captivating experience through music is to introduce dissonance into its classical aesthetic elements.

DAD: When classical harmonic climaxes are being reached in a composition, dissonances in particular crave to be introduced, like an incantation of a kind.

MOM: And yet, music has been becoming purer and purer in sound and any noise is now being avoided at all costs, like in most other spheres of society.

DAD: The music practice rooms and concert halls of elementary and middle schools aside.

SON: Is this why I found you squatted, sobbing behind the rolling wall of that concert hall where my fourth grade class gave the string orchestra performance last fall?

DAD: That music, that day, was a stellar experience to hear. It lay far from the extreme of perfect consonance, where everybody would play the right note at the right time, which would have been drowsing and dull, but it was not a complete dissonance either. It fell onto territories that are between these two extremes and its rhythmic, harmonic and melodic simplicity was made alive by the constant dispersion of dissonant tones across the sonic palette. The music had just about enough of the human element to inspire and elate, but all these dissonant elements that the classicists would classify as errors were there to make the music infinitely alive. Music like this becomes magical, never boring to listen. Like gazing at an abstract expressionist painting never grows old, as one can always discover therein some new forms, signs, emotions and messages, so is it with music made from the crumbly bricks of disharmonious harmonies.

MOM: Isn't it magnificent that once again, like in our quest for science of the heart, we become guided to children and their artwork in our search for music that depicts the infinite?

DAD: Indeed, it was a type of music that I dreamt of and searched for for what seemed forever and then found it in the least expected of places: in the sound of untrained children's string orchestra.

SON: So, we, children have it in us then.

DAD: Of course, son, everywhere and at all times.

MOM: The guides and the guided should really swap places; the sooner, the better.

DAUGHTER: And all should make the rattle and the clatter like the world has never heard.

DAD: Here I bring to mind the sirens as the first sounds to open *It Takes a Nation of Millions to Hold Us Back* (Public Enemy, 1988). Here's to the call to make some noise!

SON: Here we go: trump-para-pum bongily-bosh (♪♫♪).

DAD: Who knows how far rap and hip-hop would have gone had this route been followed in their evolution, as opposed to the airs-, monies- and pleasures-paved one (DJ Shadow, 1996).

SON: Can we say that chaos is the ennobler of the reactionary conservatism?

DAD: Always was and always will be. Alas, already from the 1960s on, the masses have been made aware of the adversities entailing excessive consumption, neoliberal capitalism and environmental degradation, and yet the planet has never been enveloped in as much greed, voluptuousness and negligence about the ecosphere and most anything else extending beyond the boundaries of the self as it is today. Similarly, we have come to know life that is being brought to musical compositions by adding cacophonic elements to their euphony, and yet it is a talk that no one anymore walks, at least not on major avenues.

SON: Music, as, I believe, Confucius noted (Brkić, 1983), is the best mirror of the society's spirit.

MOM: But wasn't most of the music you mention built on the back of the domineering desire to stand out over others? If so, then doesn't this seed of selfishness, if not sheer narcissism, buried deep within this music make it spiritually corruptive?

DAD: Very much so. This point, it is worth adding, applies to every other human discipline, science included, especially in the heavily competitive world of the day, where mostly people with psychopathic mental traits end up emerging on

the tops of their professional pyramids. Cite anyone famous or successful and remember that their countless stomps over fellow humans have enabled their words to be heard and, well, cited.

MOM: This means that we must besmirch ourselves and the world by allowing these pop stars, science celebrities and other public figures to draw before us the paths to follow.

DAD: This can be the starting point of our descending deep underground, to hold hands with and lean ears onto the hearts of those who will never become renowned or famous. This is our stepping out of the limelight and into the dark, the task that every shining star must be prepared for, sooner or later.

SON: Moreover, the world is not black and white. The traits of everlasting beauties are scattered in everything, everywhere.

DAD: For this reason, the music cited here, its megalomaniacal allures notwithstanding, can be inspiring to listen to due to the equally great desire to ennoble the world that was woven into it. In fact, we know now that in this embodiment of diametric antipodes lies the ability of any art to mesmerize its consumers.

MOM: The best music has always been a cross crucifying the listener between diametrically opposite emotions.

DAD: Still, if the toxic ego and thirst for fame that popular music has been imbued with silently spoil the listener's spirit, then there may come a time in everyone's life when this music of the people and for the people is to be left aside and we turn to birdsongs and myriads of accidental sounds pervading the natural world instead.

MOM: This makes a whole lot of sense. Should we find in them an equal source of pleasure for the senses as we did find in human music celebrated by the masses, we may know that we have reached the anterooms of eternity.

DAD: That was exactly the point of the early proponents of atonalism, such as Schoenberg or Berg, or of the climax-deprived, broken-puzzle music of the likes of Bruckner or Scriabin. They argued that our ears must adjust to this new kind of music and that listening to it initially would be a difficult experience. However, in the long run, after the learning process is over, we would be able to listen to the most ordinary natural sounds, be it the bird chirps or the fridge buzz, and hear in them music as inspiring and rejuvenating for the soul as a Beethoven's symphony or a Prefab Sprout's record. The world, then, will be ours and the enlightenment will be in our hands.

MOM: Does this mean that we can still listen to 33 (Smashing Pumpkins, 1995) and have our hearts bleed with emotion?

DAD: Of course. It can be a breathtaking emotional experience to slide up and down the rollercoaster of climaxes and potential energy buildups in a pop song,

just as well as we may gladly sink our souls into seas of that special breed of songs that turn sinners into saints in the blink of an eye, if only embraced with our whole hearts. We can also imagine music as a mystical space through which the silhouettes of our spirits may roam to encounter their past, present and future, if not dance with muses on starlit rooftops. However, there are many other ways of listening to music.

MOM: My favorite way of listening to music is by allowing it to simply create an atmosphere that inspires reflection on our place in the world. Such a way of listening can easily transform into a clairvoyant experience, which is in many respects deeper than the transient satisfaction that the rollercoaster rides up and down the peaks and troughs of the aural space of a catchy pop song offer.

DAD: Whatever the case, we, as humanity, collectively, have not learnt yet how to listen to natural sounds in any profoundly satisfactory way for our emotional senses, but there is no reason not to expect that future will teach us so.

SON: First the theory, then the experiment.

DAD: At least for us, the introverts, who break down every pending action to abstract pieces before performing it.

SON: Us, the angels who fear to tread.

MOM: In lieu of fools who're all about rushing in (Pope, 1709).

SON: Really, then, anything can be music. Should we listen for a minute or so to the music of the ocean waves breaking against this sandy shore (Fig. 2)?

Fig. 2. Sound of the ocean waves captured on tape by the Pacific shore at Newport Beach. The reader is referred to the supplementary folder "Figure 2" for the mp3 file of the audio sample.

DAD: Ah, whoever finds in this sound an equal source of pleasure for the auditory senses as in any piece of music that uplifts the soul due to its classical tonal structure holds a holy grail inside oneself.

MOM: Knowing this, I do not feel bad anymore that we live surrounded by an awful mess of scattered plush animals and a sundry of other toys. Sometimes there is no empty spot on the floor to step on, but so what? Beautiful, as we see, is not the artificially clean, but the naturally chaotic.

SON: What can science learn from this?

DAD: This.

MOM: Ah, this was refreshing.

DAD: I would certainly, any day now, rather talk about music than politics.

MOM: But the wonder still remains over whether these musicians you mentioned can be credited as the real pioneers or the truer inventors of the new forms remained in the shadow of the limelight.

DAD: Well, popular music has been popularly documented, but the history of science is not significantly different. Looking back at both, we could build our theses only based on what has been released by record labels and journals and, as such, documented in libraries. What has been undocumented is equivalent to nonexistent to historians, even though we know that this cannot be true. Moreover, popular taste and the cohesion of minions still largely dictate what will go down in history and what will be pushed down the cliffs of oblivion. Without a plethora of devoted followers, not many individuals ended up being instated in the pantheons of science or art.

MOM: But we worry about that least.

DAD: Our mindset is like that of the defenders of my hometown from imperialistic conquerors a century ago; they were told to have been wiped out from the list of the living, which gave them supernatural powers with which they held off the enemy at bay. Likewise, we do not burden ourselves with rewards and other games of the ego, which is a good thing because it prevents us from getting sewn into submission and thinking with other people's heads. What falls down on this paper here is undefiled by convention and pure as the whitest snow.

DAUGHTER: The birds have visited us and then backed off. Back into the sky they went.

DAD: Great. They must have given us some clues. It is time to sum up the results.

SON: Here is the first set of graphs (Fig. 3).

DAD: This is striking. The birds did sing less or more quietly when we played our piano tunes to them (Fig. 3a). As we could see from the analysis, there is a high and extreme statistical significance of the drop of the birdsong volume when the birds sang to the simplistic and the complex tunes, respectively.

