

The science-practice gap in education: knowledge conceptualization, knowledge production, and knowledge transfer problems

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Abstract

There is a disconnection between the knowledge that researchers produce and the knowledge that practitioners use in their daily routines. This so-called science-practice gap is one of the main scientific challenges in this era in applied fields such as educational sciences, because it implies that practitioners fail to adopt evidence-informed practices. This conceptual paper presents a theory synthesis with the aim to unravel the complex challenge of reducing the science-practice gap in education. Based on an integrative conceptual literature review, I argue that new leads to reduce the science-practice gap in education lie in a fundamental understanding of (a) the knowledge conceptualization problem, (b) the knowledge production problem, and (c) the knowledge transfer problem. We face complex societal challenges that can only be solved by collective engagement and collaboration between researchers and practitioners to address these three fundamental problems. In this paper, I propose that the interchange between science and practice should start with the question “What knowledge do we need to improve educational practice?”.

Keywords: research-practice gap; ontology; epistemology; research-practice partnerships; evidence-informed practice



1. Introduction

Scientific research is expected to lead to advances at the frontiers of knowledge and to have scientific and societal impact. Although scientific research can be fundamental, policy- or practice-oriented or combinations thereof, ultimately any type of scientific research can have an impact on society by the scientific knowledge that is produced. Nevertheless, there is a disconnection between the knowledge that academics are producing and the knowledge that practitioners use in their daily routines. This so-called *science-practice gap*, referring to the gap between scientific knowledge and its application in practice, has been recognized as one of the main scientific challenges in this era, because it implies that scientific knowledge insufficiently represents evidence for the change and improvement of practices (Banks et al., 2016). Evidence-based practice is about making better decisions and is needed more than ever to resolve societal challenges (Rousseau, 2020). For example, in response to the COVID-19 pandemic, the priority recommendation by the Global Commission on Evidence to Address Societal Challenges' was for multilateral organizations to provide commitment and greater support for the use of research evidence in making decisions (GCEASC, 2022).

The science-practice gap plays out in many fields, such as the social sciences (Brown et al., 2017; Kazdin, 2016; Lindblom & Cohen, 1979; Visscher, 2021), medical sciences (Allmark, 1995; Bero et al., 1998; Bijapurkar et al., 2022), organisational sciences (Barends & Rousseau, 2018), management sciences (Bansal et al., 2012), and environmental sciences (Bertuol-Garcia et al., 2018). Researchers in these fields often struggle with translating their research findings for use by practitioners. At the same time, practitioners often struggle with adopting scientific knowledge and insights in their daily practice (e.g., Brown et al., 2017; Visscher, 2021). This struggle has become more prominent as practitioners in these fields are increasingly expected to work evidence-informed and act based on the latest scientific insights. Chi (2021) summarized the commonly mentioned causes as research-based knowledge being *too theoretical*, researchers addressing questions that are *irrelevant* to practice, practitioners finding researchers' work *inaccessible*, and practitioners *lacking time* to digest available research findings. In the field of educational sciences, researchers indeed struggle with developing research projects that enable sustainable changes in teaching practices and student learning. Likewise, practitioners (e.g., school leaders and teachers) struggle with adopting evidence-informed practices and implement evidence-informed innovations in their schools.

In the medical field, a general evidence-based practice model was developed to improve clinical decision-making (e.g., Sackett, 1997; Yost et al., 2015). The model describes that evidence-based decisions are based on (a) appropriate theoretical grounding, (b) the best empirical evidence available, and (c) practitioners' professional judgement. Evidence-based practice is about integrating professional expertise with the best external evidence from research to improve the quality of practice (Sackett, 1997). From an evidence-based perspective, rigorous research designs such as randomized controlled trials produce 'the best



evidence available' for clinical decision-making, as these are often assumed to produce ecologically valid and generalizable results. More generally, research results produced by quantitative designs are often presented and/or interpreted as generalizable findings. However, the idea that something that 'works somewhere' will by default 'work anywhere', regardless of context, has met with much criticism. Many scholars and practitioners have argued that evidence-based practice is too restrictive and that decision-making should rely on different types of evidence (e.g., Cook & Cook, 2016; Gale, 2018; Nevo & Slonim-Nevo, 2011). Cook and Cook (2016), for example, proposed practice-based evidence as opposed to evidence-based practice, that is, "evidence derived from real-world settings and practitioners" (p. 144) as a means to foster partnerships between practitioners and researchers to advance evidence-based practice.