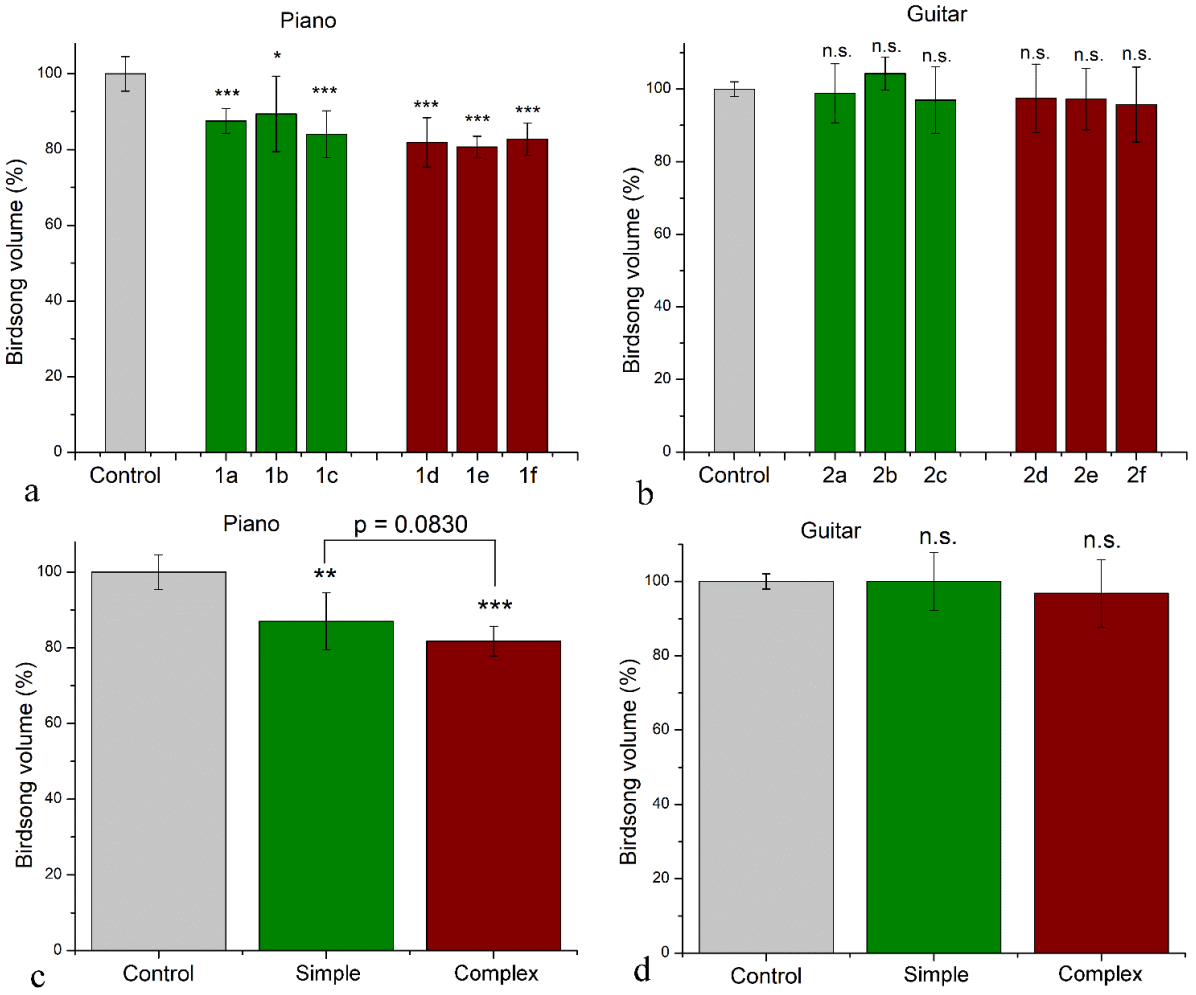


Fig. 3. Birdsong volume expressed in percentages relative to the volume of the control depending on what tunes were played to the songbirds, including the three simplistic tonal tunes and the three complex, partially atonal tunes played on a piano (a) or a guitar (b). Tune annotation (1a – 1f, 1a – 2f) is given in Tables 1 and 2 for the piano tunes and guitar tunes, respectively. Average relative birdsong volume is summed for all the simplistic, tonal melodies played and all the complex, partially atonal pieces played in (c) and (d) for piano and guitar, respectively. Data points represent averages, while single, double and triple asterisks denote statistically significant differences with the levels of confidence, p, lesser than 0.05, 0.001 and 0.0001, respectively, relative to the control. Data points not statistically significantly different from the control ($p > 0.05$) are labeled with n.s., which stands for non-significant.

MOM: Moreover, there seems to be a clear difference between their responses to the simplistic piano compositions and to the more complex ones (Fig. 3c).

SON: They got quieter more when we played them the complex tunes than when we played them the simplistic ones.

DAD: The confidence level, p, of 0.08 for the difference between the response to simple piano tunes and the response to the complex ones is still pretty high, very near that magical boundary of 0.05.

MOM: Ah, those boundaries of convention, how faded in our eyes they have become.

DAD: Indeed. Let us never forget that p = 0.05 is but an arbitrary standard and that levels of confidence slightly bigger or slightly lower than it should be treated similarly.

SON: But why?

DAD: Why what?

DAUGHTER: Why it all.

MOM: Ah, those endless whirlpools of knowledge whereat whys after whys toss us, the questers for beauty and truth.

SON: Why, I mean, why did the birds quiet down when we played them our music?

DAD: Who would know that? Not me.

SON: Maybe because they liked it so they wanted to listen to it?

MOM: Or maybe they toned down their singing because they got a bit frightened by our music.

DAD: Hard to tell. As with every good experiment, we are left with more questions that what we started with.

SON: But the birds responded a whole lot more indifferently to your guitar tunes (Fig. 3b, d).

DAD: Is this to say that the birds liked the stuff children made (Table 1), with their authentic children's energies, more than what this old man in a boy's body did two decades ago (Table 2)?

DAUGHTER: Pin, pindilly, poof…

SON: …the pigeon is toddling up on the roof…

DAUGHTER: …the roof that is my hat…

SON: …and in it sunshine and a million one pet.

DAD: There goes our answer, I guess. Veiled by the sweet mystery of children's play. Like every answer we'd be on the search for on this glorious day.

MOM: Both piano and guitar are string instruments, but the piano sounds have had less treble in them and did sound a bit crispier, so I wonder if the timbre of the sound played some role here.

DAD: We should never forget that birds hear differently than humans.

MOM: Indeed, it is a common misconception that songbirds can hear what humans cannot (Konishi, 1970), when most birds, in fact, lack the high-frequency hearing range (6 – 20 kHz) that mammals are sensitive to (Heffner & Heffner, 2007).

DAD: Hence, with the guitar tunes having more bass in them than the piano tunes, could it be that they were more audible to birds?

MOM: Whatever it is, the facts are right here, before our noses, in these results, saying that there must be some sound quality difference between the piano tunes and the guitar tunes.

DAD: This is sufficient to help us deduce that birds are affected by the harmonic makeup, the tonality and the musical complexity of human songs, but will also react differently to different instrumental arrangements.

SON: One interesting thing I noticed is that if we look how much the birdsong volume changes the first time a new tune is played compared to the tune preceding it, no tune has silenced the birds as well as *True Love Waits* (Fig. 4).

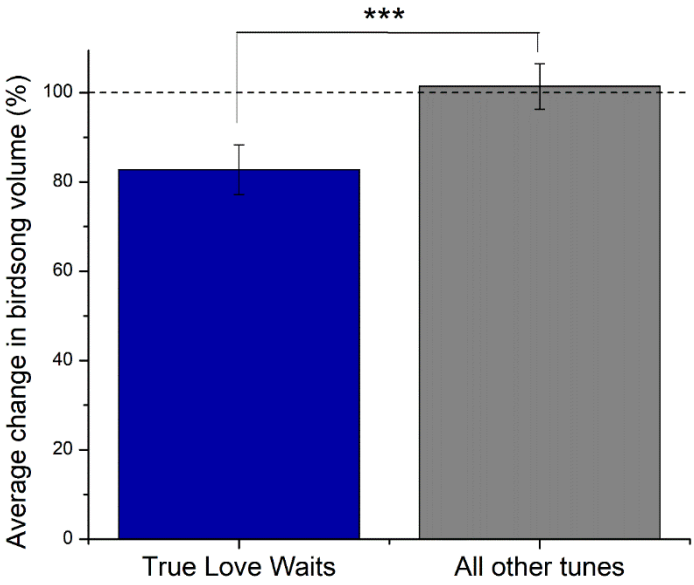


Fig. 4. Average change in the volume of the birdsong played to *True Love Waits* (Table 2f) relative to the birdsong played to the preceding tune upon its first playing to the birds on a single day, as compared to the average change in the volume of the birdsong played to all other tunes relative to the birdsong played to the song preceding them. Data points represent averages, while triple asterisks denote a statistically significant difference with the level of confidence, p, lesser than 0.0001 relative to the control.

MOM: It is a magical tune. Perhaps it is as if the world listened, birds included.

DAD: All of the complex songs we presented to the conference of birds have a tint of magic in them, I think. As for *Revolution Sunup* (Table 2d), note how wobblier, sloppier and more momentous the play gets with each revolution, pardon repetition of the song. As for *Christianity* (Table 2e), there are gargantuan grief and steams of passion pervading the sound, evoking the image of the miser on the cross, distilling all the world's wretchedness into the cries of this guitar in a youth's hands. Then there are the luminescent dissonant chords in the piano pieces (Table 1d-f) that evoke the post-impressionistic roots of the atonalism in the early 20th century.

MOM: All in all, sweet.

DAD: And sour and grave and laden, lest all that sweetness for the soul vanishes in thin air.

SON: And then, from the columns of air, we drop into the ocean. Here is what the ocean wanted to tell us (Fig. 5).

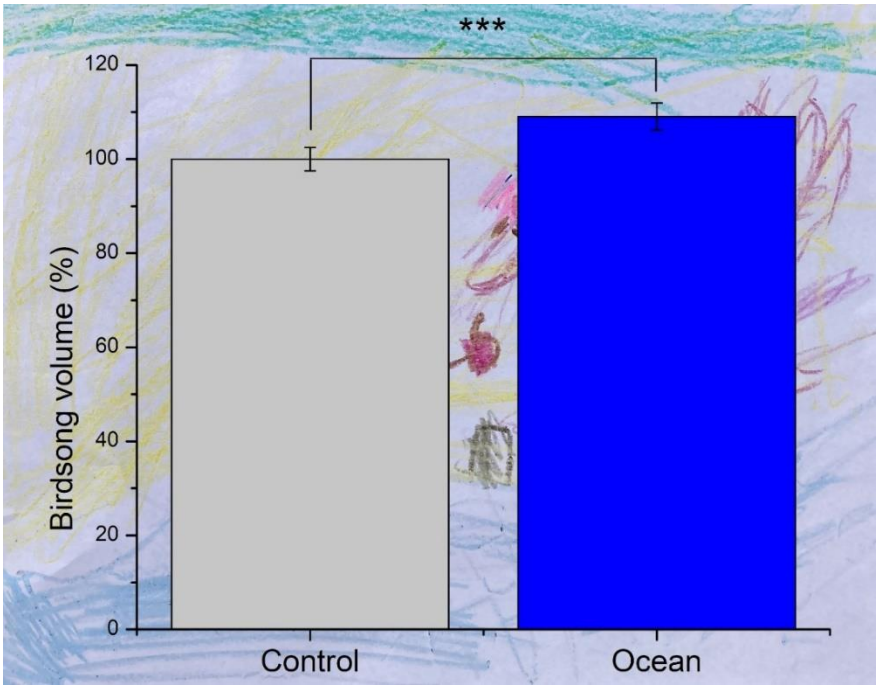


Fig. 5. Birdsong volume relative to the volume of the control when birds were exposed to the sound of the ocean waves. The diagram is being superimposed on the daughter's impromptu drawing of the family playing by the ocean shore with a big bird, whose beak and wings peek from behind the ocean bar. Data points represent averages, while triple asterisks denote a statistically significant difference with the level of confidence, p, lesser than 0.0001 relative to the control.

MOM: The birds seem to be singing louder to the sound of the ocean waves!

DAD: I wonder if this is because they liked that music of Nature more than they like human music. Or because this white noise sounds so natural that it makes them feel safe, so their songs become more sonorous.

MOM: Or because they associate water with the competition with other avian species, so their drive to announce territoriality through song becomes spurred.

DAD: Once again we have more questions in our hands than when we started this inquiry. Our earliest questions sprouted into the stem of this experimentation, which is now branching into a tree with innumerable branches of new questions, and is growing bigger and bigger.

SON: So let us let the questions sublimate, for a second at least.

DAD: And have us rejoice in what this finding may hint at, which is that if birds really like the white noise of Nature more, then we ought to turn to that music too. Even though it may not give us as much of emotional satisfaction as human music does right now, if we befriend this music and listen to it with our hearts day in, day out, maybe a day will come when it will start resonating with our emotions and when we would be touched by it more deeply than what any human music can achieve. This is how we may expand our intellects: by listening to this new music of the spheres.

DAUGHTER: May I notice that the birds were greatly affected by children's music?

DAD: They did, certainly more than that of one coming-of-age adult (Fig. 3c-d).

MOM: For, it is to children that the world will be left.

DAD: As that mysterious, all-seeing, omnipresent guiding light goes out to hide.

MOM: Like the characters in this play behind the data bar columns in this last graph (Fig. 5), playing by the ocean shore, with no one to see them.

DAD: Aren't all of the world's most beautiful things hiding in corners? Like the beauty of the music of Nature, all arrhythmic and atonal, which no one among us is ready to rejoice in fully yet.

SON: As for hiding, the birds seem to have hid themselves very well from us, too, at least to some extent. So do say the results of our bird tracking experiment (Fig. 6).

MOM: Hmm, from what I see, the lack of statistically significant difference notwithstanding, the birds did tend to visit us less when the songs we played were simple and tonal, but they also did seem to hang in our cage more when we played them our intricate, atonal piano tunes than when we played nothing at all, which is a pretty rad finding.

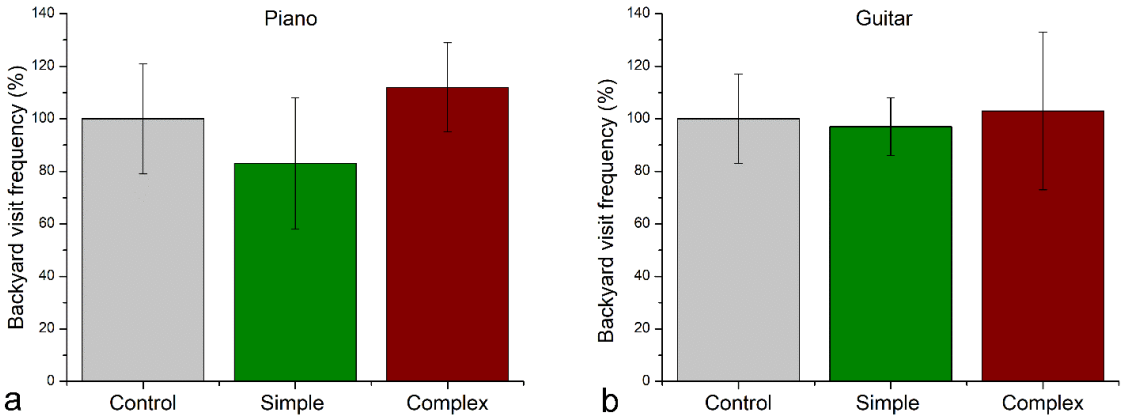


Fig. 6. Comparison of the number of times songbirds landed within the limits of the backyard when no music was played (control), when simplistic, tonal melodies were played (simple) and when arrhythmic and atonal pieces were played (complex). Backyard visit numbers are expressed in percentages relative to the control and shown in (a) for piano tunes and (b) for guitar tunes.

SON: Could they have been somewhat quieter to these atonal piano tunes because they were curious about them and were listening, which attracted them closer to us?

MOM: With cells, it is like that: when they undergo mitosis, their differentiation stalls, and *vice versa*.

DAD: Still, for the most part, the birds hung around us just fine, whether we played them music or not.

SON: If anything, this means that they were not frightened or disturbed by the music and that they did not leave upon hearing it.

DAD: This, further, very importantly, implies that the reduced volume of their birdsong in our prior experiment was their musical, auditory response rather than the consequence of their simply taking off.

SON: So birds hear us and sing to our songs.

MOM: The whole Nature joining us in our musicianship.

DAD: When we whistle, it is all a symphony around us.

DAUGHTER: How prettyful.

DAD: Let us enjoy in this moment for a bit. This was an experiment that elated and uplifted our weighty corporealness on the wings of music and made us so light that it is as if we might soar into the sky any moment now.

MOM: The cups of our spirits have been filled with the nectar of art.

DAD: This is what science should be like. This is the science I have dreamt of all my life – science that is spiritual, that speaks to the soul, that sets us into the states of mind so sublime that we feel transformed into birds that we have studied all day long.

MOM: It will not be the first time that the observer and the observed fuse into one, so well that neither of them knows anymore whether they are one or the other.

DAD: The experiential reality is such that the observed is always a mirage of the observer's inner world and *vice versa*.

SON: Back to the science of the day, I wonder if some other biological systems, such as plants, cultured cells or even self-assembling protein molecules, would behave differently than the birds. Maybe they would respond with their heights, viabilities or symmetries, respectively, more positively to a different type of music than the birds did.

DAD: We won't know it until we test it. But here, we have communicated with birds for all the aforementioned reasons, the most important among them being our hope that they would help us fly high and away from this prison to which we have been confined.

SON: That would be a dream come true.

DAD: Also, in our earlier study (Uskoković *et al.*, 2022a) we used colonial birds as proxies for our cognitive systems and here we continue where we stopped then. Birds, namely, albeit solitary, may tell us about the inclinations of our cognitive apparatuses that we may not be wholly aware of. Are we turned down by too much order, or perhaps by too much disorder? Or, are our brains tuned to the balance thereof?

MOM: It is worth remembering that studies in cognitive science have consistently showed the loss of noise in terms of neural signal variability in human brains upon aging (Garrett *et al.*, 2010; Agrawal *et al.*, 2018; Levy 2021).

DAD: This is to say that noise is a hallmark of mental health, quite unlike what has been traditionally believed. Likewise, things that are in a state of disorderly order may bring about the resonance of our spirits far more effectively than things that are superiorly orderly ordered.

MOM: And art that infuses celestial harmonies with cosmic chaos may be best suited to act as the elixir of life, a nectar for the eternal youth of our spirits.

SON: This brings to mind an earlier experiment you did and once told me about.

DAD: Yes. Once, I was directed by my advisors to work on a retina mimicking project and got trained on a photolithographic equipment for that purpose. But

then, the way I am, a rebel at heart who always counters the rules and conventions, I came to the idea to test something that seemed more exciting to me, especially given the stalls I faced on this project. In that experiment I created polymeric surfaces with ordered and disordered cylindrical features and then looked at how fibroblastic cells behave on them. Initially, I thought that the cells would respond better to the disordered surface than to the ordered one, but that is not what I saw. It turned out that the cells were mechanochemically stressed more on the ordered substrates, but this stress impelled them to be more metabolically active (Uskoković & Desai, 2014a).

SON: A very ambiguous response it was.

DAD: Very typical for science in general. When we ask a beautiful question through an experiment, there is a great chance that the answer would be equivalent to an even more beautiful question.

SON: That is how science evolves: through questions, not answers.

MOM: And this is how our day ends: with our bosoms full of new questions, more exciting than those we asked in the first place.

SON: But if an experiment has yielded more questions than answers, cannot it be then considered inconclusive and perhaps purposeless when viewed from a different angle?

DAD: There is nothing in this life that has been stripped of purpose. Even the experiment that failed flat on its head is never failed. The only thing we need to do to glimpse its purpose is to expand the frames within which we view it. And as we expand and expand and adopt ever more holistic views, all of a sudden we become…

SON:…free.

DAUGHTER: Free like a bird.

ACT III: Breaking through to Freedom and then giving it away for Love

(*The cage has remained intact, but its walls have proven transparent and the family of four has now passed through them and got lifted into the air.*)

MOM: What is this now? Where are we?

DAD: Our feet don't touch the ground anymore.

MOM: We feel lighter than before. Neither are the walls on this cage as confining as before.

SON: We pass through them easily.

DAUGHTER: We are soaring into space.

MOM: On the wings of music, we took off, lightly. And now we are flying.

DAUGHTER: Look at all the things we can do now. We are silhouettes summersaulting in the air.

SON: Look at me. I am using this jet stream as a slide.

MOM: And I am making snowballs from this condensed vapor.

DAUGHTER: Hey there, an eyelash.

DAD: The air must have blown it off your pretty eye. Here, blow three times and make a wish.

SON: I did.

DAUGHTER: I did, too.

DAD: Don't tell me what it is. Here is a kiss and a hug for both.

SON: My wish just came true.

DAD: Already? Was it materialistic or an angel's one?

SON: It was for you to give me a kiss and hug me.

MOM: How dear. When your heart is as pure as children's, wishes can come true faster than the bolts of light.

DAD: You know, love's the greatest thing.

MOM: It is that single thing that never leaves those whom it was bestowed on once.

DAD: Which is to say that all we need to do is watch the world with love and rest assured that all those loving thoughts emitted will be the waves that rock against the shores of reality long after we are gone from it.

MOM: Many a ship will these waves guide on their streams, silently and mysteriously, without anyone ever finding it out.

DAD: Could we then christen love the highest art and skill and wisdom we could attain in this life?

SON: Whoever has put us into a cage, may they know that love will set us free.

DAUGHTER: My wish has come true, too. It was to fly, fly high.

SON: Everything looks calming and elating from up high.

MOM: Now we know what is real. The spirit is real: this realm that we could fly across anytime we want to.

DAD: All we need to do is close our eyes and listen to the music with our heart, and it will soar us high.

MOM: Funny how people often suppose that the material is real and the spirit is not, but we see it clearly from here that it is the other way around.

DAD: Alright, fliers, who remembers the story from the Upanishads about the two birds, the searcher and the finder (Vivekananda, 1899)?

SON: I remember it.

DAUGHTER: Tell us, tell us.

SON: Well, the bird in search of enlightenment was resting on one of the lower branches of a tree and it always looked up to the enlightened bird that rested on the treetop. The searcher bird was feisty, tasting all sorts of fruit, becoming elated one moment and depressed another, whereas the finder bird was always calm, looking faraway in the distance and glowing with an unexplainable peace of mind. Every now and then, the searcher bird would think that she would never, not even in a million years, reach the enlightenment of the finder bird, and this made her so depressed that she would break down in tears and cry endlessly. But then something happened. Suddenly, after many soars and slumps after the sweet and the bitter fruits of the tree it tasted, the searcher bird realized that it has become the bird that it looked up to for so long and that, even more strangely, it has always been that bird, very deep inside its soul. All this time, it was only her allurement with the superficial things in life that stood in the way of her seeing so. But once this shell was removed, the view of her true nature was there, within sight.

DAD: I must notice an obvious similarity: after gazing at birds with the inspiration of music in our hearts, we now realize that we have become such birds, too.

MOM: We have become free, having flown out of our cage.