In the field of educational sciences, the narrow perspective on suitable research methodology to produce 'evidence' relevant for education practice, is also much criticized. This is because educational researchers apply a wide range of quantitative, qualitative and mixed methods approaches to the empirical investigation of educational phenomena, that produce a wide variety of research findings that may be relevant for use by practitioners. Moreover, collaboration between researchers and practitioners has become much more common in the past decades, which has widened the various research methodologies that are applied in the field. Hence, at least within the field of educational sciences, a more realistic and suitable perspective is to promote evidence-informed practice rather than evidence-based practice, which considers all different types of evidence (or rather: empirical support) stemming from quantitative, qualitative and mixed-methods designs. All types of research are considered valuable sources of information in decision-making processes (Hargreaves, 1999) and may contribute to sustainable educational change and innovation.

I realize that promoting evidence-informed practice and evidence-informed decision-making can be criticized as being too researcher-driven, but researchers and practitioners have a shared goal: giving students the best education we can provide. In my perspective, being a researcher and teacher myself, what makes teachers professionals is that they make educational decisions based on the knowledge available to them and as well as their professional judgement about a specific child in a specific context. Which knowledge is or should be available to teachers and what (types of) knowledge should be incorporated in these decision-making processes lies at the foundation of the science-practice gap in education.

2. Three fundamental challenges

Irrespective of the applied research methodologies, educational research is generally expected to produce research findings that can be directly translated and implemented into educational practice. Furthermore, it is often assumed that practitioners are able to find, understand, and use scientific knowledge in their day-to-day teaching practices and educational decisions (Broekkamp & van Hout-Wolters, 2007). These assumptions are not always met, resulting in educational innovations that get watered down or fail, and thus the science-practice gap in education remains (Cohen-Vogel et al., 2015; Issitt & Kyriacou, 2009; See, 2018). Moreover, researchers have raised concern that practitioners participating in practice-based research, often fail to implement procedures as originally designed or lack the knowledge and understanding of research design requirements (Greenwood & Abbot, 2001). Bansal et al. (2012) argue that the paradoxes



underlying the relationship between research and practice make it difficult to bridge the gap: “Researchers are torn between the imperative to define research problems precisely and investigate them carefully and deeply, and the messy reality of the problems of practice, which require breadth and immediate clarity.” (p. 84). There can be mismatches between researchers’ and practitioners’ understanding of the educational problem as well as between their beliefs regarding suitable research methodology (research designs, data-collection methods, sampling techniques, et cetera) to study the phenomenon and to produce educational change.

This disconnection between research and practice in education has a long history, already mentioned as early as 1929 by Dewey (see also e.g., Kennedy, 1997 for a historical overview). A fundamental understanding of what the gap exactly is about is, however, missing. That is, the solutions to the challenge of reducing the science-practice gap in education are not straightforward and I strongly believe that this challenge requires conceptual clarity as to *what* it is that needs to be bridged between research and practice to enable practitioners to adopt evidence-informed practices.

To provide more conceptual clarity, the present paper presents a theory synthesis (Jaakkola, 2020) with the aim to unravel the complex challenge of reducing the science-practice gap in education. An integrative conceptual literature review (Torraco, 2016) was conducted to identify publications that addressed the science-practice gap in education conceptually and/or empirically. These publications were used as building blocks in the theory synthesis. By reviewing, critiquing, and synthesizing representative literature, integrative reviews use existing literature to create new knowledge on a topic. They are particularly suitable for identifying contradictions and inconsistencies in the literature and for reflecting on discrepancies between the literature and reality (Torraco, 2016). Integrative reviews differ from systematic literature reviews in that they generally do not aim to be exhaustive (i.e., summarizing all available literature on a specific topic), which is also represented in the search strategy and paper selection procedures that are often not mentioned, due to the different nature of integrative reviews. However, for transparency reasons, I do present the databases, search strings, sampling method, and analytical approach I used while conducting the integrative review, as these decisions have influenced my developing perspectives throughout the research process.