DAD: Now, who remembers Farid ad-Din Attar's story about the thirty birds who set out on a quest to find Simorgh, the king of all birds?

DAUGHTER: I remember it. As they traveled through the sky and traveled more and more, they came to Simorgh. And then they looked at it and became puzzled and could not tell if they were looking at Simorgh or they were looking at themselves.

DAD: So they asked Simorgh to explain to them what they saw, and Simorgh said that only while they were seeking it, with their entire hearts, they were on the right way and were kings, so to speak, the objects of their search.

MOM: Finally, summoned by Simorgh, "the birds faded away in him, the shadow disappearing in the Sun, and that is all" (Vitray-Meyerovitch, 1978).

DAD: Once again we see that the destination lies within every segment of the road we tread and that, like in Ivan Karamazov's dream (Dostoyevsky, 1880), the interstellar road of an infinite length can be crossed in the blink of an eye.

SON: Which is to say that with the right mindset, we can soar into the sky anytime we want to.

DAD: As we fly, allow me to question the purpose of our bird experiment once again. Has anyone expected that the birds would really tell us what the right music to listen to is?

SON: Not really. Because whatever the birds were more inclined to, if I preferred listening to music that blends order and chaos in it, they would not change my musical preferences by even an iota.

MOM: That is indeed so. It was a silly experiment, but beautiful too. It may mean little to us empirically, but it has had a key effect on soaring us high and taking us beyond our little cage. It bequeathed freedom to us.

SON: Freedom that is about the flight of the spirit, across open skies.

DAD: In a world where the meaning of freedom has deteriorated into silly little figments, such as dying one's hair green, wearing the costume of a gomphothere to a class or walking down the aisle with a wastebasket for a hat, let alone that of corporations to kick employees to the curb anytime they wish to do so, this freedom portrayed by skyward flights, first of birds and now of ours, may be the profoundest of them all.

SON: So we see that sometimes science can be art that lifts the scientists' spirit.

MOM: It is this new science, science married to its great complement, art, that this paper has been, as far as I see it, all about.

DAD: Our dream of this new science has bled across this paper and magically written it.

MOM: It also soared us this high into the sky.

DAD: Now that we have left our writer's block behind, we may see subjects for new, meaningful research from these aerial perspectives.

SON: I wonder what exactly we shall see from here.

DAD: There, an idea. It just swooshed through my head so let me share it with you before it dissipates from this messy pot.

SON: Go on.

DAD: What if we photograph the nests that the birds we experimented with left behind and then create scaffolds based on their prototypes and measure the response of cells grown on them?

SON: That would be such a cool subject for research.

DAD: What is even more important, no one has done it before. No one has used bird nests as an inspiration for biomimetic research.

DAUGHTER: Sounds like a great plan to me.

SON: I have also come up with a lot of ideas, but I will tell you later about them. I am too busy flapping and flipping right now.

DAD: There is one problem only: we cannot do experiments up in the sky.

MOM: Now we can feel for all those angels jealous of the human condition (Wenders, 1987).

DAD: That is to say that music and art, which we have fused with science, have helped us soar out of the cage of labyrinthine logic and reach the sky, where inspiration for exciting new experiments has dawned on us. Alas, these experiments, which may benefit the humankind, can only be done if we anchor ourselves to the floor of our cage again.

SONS: So coops need not be uncool.

DAUGHTER: They are nice, safe and they have lots of pets.

SON: And what is best, we all get to be crammed together.

DAUGHTER: Hearts so close that they bounce from and into one another.

MOM: Who needs Xanadus and Gracelands when we would hardly see each other inside such enormous edifices?

DAD: Sensory-deprived spaces like our sunny sojourn have other pluses, too. A major one I could think of is that of allowing our reflections on the past, present and future to come to the forefront of our perception. And when visions are the only reality, then we have reached ideal grounds for consolidating our thoughts about life and coming up with milestones in our oeuvres.

SON: Now it is clear why the bard you mentioned earlier warned us to mail him letters no more, “not until you mail them from desolation row” (Dylan, 1965).

MOM: In other words, freedom has been attained and the cage left behind, but we now consider returning back to it, having realized that “love is staying” (Fromm, 1956)?

DAD: That is exactly the love I once placed in the heart of science (Uskoković, 2012). Because science, deep down, is an endeavor dedicated to bettering the lives of others; as such, it contains love at its core.

MOM: Now that you mention returning, I wonder if we are somewhat like the inmates who willfully go over and over back to the prison because they cannot make any sense of reality nor decent living outside of the walls?

DAD: Not really. We could be just fine here, but we hear the call of humanity. And we can be of benefit to it only insofar as we are akin to a river, which, we know, must be confined to its banks to move the mill and grind the wheat.

SON: But should we be happy when we see it flood the terrain and emerge out of its bounds (Selimović, 1966)?

DAUGHTER: We should be happy.

DAD: Because as we see from here, this is when the most creative ideas come to us: when we cross the boundaries of convention, in revolt and nonconformity.

MOM: But without the confinement, neither would these words ever be impressed on this paper nor would anything palpable and effable ever be done. Therefore, when it comes to the question of whether we shall return or continue flying, so freely and carelessly, this need not be an either-or choice.

DAD: When in doubt at a crossroads, follow both paths, expand the options, be the sun that shines in every direction.

SON: Going back and forth between heaven and earth, then, is our mission.

DAD: Besides, what's the use of heaven if it's not on earth?

MOM: After all, isn't every instance of grasping an inspirational thought akin to the spreading of the arms, like wings under an open sky, and taking a pose à la St. Francis of Assisi (Elie, 2015) in ecstasy, then soaring into the sky like a bird for a second, before returning back to earth with the treasure and the pen in our hands to write it all down and share with another?

DAD: Yes, we do have to return to our binds to perform all these experiments. But now we know that anytime we want to, we can leave the lures of logic and language behind and fly out of them. This, then, becomes a story on how art can inspire science. It is on the wings of arts that we can leave this ground, at least for a moment, and gain invaluable inspiration for our sciences. We should never stop dreaming, sons. When we dream, we are free.

SON: Is this a complacent acceptance of the fact that these bodies are but housings for our brains? I thought we were better players than that.

DAUGHTER: And dancers too.

MOM: Our brains ought to continue to be the vessels for dreams, but we must indeed turn into silhouettes and adorn the rooftops of the world with dances leaving the trails of stardust behind them.

SON: So we can fly even when we fly not.

DAD: That is exactly the point. We are free, irrespective of our confinements. The freedom of the spirit is infinite.

MOM: So let us fly back to our binds. There is nothing to fear.

(*The family lands back into the clean and comfortable cage.*)

MOM: Alright, everybody take seats and get busy!

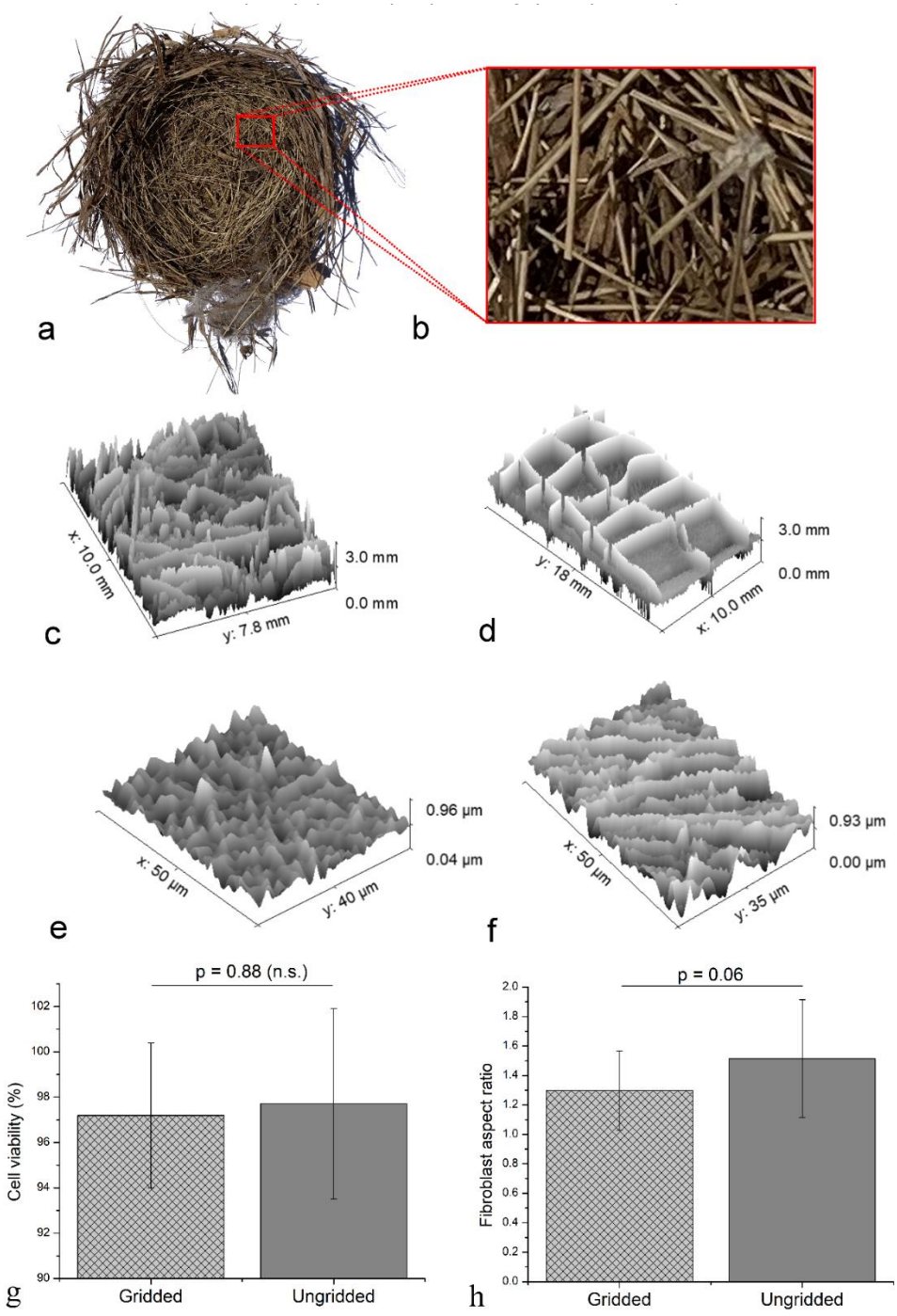


Fig. 7. A sparrow's nest (a) and a magnified view of the disorderly order of twigs comprising it (b). Processed photographic images of the cross-section of a sparrow's nest (c) and its gridded artificial replica (d), along with the electrospun scaffolds replicating these two structures, respectively (e, f), along with the comparative viabilities (g) and aspect ratios (h) of human fibroblastic cells that adhered on them. Bars in (g) and (h) represent data points as averages of three independent sample replicas, while the error bars represent standard deviation.