I applied mixed purposeful sampling (cf. Suri, 2011) to select representative, central or pivotal sources (cf. Cooper, 1988), using criterion-based sampling to search the abstracts of ERIC, PsychInfo, Scopus and Web of Science databases by using the following search terms: ("science-practice gap" AND "education") OR ("gap between science and practice" AND "education") OR ("research-practice gap" AND "education") OR ("gap between research and practice" AND "education"). Moreover, I used theoretical-, snowball- and emergent sampling to identify additional sources, that is, studies that represented important theoretical constructs about the phenomenon of interest, studies that were highly valued by other researchers (e.g., by checking the reference lists of selected publications), and other pivotal or illustrative studies that emerged during the research process.

Syntheses can be arranged in different ways, such as historically (e.g., chronologically), methodologically, or conceptually (e.g., papers that address the same idea are reviewed together) (Cooper, 1988). Aiming to gain more conceptual clarity regarding the science-practice gap in education, I sought a



conceptual organization most suitable. Therefore, through inductive reasoning, I synthesized from the selected publications three problems associated with the science-practice gap in education, namely, a *knowledge conceptualization* problem, a *knowledge production* problem, and a *knowledge transfer* problem. While reading the broad variety of papers chronologically, I noticed some changing perspectives over time. Moreover, I came to understand that disentangling these three fundamental problems is needed to unravel the complex scientific challenge of reducing the science-practice gap in education. The *knowledge production* problem and *knowledge transfer* problem are often reported in the literature—albeit conceptually blurry and rather wide-ranging—whereas the *knowledge conceptualization* problem lacks clarity and is ill-defined. The *knowledge conceptualization* problem has not been labelled as such in the literature, but defining it as such may help progress our understanding of the fundamental problem it represents. The three fundamental challenges are discussed in the next paragraphs, with the aim to provide more conceptual clarity and conceptual integration.

2.1 The knowledge conceptualization problem

Firstly, it is suggested in the literature that theory and practice simply represent distinct kinds of knowledge, reflecting a different ontology (truth claim) and epistemology (method) to address different questions (Van de Ven & Johnson, 2006, see also Fenstermacher, 1994; Negri et al., 2019). Aukland (2022) states that “the research-practice gap could be understood as a clash of knowledge forms, and the limited impact of research could come as a result of researchers one-sided emphasis on a form of knowledge, overlooking the importance of another” (p. 150). Similarly, Miretzky (2007) states that “Educational research—whether theoretical or empirical—may not offer concrete solutions to teachers’ dilemmas (or set out to), but it can provoke thinking differently about educational problems.” (p. 279). As a result, practitioners may view the knowledge produced by scientists as irrelevant to them (see also Cascio & Aguinis, 2008; Nägel et al., 2023). As Biesta (2007) states it: “Whereas the outcomes of research might play a role in professional judgement, they can only ever assist professional judgement and action but can never dictate what should be done.” (p. 4).

Evidence that there is, in fact, a *knowledge conceptualization* problem, can be illustrated by the widespread—yet scientifically disproven—belief among practitioners that equal educational opportunities for all, result from treating every child the same. Equality of opportunity is “a key ingredient for a strong and cohesive democratic society” (OECD, 2021, p. 11). A huge amount of scientific knowledge is available on promoting equal opportunities in education, but researchers and practitioners alike appear unable to enact this knowledge in schools, which is a failure to improve the lives of the next generation and a loss of human resources and public funds. Schools (re)produce inequality, and evidence-informed practices are needed to contribute to solutions. Conceptually, researchers and practitioners seem to approach the issue of equality of opportunity, differently. That is, the knowledge produced (see paragraph 2.2) and the knowledge transferred (see paragraph 2.3) about equality of opportunity may need some refinement, but the fundamental, underlying conceptual issue, is that the available scientific knowledge does not inform practitioners *how to act differently* in their day-to-day practices to actually promote equal opportunities for all students.