DAUGHTER: Here are a few nests I found tangled inside these bougainvillea vines.

DAD: I will rearrange the twigs in one of them into a 90 ^{o} pattern (Fig. 7a-b).

SON: And I will photograph the nests, process the images and turn them into blueprints for the scaffold design (Fig. 7c-d).

MOM: Cells can be seeded on the scaffolds, but we are too broke to even think about any more elaborate cell assays than the viability one.

SON: We could still image the cells on the materials and measure their dimensions.

DAD: That can tell us about their affinity for the surface.

DAUGHTER: And I will break this Easter egg.

DAD: Break our good guardian? What's the idea behind it?

SON: To use its peel as a drug delivery carrier. That was the idea us two came up with on the fly, while flying.

DAUGHTER: To crush the shell and to free life from it – that is our goal.

MOM: How sweet of an analogy. Breaking the shell and hatching the life contained latently inside it bears a solid resemblance to twisting and melting the bars of the prison confining us and blasting off into freedom, at least for a little while.

SON: As we somersaulted through the air, we saw past and present and future all mingled into one and we glimpsed ourselves as unborn babies and children and adults and spiritual vapor at once. It became clear to us that as we grow up, we build a thicker and thicker harness around our most intimate feelings.

DAD: The crust enveloping you and me and everybody else, serving the supposed role of protecting our vulnerabilities with a barbed-wire fence of fake confidence, indeed tends to grow thicker with age.

DAUGHTER: But we should be free.

DAD: Like our cage, so must this crust be crushed and our hearts, soft and tender, exposed in their "true colors" (Lauper, 1986) to the world.

MOM: No matter all the arrows that the world will gladly shoot at them. They are greater than that.

SON: Still, the more tender and beautiful our feelings are, the more they hurt when poked.

DAD: That is verily so. The poets and the artists among us have been destined to grow particularly thick and sturdy fortresses around the capsule of their innermost feelings, simply because they are so vulnerable and touchy that

the mere thought of their emergence to the surface of their beings is met with horror.

SON: But here's a feedback loop, which you taught us to recognize in every natural system.

DAD: Positive or negative?

SON: Positive, which means negative. Besides, loops are always such that their diametrically opposite termini blend into one.

DAD: What I think you have in mind is that it is a self-reinforcing loop with negative repercussions on our mental wellbeing. Am I correct?

SON: Yes.

DAD: If so, as this shell surrounding our vivid inner world thickens, people tend to assume that this inner world is dull and lifeless, just like the surface, which prompts them to interact with each other in equally boring manners, lest the equilibrium be disturbed. This, however, over the course of the interaction, makes the interactors duller and duller, thickening this shell more and more with each passing day.

SON: Until a scream cracks it and life emerges from the gate, freed.

DAUGHTER: Sheeeeelagh!

MOM: A message for dreamers all the world over is that once you recognize that this overprotection of feelings means that no one may get to glimpse your true self, in its infinitely beautiful and "true" colors, and that you may, therefore, love little and be equally little loved by the end of that long, long day that your life is, it can be the starting point for the change of your ways.

DAD: And for planning the great escape.

MOM: If you, one fancy footwork aficionado, have the escape to freedom from that famous soccer field in mind (Huston, 1981), remember that the players opted to stay and play, and it was not selfish rushes to liberty, but love that opened the gates to freedom. Freedom for the sake of freedom is void and empty and only love gives it its infinite meaning, even though love anchors us to one another.

DAD: Only on the wings of a grand paradox like this could we be heaved to heaven.

DAUGHTER: I will keep on watching the birds.

SON: They, who have been an inspiration for our flights to freedom.

DAD: Well, for reason it is said that whichever it is that we study intently, we sooner or later become.

MOM: To pore over a shell as it cracks is to befriend the call for freedom, but to look at the new life hatching is to be overcome by love for life. Together, they give us wings to fly.

DAD: The idea to use a broken eggshell as a drug delivery carrier, I must agree, is quite in the spirit of our shattering the walls of cages imprisoning us, given that the eggshell is a form of a cage. This is to say that cages can, in fact, be made a great use of.

SON: Easter also symbolizes the destruction of an old and the birth of something new.

MOM: And we, here, are quite clearly after it.

DAD: The renaissance of a newer, more beautiful science where everything is possible we indeed dream of in this paper.

MOM: What the children suggest is that only by resolutely breaking things can these dreams flourish inside us and, one day, become alive.

DAD: Then this is love amongst the ruins at its best.

DAUGHTER: We should not be afraid of shattering a shell or two.

SON: You have always been telling us about the seed that must crush its crust and fall apart in the soil in order to sprout into a stem and stem into a tree.

MOM: Very interesting, darlings. So what are the results telling us?

DAD: First of all, we see that the viability of cells grown on the structurally disordered scaffolds is indeed higher than that of the cells grown on their ordered counterparts (Fig. 7e).

MOM: However, despite this conforming to our hypothesis that the cells prefer the naturally disordered structures, this difference between the two viabilities is all but statistically significant.

DAD: The viabilities of cells seeded and grown on these two types of scaffolds both exceed 97 % and at that level it is almost unrealistic to expect to see a statistically significant difference between them. Simply, we could conclude that cells adhering on both of these materials are healthy. However, there is a far more significant difference between the spread of these cells on the materials. As can be seen from Fig. 7f, the fibroblasts grown on the disorderly structured scaffolds possess much higher aspect ratios on average than the cells grown on the gridded substrates. Since the aspect ratio of fibroblasts is directly indicative of their spread, that is, the affinity for the surface, it can be concluded that the cells, here, do prefer the unstructured scaffolds as opposed to the orderly ones.

MOM: It would be tempting to think that the lower aspect ratio of cells grown on the, more or less, gridded substrates is due to their enhanced adoption of an osteogenic phenotype, considering that fibroblasts transitioning to osteoblasts

turn out to have more square-shaped morphologies, as opposed to the spindly fibroblasts. However, with only 3 days of aging of the cells on the scaffolds prior to analyzing them under a microscope, this is unlikely to be a sufficient time for them to transform to osteoblasts.

DAD: Wonderful. I am marking everything down. Now, let us see what the drug release experiment has told us.

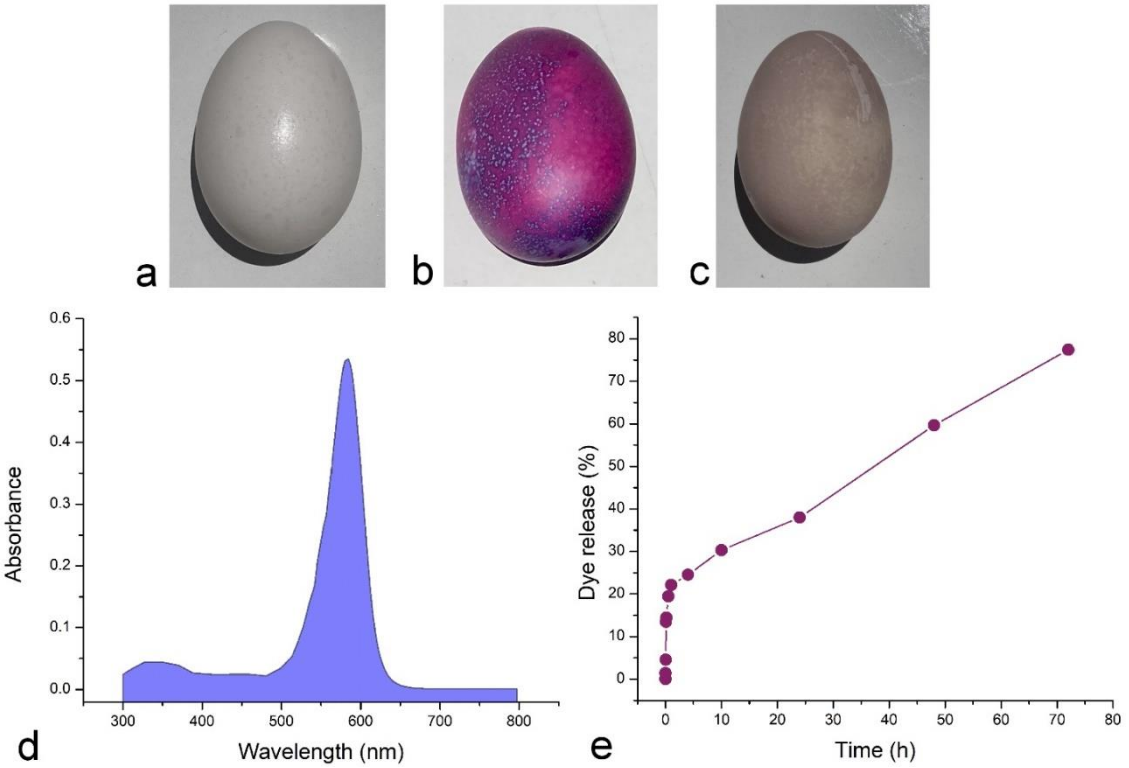


Fig. 8. An uncolored egg (a), a colored Easter egg (b) and the colored egg after 72 h of immersion in water (c). The egg was colored with a dye whose UV/Vis absorbance spectrum shows a distinct peak at 580 nm (d). The sustained release of the dye from the egg shown in (b) upon its immersion in water over 72 h is shown in (e). Data points in (e) represent averages of three independent measurement replicas, while the error bars, mostly invisible to the naked eye, represent standard deviation.

SON: Firstly, a cooked egg was colored with a reddish food dye. Initially, the egg was white (Fig. 8a), but after an overnight immersion in the dye solution, it gained a purple color with hints of red and blue (Fig. 8b). Then, we immersed the eggshell in water. The eggshell gradually released the dye and, as a result, it became paler and paler over time. After 72 h, the eggshell retained some of

the color and was not white yet (Fig. 8c). The absorbance spectrum in the visible range of the food dye used to color the egg is shown in Fig. 8d, showing the peak at around 580 nm, which corresponds to yellow color. The absorbance peak also covers green on the low wavelength end and orange on the high wavelength end, leaving violet, blue and red to be reflected off the dye, endowing it and the egg with the purplish, red and slightly blue tinge (Fig. 8b).

DAD: From the release profile I can see in Fig. 8e, it appears that the experiment was a success.

MOM: There is definitely a gradual release of the dye from the carrier.

DAD: Aside from the moderate burst release occurring in the first minute of the immersion of the eggshell in water, the release followed a monotonous course, taking the form of a linear, so-called zero-order release from the kinetic standpoint (Fig. 8e). The rate of one such release is independent of the concentration of the dye inside the carrier and is often considered ideal in the drug delivery context (Uskoković & Ghosh, 2016; Uskoković & Desai 2014b).