To explore the *knowledge conceptualization* problem further, let us first consider the important work of McIntyre (2005). McIntyre (2005) argues that the fundamental problem is the two sharply contrasting kinds of knowledge that represent a continuum of different kinds of knowledge. Pedagogical knowledge on the one extreme is, “knowledge that directly informs their own practice in managing their classrooms and in facilitating their pupils’ learning” (p. 359), drawing on all other kinds of knowledge, and referred to by McIntyre as ‘knowledge how’. This is different from research-based knowledge on the other extreme, referred to by McIntyre as ‘knowledge that’, or propositional knowledge, which needs translation into situated, context-specific pedagogical knowledge. Important here is that McIntyre contrasts not only two kinds of knowledge, but also their nature, referring to the *impersonal nature* of research-based knowledge and practitioner knowledge as *personalized*. In my view, however, research-based knowledge, specifically in social sciences, is not at all *impersonal*, as it is still produced and interpreted by people, and is thus to some extent subjective and normative. A more comprehensive view on this matter is presented by Huberman (1983), who distinguishes at least three dimensions of knowledge sources: locus (proximate or distant in relation to the user), format (person-mediated or impersonal), and derivation (craft versus scientific).

Now let us take a closer look at the extremes of the continuum proposed in the literature. Korthagen (2007) refers to these as formal knowledge versus practical knowledge. Formal knowledge, or propositional knowledge “is the knowledge produced by conventional research (...). It meets criteria for reliability and validity and has the potential for generalization.” (p. 306). Practical knowledge “enables teachers to deal effectively with practical problems. The validity of this knowledge is confined to the type of contexts or situations within which the events occur.” (p. 306). Korthagen draws upon Aristotle’s distinction between *phronesis* and *episteme*:

The character of *phronesis* is more perceptual than conceptual: it –often unconsciously– focuses the attention of the actor in the situation on certain situational characteristics that are important to the question as to how to act in that situation. To put it concisely, *episteme* aims most of all at helping us to know more about many situations, while the emphasis of *phronesis* is on perceiving more in a particular situation and find a helpful course of action on the basis of strengthened awareness. The best translation of *phronesis* may be “practical wisdom”. (Korthagen, 2007, p. 306).

This practical knowledge (e.g., Aukland, 2022) is also labelled craft knowledge, wisdom of practice, knowledge-in-practice or practitioner knowledge in the literature, generally referring to personal knowledge that practitioners gained from their experience as a teacher (Cochran-Smith & Lytle, 1999; Cook & Cook, 2004; Fenstermacher, 1994; Hiebert et al., 2002; McIntyre, 2005; Shulman, 1986, 1987; Tseng, 2012). Hiebert et al. (2002) characterize practitioner knowledge as being more concrete and contextually rich than generalizable and context independent. Practitioner knowledge is generated through “active participation and reflection on their own practice” (p. 4). Proposed advantages of this type of knowledge are that it is (a) linked with practice (i.e., developed in response to a specific problem in practice), detailed, concrete, and specific (i.e., directly related to the specific problem in practice), and (b) integrated into practice (i.e., integrated and organized around the specific problem in practice) (Hiebert et al., 2002). Note that Hiebert et al.’s (2002) characterization of practitioner knowledge implicitly characterizes research-based knowledge as more generalizable and context independent, ignoring the fact that qualitative and mixed-methods research



often explicitly integrate contextual aspects in the research designs and research processes. The implicit characterization restricts research-based knowledge to knowledge gained from quantitative research and randomized controlled trials, rather than defining research-based knowledge as knowledge gained from broad spectrum of research methodologies. I see this as an important discrepancy between the representation of educational research in (parts of) the literature and actual research practices adopted in the field of education. Nevertheless, it is unarguably clear that there are conceptual differences between personal, embodied knowledge and formal, propositional knowledge (Polanyi, 1966). For further reading on the contrasting types of practitioner knowledge versus research-based knowledge, I refer to El-Hani and Greca (2013), Miretzky (2007), and Wahid and Sulong (2013).

All in all, the reviewed literature does not convince me that ‘knowledge’ in these constructs necessarily means something different, although practical knowledge and propositional knowledge may of course differ in origin (i.e., in how the knowledge was created). Moreover, the proposed continuum does not address the question what types of knowledge are needed to bridge the science-practice gap in education. Very few scholars have studied the science-practice gap in light of the different types of knowledge that could and should inform educational practice and thus teacher actions. I will return to these points in paragraph 3.

2.2 The knowledge production problem

Secondly, the science-practice gap can be framed as a *knowledge production* problem (e.g., Joyce & Cartwright, 2019; McIntyre, 2005; Meyer et al., 1998; Van de Ven & Johnson, 2006), which is related to the *knowledge conceptualization* problem. The *knowledge production* problem is comprehensive, and can be problematized as an issue of limited *usefulness* of scientific research for educational practice (Bauer & Fischer, 2007; Conrad & Gunter, 2000; Greenwood & Abbot, 2001; McIntyre, 2005; Ming & Goldenberg, 2021), but I distilled from the literature that it is also as an issue of *who* should (or could) produce or develop knowledge that is relevant for educational practice, and, a related issue, *how* knowledge production should be organized.

The limited *usefulness* of scientific research for educational practice, is illustrated by teachers finding scientific research as too detached from their classroom practices and too decontextualized to be relevant or meaningful for them. Swanwick and Marschark (2010) investigated perceived usefulness in the context of practitioners views on research into education for the deaf and listed the following views: (a) I cannot apply it to my practice, (b) it is inaccessible, (c) it is conflicting, (d) it is inconclusive, (e) it is not relevant to my context, (f) it is not my question, (g) I already knew this, (h) it tells you what deaf children do not or cannot do, not what they can do, (i) it inhibits development, and (j) it does not tell you what to do.

Some researchers suggest to widen and improve research methodologies to enhance the usefulness of scientific research for educational practice (Conrad & Gunter, 2000; Stoiber & Kratochwill, 2000), for example, by applying a problem-based methodology (Robinson, 1998), mixed-methods research (Joyce & Cartwright, 2019; Klingner & Boardman, 2011), formative and design experiments (Bradley & Reinking, 2011), and design research (Brown, 1992; McKenney & Reeves, 2012). The science-practice gap is again



illustrated by a continuum, with *formal research* conducted by researchers and *practical inquiry* conducted by practitioners (Richardson, 1994) at the extremes, and a wide variety of research methodologies on the continuum. Cook and Cook (2016) suggest a mixture of suitable research methodologies, such as case studies, qualitative research, single-case designs implemented by teachers, participatory action research, and narratives, “as long as it reflects the real world of teachers and classrooms” (p. 146). Particularly intervention studies have been proven difficult to design in order to produce sustainable educational change:

Unless an intervention is a good contextual fit—in the sense of being acceptable to teachers and students, being consistent with their values and beliefs, not requiring too much effort, being relatively unobtrusive, and holding the promise of effectiveness—it is likely to fail no matter how well designed it is. (Walker et al., 2004, p. 74)

Similarly, Meyer et al. (1998) listed criteria for what they call “naturalistic interventions” that represent ecologically or socially valid changes to practice, namely that the intervention should be doable in context, with available resources, sustainable over time, constituency owned and operated, culturally inclusive, and intuitively appealing.