MOM: After approximately five days, the drug content gets exhausted, but this is certainly better than the traditional drug administration where this whole content would be dumped all at once into the organ or the bloodstream.

SON: It is interesting that calcium carbonate crystals can release small molecules at such a sustained rate.

DAD: It is disputable if calcium carbonate in the form of a powder would be able to do so, given that, like calcium phosphates, it can only bind small molecules by weak physical forces. This desorption rarely, if ever, leads to sustained release over prolonged periods of time. Also, the burst release by desorption is usually much higher, in the order of 50 % of more. Therefore, it is likely that the fine pores permeating the calcium carbonate part of the eggshell play a key role in allowing this sustained release to occur. They provide a solid reservoir for the small molecules to get confined in. The slow process of water penetration and the consequent release of the drug may, therefore, be conditioned by the characteristics of this porosity.

MOM: Eggs from different species may have different shell porosities and may thus display different release profiles for the same drugs.

DAD: Simultaneously, every release profile is a consequence of the affinity of the drug for the carrier, meaning that a different chemical identity of the drug might exhibit a completely different release profile (Uskoković, 2019).

DAUGHTER: Note that the white of the egg gets some of the color too.

DAD: This is a vital hint. Because the fact that the egg white gets mildly dyed implies that the dye likely penetrates through the mineral part of the shell and to the underlying protein lining, a.k.a. bloom or cuticle.

MOM: Eggshell, even when not cracked, is a semipermeable membrane, allowing air and water vapor to pass through it using pores as the passage route.

DAD: Also, albeit composed of 94 – 97 wt.% calcium carbonate crystals, even the outer, brittle part of the eggshell contains some protein (Stadelman, 2000). This is approximately the same ratio of mineral-to-protein as that typifying the tooth enamel (Uskoković, 2010).

SON: What would be the significance of this protein?

DAD: Protein is more prone to provide conditions for sustained release owing to its ability to entrap the small molecules deeper inside its polymeric network. This is to say that this second, protein-based component of the composite that eggshell is may play a key role in enabling this zero-order release profile.

MOM: And yet, it is most probable that the synergy between the mineral and the protein, like that we have in our teeth and bones, determines this profile.

DAD: Very much so in this world where synergies between weak and strong produce things stronger than the strong.

MOM: Like the bonds that the two of us, parents, or the two of you, children, create, both forming between a pair of utterly different personalities.

SON: A practical question: has eggshell been used before as a drug delivery carrier?

MOM: The shell of leghorn eggs was cracked before and tissue engineering constructs were placed in contact with the chorioallantoic membrane lining the eggshell to measure the angiogenic response of the embryos to biomaterials (Govindarajan *et al.*, 2017). But eggshell *per se* does not appear to have been used before as a drug delivery carrier.

DAD: It has not, interestingly, but processed eggshell has been used for a plethora of applications in materials science and engineering, ranging from catalysis to energy production to electrochemistry (Matej *et al.*, 2021). It has also been used occasionally in medical projects, but the vast majority of such studies have made use of only the protein membrane forming the inner part of the eggshell. Traditionally favoring calcium phosphates over carbonates in medical applications, researchers have had a habit of transforming the mineral part of the eggshell to calcium phosphate before using it for biomedical ends. But when such materials are used as drug delivery carriers, they have not even their basic chemistry equivalent to that of the eggshells from which they were made (Jayasree *et al.*, 2018).

MOM: Hence, the privilege of innovation is ours, except that we could not care less about being first in anything.

SON: Us, the careworn us.

DAUGHTER: We care and we care.

DAD: But our care is not that of a hamster that spins the running wheel in a cage faster and faster, trying its best to win a race, albeit only to be eaten, as a real champion, by a rock star (Graham, 1988).

MOM: Our care, rather, aspires to be that of a mom and pop bird building a nest, twig by twig, spit by spit, then raising a newborn in it, simply because "that's one gift that this world allows" (Everything but the Girl, 1990).

DAD: Bite by bite, they feed the birdies, digesting the grains for them, in just about the same way as we digest the big picture of science here and feed it to the fledglings, turning science into a sermon of a kind.

SON: Does this make us preachers in the making? Humbler oracles I have always thought we would become.

DAD: We may prophesy, but we intend neither to preach nor to patronize, for our praising questions here, not answers, stands in stark contrast with any efforts to inculcate any credos into anything or anyone. Rather, we strive to fly, carelessly, like birds. Instead of trying hard to make others see, do or feel the way we do, we let the sun of inspiration shine forth from our hearts and that's all, paying no heed as to which way it will liven up and which way it will hide behind shadows. We simply live true to our nature, like our avian friends.

MOM: And now, with all this careless care gracing us like shafts of starlight, we should be able to recognize how much care for another was embodied in these objects that we have experimented with. This nest, for example, is pure care condensed into a palpable, physical form.

DAD: Maybe this answers the question posed by that African graphic designer, when his long and elaborate musings about how creative ideas are being formed in us, moving towards harder and harder concepts to grasp, got intercepted with a blue sheet of paper and a few birds sketched on it, next to a big question: "But the idea of nest in a bird's mind, where does it come from?" (Fletcher, 2001)

MOM: Love and care – they are really wings to our dreams.

DAUGHTER: I have an idea.

SON: Idea? We are all made up of ideas.

DAD: We, indeed, are walking talking questions. Our spirits would petrify and harden into rocks, shackled by dogmas and entombed in the concrete of bigotry, should we ever turn into answers.

MOM: And the idea?

DAUGHTER: The idea is that each one of us draws a nest.

MOM: At the end of the day, we all draw best what we care for most.

DAD: But nests also take us far away back in time. As that good old professor of natural sciences turned philosopher had it, "When we discover a nest it takes us back to our childhood or, rather, to a childhood; to the childhood we should have had. For not many of us have been endowed by life with the full measure of its cosmic implications" (Bachelard, 1958).

MOM: He and his characteristically casual and sloppy choice of words, encouraging thereby even the least verbose amongst us to trust the flow and put the words on paper confidently.

DAD: And then right after this, he hops on, like Peep's friend, Chirp, to tell us about the melancholy of finding an empty nest, a "daydream of refuge", of once "happy household" nested among the leaves of a tree.

MOM: As if the most beautiful things are not always hidden. Beautiful abodes, from chalets to cathedrals to books to beloved's hearts, for one, always have many a place to hide.

DAD: Yet, shells, sooner or later, must break and all things hidden under the sun be released.

MOM: To freedom.

DAD: To freedom.

DAUGHTER: All, emerge from your hideouts and hand me your drawings.

DAD: The best dreams of freedom are born under the strictest and narrowest of the confines, I guess.

DAUGHTER: Here they are, our drawings of the bird nests (Fig. 9).

SON: I wonder what they may tell us from a psychoanalytical perspective.

MOM: Drawings of bird nests have been occasionally used in psychotherapies to hint at the drawer's innermost feelings and psychological inclinations. For example, an empty bird nest has signified a lack of family bonding (Kaiser & Deaver, 2009), whereas a nest with birds in it has indicated emotional comfort and harmonious upbringing.

DAD: It is funny how we were all told to draw the same thing, namely a bird nest, and yet we all came up with a completely different scene to draw.

DAUGHTER: This is my nest (Fig. 9e). There are three baby birds hatching from the eggs and daddy bird on the right and mommy bird on the left. There is sunset in purple, a sun in yellow and a moon in blue, and also clouds and a tree and a flower and some grass.

DAD: And this?

Fig. 9. The drawings of bird nests as a form of art therapy by the dad (a), the mom (b), the son (c, d) and the daughter (e, f).

DAUGHTER: This is another nest (Fig. 9f). Here I drew a little chick that just got out of the egg and it waits for his brother and a sister to hatch too, and there is his mother on the left and father on the right, who holds a bad worm in his mouth, ready to feed the chick.

SON: I drew leaves coming out of the nest and colored eggs in it (Fig. 9c). Then I drew a nest with hatching eggs, sitting on a spikey branch, with ghostly clouds over it and a purplish sun peeking from behind a grassy hill (Fig. 9d).

MOM: And this is my nest, resembling an egg forest (Fig. 9b). Eggs are like trees, rising up to the sky.

DAD: I drew just the nest (Fig. 9a), having taken on the task too literally. There are neither eggs nor hatched chicks nor mother chicken in it, nor are there any signs of life around it. Just a bunch of twigs arranged into this lousy decor.

DAUGHTER: No need to be sad, you can always go with us. We can build beautiful nests.

DAD: Indeed. We, the grownups, with the bare insides, resembling more a desert than a forest flourishing with life, better do follow children. We should follow each step of yours, for there can be no better guidance on how to find the way back to the garden of Eden than you.

MOM: We should set you up so high on the pedestal of glory that all our walks of life should be directed toward you and you only.

DAD: We should strive to become ever more like children as the time goes by rather than doing things the other way around and forcing children to become akin to us.

SON: Geez, I am almost getting dizzy with so much data we produce and comment on at once. What is next, a firework lighting up the sky, or this is it?

DAUGHTER: Here's your firework, but neither of sparklers nor bangers, but of flints.

MOM: Flickers of flints, the still small voices of this world, we have always related to.

DAD: Hear, oh hear the rocks stricken in your hands making sounds like the opening riffs of *Marquee Moon*. Crank it up, hon. They seem to be saying that the end is not the end.

SON: Is that the song (Television, 1977) that the band played with the intention to invent a new song in the midst of the one played (Ambrozić, 1996)?

DAD: A song of swans it is. Raw, unadorned with any sound effects. Recorded right around the time I was born.

DAUGHTER: Tick, tock, tick, tock.

MOM: In one take only, which some band members, I hear (Heylin, 2005), thought was only a rehearsal.

DAD: Not only does it occupy the central place in the eponymous record that wedded the two completely disparate and unthinkably joinable musical genres, namely punk and prog rock, the former of which is minimal and the latter of which is, so to speak, maximal, but it was also a mastery of improvisation by the edge of the cliff where the concrete meets the subliminal.

MOM: This is like talking about the feat we have achieved here on a different level, through an analogy, from our blending science with art, a marriage unthinkable to many, through our frequent departures to the streams of consciousness to falling in love with take ones of all forms and shapes to, last but not least, our switching impromptu from one research objective to another and then another and then yet another in the research paper that this is.

SON: I would only add that toward the end of that exhaustive guitar solo, the song did make some noise too, albeit with guitars, whose cacophony irresistibly resembled bird chirps.

DAD: That is when the song finally finds that long-sought song within a song: in the racket of a "thousand bluebirds screaming" (Hermes, 2011), as Patti Smith described it once.

SON: Haven't we found our project within a project too by being surrounded with all these beautiful avian sounds?

MOM: The birds, those terrestrial proxies for angels, of souls risen to the sky on the wings of lyrical inspiration, have inspired us and may have inspired these antsy New Yorkers to deliver this timeless record.