The issue of *who* should (or could) produce knowledge relevant for educational practice comes down to the question whether researchers and/or practitioners should produce the knowledge, who are often characterized as two very distinct kinds of people. I came across terminology and juxtapositions such as *consumers* (practitioners) versus *producers* (researchers) (Carnine, 1995, 1997), and *insiders* (practitioners) versus *outsiders* (researchers) (Conrad & Gunter, 2000). Note that the issue of *who* should (or could) produce knowledge does not address what types of knowledge should (or could) be produced by researchers and/or practitioners to improve educational practice, except that researchers tend to write about the (co)creation of knowledge or the production of ‘new’ or ‘usable’ knowledge. Mosher et al. (2014) is one of the very few defining ‘new’ knowledge, namely as “the capacity to take action” (p. 7), stemming from the idea that the source of change is in practitioners themselves (internal) rather than in instrumental use of research findings (external). Although not offering a clear definition of ‘usable’ knowledge, Hargreaves (1999) presents his idea of the knowledge creating school (system), where teachers and researchers work together in the creation of *usable knowledge* [emphasis added] and knowledge thus evolves within the context of its application (see also Gibbons et al., 1994).

Hargreaves’ emphasis on collaboration taps into the question *how* knowledge production should be organized. Many researchers increasingly believe that knowledge should not be produced by scientists alone, but instead produced and cocreated through collaboration between researchers and practitioners (Conrad & Gunter, 2000; Greenwood & Abbot, 2001; Meyer et al., 1998; Korthagen, 2007; Richardson, 1994; Sanchez et al., 2017; Vanderlinde & van Braak, 2009). I have to acknowledge that I did not come across studies that explicitly asked practitioners what they thought was more productive, but considering the vast increase in researcher-practitioner collaborations, one can assume these are to some extent shared beliefs. To address the *knowledge production* problem, literature suggests that researchers and practitioners should work more closely together in a broad variety of research-practice partnerships (RPPs; Penuel et al., 2020) and thereby improve the societal relevance and applicability of scientific endeavours. RPPs are long-lasting collaborations between researchers and educational practitioners to jointly explore problems in educational



practice, agree on joint goals and approaches, and work jointly on educational improvement (Coburn & Penuel, 2016; Kali et al., 2019; McKenney, 2016). RPPs are regarded as approaches to (a) teacher and team professionalization and (b) knowledge and co-creation between researchers and practitioners (März et al., 2017; Prenger et al., 2021). They appear in a variety of organisational structures, such as professional learning communities, communities of practice, practice-based research, design-based research, and social design experiments, all deemed suitable for obtaining ecologically valid research results and sustainable educational innovation. Hence, it seems that RPPs can facilitate the creation of knowledge useful for practitioners, which relates to the first challenge, as well as can facilitate better transfer of this knowledge, which is the third challenge. Examples of RPPs in the field of education that explicitly argue for RPPs as a solution to narrow the science-practice gap and/or investigated under which conditions RPPs can be (more) successful, include, for example, Abbot et al. (1999), Brown and Allen (2021), Cawley et al. (2002), Cohen et al. (2016), Datnow et al. (2023), El-Hamamsy et al. (2023), El-Hani and Greca (2013), Herrington and Daubenmire (2016), Hopkins et al. (2019), Ko (2022), Marshall et al. (2021), McDonald et al. (2021); Parsons et al. (2013), Shu et al. (2023), Sjölund, (2023), Sjölund et al. (2022a, 2022b), Szteinberg et al. (2014), Zala-Mezö and Datnow (2024).

An interesting case is the work of Sanchez et al. (2017), describing how knowledge development took place in a design-based research project in which practitioners and researchers collaborated intensively and both were stakeholders throughout the entire process. Drawing on the work of Chevallard (1999), who distinguishes the *know-how* (*praxis*) from the *know-why* (*logos*), Sanchez and colleagues conclude that there was a gap between practitioners and researchers regarding the *know-how* (e.g., how to perform student assessment) as well as regarding the *know-why* (e.g., the theoretical or technological justification provided), that limited the development of shared goals and collaboration. They emphasize the importance of having a broker leading the ‘bargaining’ between the practitioner and researcher stakeholders to develop a common *praxeology* (“a common discourse on a shared teaching practice”, p. 2806) and to make knowledge transfer possible.