DAD: 'twas punk of the 1970s at its most romantic.

MOM: I hope that that abovementioned take-one Polaroid photographer haunting the Motor City subway as a hooded hobo and a long-time fan of Arthur Rimbaud does not hear us (Smith, 1975 & 2015).

DAD: Regardless, the fact that the singer and a lead guitarist named himself after Rimbaud's best friend, a decadent romanticist, Paul Verlaine, should speak for itself.

MOM: Naturally, any relation with romanticism, we, ourselves, relate to.

DAD: In fact, to tell you the secret, at the peak of my musical career, my alter ego reminded me on some days of Tom Verlaine from the cover of *Marquee Moon*, with eyes seeing deep into the soul of things, Adam's apple ready to pop out from all the flows of artistic inspiration centering around the throat, hands cold and willowy, gracefully open, fearing to touch anything lest it be turned into gold, treading through the night on the sides of the highway of life with a shiny ball in his arms, blinded by the headlights of the souls in passing. I do not know why I am telling you all this, except that "blinded by beauty" could be the summation of my "still life" (Suede, 1994b) as a youth, and blinded by beauty I, a poet, have been ever since.

MOM: If I get it correctly, our being inspired by a song that searches for a new song in the misty midst of it is to tell us that the openness to improvise and readiness to reinvent oneself and the road one is on from one moment to the next is what we are to be on the quest for.

DAD: It is renaissance at its truest. Without this incessancy of self-renewal, no renewal of anything in the world, including science that we try to resuscitate with these lines, could be accomplished.

MOM: Hence, the goal is to be like a baby, a child, open to change oneself and flow freely with the streams in this ocean of signs of the times that lies before us.

DAUGHTER: To become a baby, like the baby that swam in your tummy. All are in.

DAD: We move forward best when we step backwards.

MOM: This is how we lose ourselves and find ourselves, all in the course of a single research paper, fulfilling the dream that tried to be made true on the grooves of another record that comes to mind (Pareles, 1995): *Mellon Collie and Infinite Sadness*.

DAD: Sky is indeed the limit when it comes to free forms that the scientific paper can now adopt.

SON: I feel that we have liberated it from the shackles of convention and now everything is possible.

DAD: As for this paper, crafted on the go, in one take, I see that it is starting to adopt a very unusual structure. Not only have we shunned the standard form of the scientific paper and incorporated unconventional dialogues and a dramaturgical narrative in it, and not only are we reinventing the research objective and method as we proceed along, but we are also turning this coda into a real results section, at least to a physical chemist and a molecular biologist that we are, packing it up with a bedazzling array of all sorts of experimental data.

MOM: This is one of the ways in which, structurally, this paper becomes innovative compared to what can be considered the former two parts of our theatrical play trilogy (Uskoković *et al.*, 2020 & 2023). This coda is a festival of ideas, as exuberant as that of a romantic symphony coming to a close.

DAD: Indeed. First there were the tissue engineering experiments, then the drug delivery ones, and finally there are the drawings from an art therapy we conducted *ad lib*, so as not to lose touch with the artistic senses in us amidst all this scientific experimentation.

MOM: For, we clearly see that the artistic sensibility is a great inspirer of the creative scientists in us.

DAD: I have even thought about us not presenting the results of the musical experiments with birds at all because the outcomes of those experiments have been wholly irrelevant for the overall story. That would have been yet another innovative feature of this paper. Just think of it: a paper not reporting the re-

sults of an experiment that it proposes to execute. How cool would it be? A paper dragging and dragging, on and on, delaying to offer anything substantial all until the last five minutes, when it all explodes into an eruption of ebullience.

DAUGHTER: I am vaguely reminded now of the mystery of the dropper of glue onto pretty girls' hairdos.

MOM: Ah, that sweet evocation of children's games in the midst of a deadly war.

DAD: An evocation that, itself, is an evocation of what we try to do here by building the edifice of children's play in the midst of an arena across which arrows poisoned by toxic egos fly around and pierce one innocent heart after another.

MOM: *A Canterbury Tale* of 1944 (Powell & Pressburger, 1944), a story of the past haunting the present.

DAD: A movie unfolding leisurely for almost two whole hours and then in the last five minutes, when the company of three reaches the ruined city of Canterbury, everything coming around in an eruptive series of events that leave the viewer awed.

SON: Kind of like Sir George Ivan whispering at full volume into the mic that he "ain't nothing but a stranger in this world, got a home on high, in another land, so far away" (Van Morrison, 1968b) as the song has already long begun to fade away, delivering the climax within a coda.

DAD: Or the winds lifting the listener up into the air and entering the song about angels dancing on the head of a pin (Prefab Sprout, 1985b) just as the song has started to quiet itself and drift toward silence, in the final seconds of Prefab Sprout's masterpiece record, *Steve McQueen*.

MOM: Or Cocteau Twins' keeping not only the last song on *Treasure* (1984), but the entire record, for 40 minutes or so, under tension and then only in the final bars of this final song providing the resolution with the quivering F-E-F-G-C line.

DAD: A couple of years later, this band from a rainy Scottish harbor would have its glossolalic vocalist from another world sing *I Wear Your Ring* (Cocteau Twins, 1990), a gem from midway through *Heaven or Las Vegas*, into a climax when the train of instrumentation has already started to pack up and depart and is almost out of sight, with barely anything to hear save the pending descent into silence between the tracks.

MOM: As for *A Canterbury Tale*, remember how they had to shoot the night scenes without almost any artificial lighting so as not to attract the German bombers during the air raids? Thanks to this, the cinematography turned into an authentic combination of English romanticism and German expressionism.

DAD: The creators did not complain about the circumstances, nor did they try to circumvent them. They rather accepted them and the results were magnificent.

MOM: Like us here embracing this poverty and lack of conditions to conduct proper research and yielding thereby better science than we would have done under regular circumstances.

DAD: This is us doing the science of our lives.

MOM: At a time when we, jobless and broke for several years now, give and give and get nothing in return.

DAUGHTER: Like birdies.

MOM: Let us look at them one more time. Let us look how they fly.

DAD: And unite our spirits with theirs.

SON: I think… this… is… one of those moments. I am now dizzy for real, from all the beauty and the grandeur and direness that I am seeing at once.

MOM: It is thus that panic and fear take over, like a million stars wrapped around one.

DAD: The onset of tremor and trepidations it is. The poet feels the weight of the universe on his hypersensitive soul, which is starting to crash under pressure.

MOM: 'tis a moment of a great doubt, too.

DAD: Oh, how quickly one can traverse the road from delight to dismay. In no time, "what if" thoughts will begin to pile one after another in this little brain.

SON: Really, what if all we have done here has been in vain? What if all this indulging in poetic expression exerts the opposite effect from the intended one? Instead of ennobling the cold and prosaic world of science, what if all we have done is repel all those with the potential to rejoice in the beauty intrinsic to science by explicating this beauty to the point of vulgarity?

DAD: I have wondered the same throughout many a dark night of the soul. What if our doing science through the prism of arts is a lunacy of the same kind as that of a hypothetic artist utilizing the scientific method in the art-making process and thus rendering his art wholly artificial and devoid of anything spiritual?

SON: Also, what if all this inadvertent exposure of the most intimate moments in the life of a child for everyone to see and our being dispossessed of normal parental attention because of days, months and years spent crafting this special science is binding us to "an analyst's couch" (Morrissey, 1994) in the near future?

DAD: I have thought about that too. What if we have abducted your childhood and taken it captive so as to transcribe its precious moments into these lines? What if all this is the product of a monstrous delusion?

MOM: Plus, what if the world will never find out? What if all of this will remain buried under the ever more rising hill of papers, documents and files comprising the written heritage of humanity, never to be dug from deep under?

SON: But what if what is to be dug out is not treasure, but fool's gold? What if all this drive to inspire those who, we think, have been deprived of inspiration in the supposedly dull scientific world has been but a testament to our lunacy?

MOM: I feel for this argument. A gargantuan effort went into carrying out a research like this and crafting a paper of this staggering degree of novelty. But would we have come up with a practical solution to a tangible scientific or medical problem if we invested all this effort in a more conventional direction?

SON: Are we depriving the world of something helpful? Are we standing in the way of progress instead of trailblazing enlightened science of the future?

DAD: We don't know the answer to any of this.

MOM: But we must continue gambling.

SON: What if we have been allured by muses, who have blinded us and dropped us into this pen and are now giggling from a place where we can't see them? What if we are neither prophets nor pioneers, but just a bunch of crazies? What if we have done more damage than benefit to humankind? What if there is a good reason why the scientific community has excluded you from their party and we now endure on the edge of existence? Would it not have been better if we never existed?

DAD: Not so loud. Clarence might hear you (Capra, 1946).

DAUGHTER: Here is a plush birdie. Hug it and a take aback might happen.

DAD: We live by the cliff. It is no secret. That has been our conscious decision.

MOM: The dangers of the fall notwithstanding, the view is beautiful. It always has been.

SON: It is. I see it now.

MOM: Birds are nesting, hon, and flapping more than usual. Look at them.

SON: I know what it was: my little moment of crisis, when the whole world shakes and I tremble like a leaf on the breeze.

MOM: Just keep calm, sweetie pie. All things pass and so will this.

SON: These tears are the sign that it is almost over.

MOM: After the crisis comes remorse, the gateway to a cleansed soul, like the lea's after the rain.

SON: The world is pure again. I am starting to miss our aerial adventure.

DAD: There is no need to choke up over this, son. Here. Raise your chin, lift your chest. Let me wipe the tear off your eye.

DAUGHTER: The sun is back in you.

MOM: We are winning this.

DAD: And remember, anytime you feel unfree, you could leave these grounds behind and soar high on the wings of art. Besides, just think: if we succeed in the venture of turning every natural sound and even children's atonal and illiterate expressions, like yours, into art, then sky, literally, is the limit. Everything around us would be an art and we would be constantly impressed by it, flying as we speak.

MOM: Every once in a while, in fact, this cage, regardless of how idyllic and comfortable it is, must be broken and our spirits, like birds in cages, set free.

DAD: It can be frightening to be in open air at times, but remember that only if we set out to life, which is filled with dangers and is threatening to turn us into the ruins that have graced the walls of our harbor, can we become a torch and a lifesaving sign for souls that await guidance. Only when we enter a relationship ready to be ruined from one moment to the next can we inspire another and turn the celestial lights lying deep inside them on.

SON: Birds are flying. How lovely.

DAUGHTER: What else should we say before we let this paper fly into the world too?

MOM: And acquire life of its own.

DAD: The moments of parting are always heartrending. The idea that no words would soon be able to be added to this play and that something so alive will set itself into stone takes life out of me, too.

DAUGHTER: Just think when you have to let us go into that same world.

DAD: My heart is being minced into a million shards at the mere thought of it.

SON: From the safe harbor to tumultuous seas one day we will go.

DAUGHTER: And be brave sailors who will discover many a new land.

MOM: The end? Is this the end? What do we say now that the curtain is about to drop?

DAD: Even writing, ever so fluid at other times, becomes stiffer now that final words are to be shed.

SON: How about this: if everything is art in the eyes and the ears of the enlightened, then what stops us from renouncing logic and language and becoming, in a way, born again?

DAD: You have just hit a Goliath in the eye with this pebbly argument.

DAUGHTER: Or was it a paper crane?

DAD: Whichever it was, it flew high and alighted on a perfect spot. Because all this documenting us, children big and small in conversation and at play, in fact, distances the documenter from the real-life experience and stands in the way of the perfect bliss of one such experience. Charting maps in cages is a gift for others, but doing so without ever exiting the cage and releasing ourselves into a nonverbal and illogical perception of a newborn makes us blind to myriad features of the territories we intend to chart.

MOM: These words pave the way to freedom, but they also put us in chains.

DAD: This is why it all, at the very end of this magnificent coda, must turn once again into an array of free verbal expressions, which gave rise, in the first place, to this awesome adventure.

MOM: Alright, then, let it be (Beatles, 1970), pardon, let it bleed (Rolling Stones, 1969).

DAD: Let this be our rock 'n' roll suicide (Bowie, 1972) and a ticket to immortality.

SON: Doesn't this make us akin to that mustard seed that dieth in the ground to bringeth new life (KJV, John 12:24)?

DAD: We have indeed reached the stage where our careers and all our creative work became nullified and we are left with nothing.

MOM: But there is a sense in the distance that we have gotten everything in return.

DAD: This must be yet another lesson on the merits of ultimate poverty and on its acting as a gateway to ultimate wealth, the wealth of the spirit, the profoundest of them all.

SON: Because where our heart is, our treasure is (KJV, Matthew 6:21).

MOM: So we leave this one with heads in the clouds (Future Islands, 2014).

DAD: There, we stand untouched by the worldly pretense.

SON: On the quest for new languages we are.

DAD: Looking back now at the beginning of this adventure, we have become freed by the unintelligible chirrups of our neighbors, the songbirds.

SON: Pet sounds in their most natural form liberated us.

DAD: Hence, these pet sounds must be followed. They hold our key to the gate of Eden, not in one of the dark corners of their dusty daises, as one may be tempted to think, but rather in everything.

MOM: Following this path takes us far away from human language, from that mere map of the territory of life, and immerses us into experiences that are infinitely enriching for the soul.

DAD: Alas, as the erasure of the maps proceeds, there will always be little snippets of memory that just refuse to go away. One of them is my recollection of a seasoned scientist watching a man on telly, "a nice-looking chap, all the facts at his fingertips, more dependable looking than most high-school principals, talking about civilian defense, his responsibility in Washington" and concluding how "if I were 16 or 17 years old and had to listen to that, or read things like that, I would want to give up listening and reading; I would begin thinking up new kinds of sounds, different from any music heard before, and I would be twisting and turning to rid myself of human language" (Thomas, 1983).

MOM: Therefore, to get rid of these last pieces of verbal fragments flying through our heads like unleashed phantoms, the freakish figments of our fancy, we must spin now, spin hard, like the whirling dervishes.

(*Everybody is spinning in endless figure eights.*)

DAUGHTER: Tweet-trill-li-li pipe-pee-pee-purl (♪♫♪)!

SON: Chip-cheery-chip choo-choo-da-choo (♪♫♪)!

DAD: From here it is goodbye to the human language and good morning to the poetry of broken, children's language, of sundry topsy-turvy flapdoodles, of bedazzling white noise, of chaos and harmony concocted into one, of the empty space wrapped around these letters.

MOM: This is where we head to. This is what we must become.

DAD: Out the frame we depart.

DAUGHTER: We fly.

SON: We are free.

DAD: But we know we will.

MOM: We will return someday.

SON: Return to the binds.

DAUGHTER: The binds of love.

Materials and Methods

Six simplistic and tonal and six more intricate and more atonal musical sequences were played to the birds hanging on the punk tree (*Melaleuca quinquenervia*, a.k.a. paperbark tree or cajeput tree) overlooking the backyard of the townhouse at 7 Park Vista, Irvine, CA. A portable wireless speaker (Tribit TS-BTS20) was placed on the backyard fence, 3 m away from the base of the punk tree on which the songbirds resided, and its volume was set to around 70 dB. A 15 minute timeslot was dedicated to each tune, which included 10 minutes during which the tune was played to the birds and 5 minutes of recording the loudness – *i.e.*, volume – of the birdsong. More specifically, each musical sample was played in a loop for 5 minutes to adjust the birds before intermittently recording the sound of the birds from the position of the speaker using the Voice Recorder-Voz app for 1 minute and replaying the tune for 1 minute (Fig. 10). These intermittent measurements took place for 10 minutes in total for each tune. The average loudness of the musical samples was measured in dB units by reading the LAeq parameter value on the National Institute for Occupational Safety and Health (NIOSH) Sound Level Meter app. To yield a single data point as the average of 5 independent one-minute sound volume measurements (Fig. 10) for each six of the tonal and each six of the atonal tunes compared, alongside the control, continuous measurements were performed over 195 minutes (13 x 15 min). To yield more data points, up to n = 7, such 195 minute long measurements were performed over different days, in the mornings, when the environmental conditions (relatively voluminous birdsong [> 40 dB], minimal migration, no background noise, and the absence of crows, parrots, gulls and geese) were in favor of the measurements. The order in which the tunes were played was shuffled each day, but all sessions began with the control measurement. Because measurements were performed on different days, individual data points were normalized to the results of the control for the same day and expressed in percentages of the control. Prior to the measurements, piano pieces were recorded by playing an electric Yamaha P-125 piano connected to Audacity software run on a Macintosh laptop.

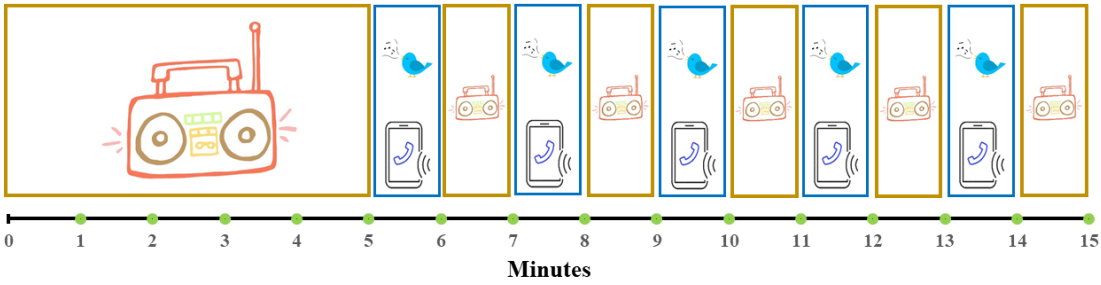


Figure 10. Schematic illustration of the temporal details of the experiment involving alternately playing music to the birds and recording the loudness of their singing back to it.

To measure the physical attraction of the birds to the tunes, experiments were conducted over 7 consecutive days (n = 7). Each tune was played for 15 minutes and birds were observed from inside the house, behind a mosquito net, so as not to disturb them. Time at least one small songbird spent within the backyard limits was marked, converted to one bird residence per hour units and compared for different tunes.

Two sparrow nests were acquired from the base of a eucalyptus tree in Irvine, CA. They were photographed at different magnifications. Their twigs were rearranged manually into patterns resembling twisted checkerboards and photographed again. These photographs were processed using Gwyddion 2.45 software to create topographic maps and models for comparison with prefabricated matching scaffolds. Scaffolds were produced earlier using a custom-made electrospinning setup, with poly(ε-caprolactone) as the starting material. A more detailed protocol for the fabrication of such scaffolds, including all the operating parameters and precursor syntheses, was reported previously (Afifi *et al.*, 2020; Ahmed *et al.*, 2019 & 2020). Two distinct types of scaffolds were selected from the database based on their electron micrographs, one of which was termed ‘gridded’ and another ‘ungridded’. The growth of a human fibroblast cell line, HFB4, was observed on the synthesized scaffolds subjected to UV sterilization. HFB4 cells were seeded at the concentration of 5×10^3 cells per cm^2 and all samples were analyzed in triplicates. All cells were incubated on the scaffolds for 72 h at 37 ^oC and 5 % CO_2 prior to the viability and morphological analyses. During this growth period, Dulbecco's modified Eagle's medium was used as the cell culture medium and was replenished daily. For the purpose of the viability testing, MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) solution was injected into each well containing scaffolds with the cells. After 4 hours of incubation at 37 °C, the MTT solution was replaced with dimethyl sulfoxide and after 30 minutes the optical density at 570 nm was measured using the BMG Labtech Fluostar Omega microplate reader and converted to viability.

Fresh, large, cage-free eggs (Kirkland AA) were purchased from Costco (Tustin, CA) and cooked inside boiling water for 5 min. Eggs were allowed to cool in the air and dry. After cooling, each egg was immersed inside a 200 ml cup holding 100 ml water dissolving the entire 35 ml capsule of red food coloring composed of glycerin, invert sugar, water, vegetable juice and citric acid (Watkins, Winona, MN). The egg was maintained in the dye solution overnight, after which it was dried in the air and used in parallel release experiments, including both the peeled and crushed eggshell as the release carrier or a whole egg as a carrier, with no significant difference being observed between these two modes of release. After different immersion times, 500 µl of the manually shaken supernatant was aliquoted and measured for absorbance on a UV/Vis spectrophotometer (Nanodrop 2000, Thermo Scientific) at λ = 550 nm. The absorbance of pure water was subtracted from the absorbance values of the dye

samples and normalized to the total dye content. All measurements were performed in triplicates and data points were associated with the corresponding standard deviations.

Contributions

As per the CRediT taxonomy, E. Uskoković and T. Uskoković are credited for investigation and visualization (Fig. 5 and Fig. 9c-f), V. Wu for resources and visualization (Fig. 9b), and V. Uskoković for conceptualization, methodology, formal analysis, investigation, visualization (Figs.1-8, 9a, and 10), writing, supervision, and project administration. The content accurately represents real-life events, observations and phenomena, while the characters, the dialogues and the storyline are the products of V. Uskoković's imagination, who wrote the paper from A to Z.

Biographies

Evangelina and **Theo Uskoković** are two budding scientists and students at Stone Creek Elementary in Irvine, California. **Victoria Wu** is a molecular biologist currently developing novel diagnostic assays for cancer and bacterial infection. **Vuk Uskoković** is a physical chemist, materials scientist and nanotechnologist dedicated to exploring seminal fundamental concepts in natural sciences and their conjunction with arts.

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