2.3 The knowledge transfer problem

Thirdly, it is often argued that practitioners are not aware of the scientific knowledge available to them (or ignore it) and/or are unable to find, understand, and use this knowledge in their practices, in other words, recognizing the science-practice gap as a *knowledge transfer* problem (e.g., Bauer & Fischer, 2007; Korthagen, 2007; Landry et al., 2001; Stoiber & Kratochwill, 2000; Williams & Coles, 2007). In the literature, different labels are used, partly as synonyms for *knowledge transfer*, partly with slightly different meanings (see also Graham et al., 2006). Note that some labels use the term *research* instead of *knowledge*, for example, ‘research dissemination’. As it is not the research itself that is transferred, it is in my opinion more accurate to use the label *knowledge transfer* in this context. Other researchers have used the labels *knowledge transmission* (e.g., Ginsburg & Gorostiaga, 2001; Miretzky, 2007), *knowledge dissemination* (e.g., Chambers, 2019; Huberman, 1983; Knott & Wildavsky, 1980; Meyer et al., 1998), or *knowledge translation* (e.g., Chi, 2021; Cook & Cook, 2004; Edelenbosch et al., 2015; Greenwood & Abbot, 2001; Hirschhorn & Geelan, 2008; Landrum et al., 2002; Paynter et al., 2022; Ward et al., 2012). Interestingly,



Ward et al. (2012) describe *knowledge translation* as “a dynamic and inherently social process which incorporates distinct forms of knowledge which come from both research and practice” (p. 298), highlighting the formal versus practical knowledge continuum described earlier. Moreover, it refers to translation being a social process, emphasizing the importance of creating shared meaning (see also Carlile, 2004). Noteworthy is also the work of Davies et al. (2008), suggesting to use the label *knowledge interaction* to describe the “messy engagement of multiple players with diverse sources of knowledge” (p. 190) rather than *knowledge transfer* and *knowledge translation*.

As was the case with the *knowledge production* problem, the underlying problem of *knowledge transfer* is quite comprehensive, and can be conceptualized as an issue of *what* kind of knowledge should be transferred, an issue of *who* should transfer knowledge and related to that aspect, *how* knowledge should be transferred to promote knowledge use. The issue of *what* kind of knowledge should be transferred is also strongly linked to the *knowledge conceptualization* problem.

The *knowledge transfer* problem appears rather instrumental if one were to characterize the science-practice gap only as a knowledge deficit among practitioners, focusing merely on a lack of knowledge utilization in educational practice (e.g., Fenstermacher, 1983; Knott & Wildavsky, 1980; Landry et al., 2001; Rodgers, 2000; Supplee, 2023). Mausethagen et al. (2025) refer to this as a deficit discourse of research use, indicating that in the literature, educational researchers tend to overemphasize that research use will ‘solve’ whatever the teaching profession lacks in knowledge, skills or competences. All educational research should be “humble in what it can and cannot provide as insights, and what can and cannot be concluded.” (Coppe et al., 2025, p. 11). Educational research inherently represents oversimplifications of complex phenomena and cannot fully capture the complexity of human behaviour in their everchanging context. On top of that, educational research largely struggles with threats to internal validity, non-representative samples, limited generalizability, and misinterpretations of findings, such as causality (e.g., Ercikan & Roth, 2014; Fendler, 2018; Morrison & van der Werf, 2016, 2021). Furthermore, theories and conceptualizations of psychological constructs such as sense of belonging, engagement, motivation, and self-efficacy are fragmented and fuzzy (e.g., Hanfstingl et al., 2025; Korpershoek et al., 2020; Marsh et al., 2019; Pekrun, 2023), hampering *knowledge transfer*. Berliner (2002) summarized this by posing that educational research is “the hardest-to-do science of them all” (p. 18), due to the conditions that limit generalizations and theory building. Hence, researchers have to be modest in what educational research currently has to offer to practitioners.

In the literature, instrumental challenges regarding *knowledge transfer* have developed from rather asymmetric power distributions to a more equal playing field for researchers and practitioners. Before the turn of the century, practitioners were often characterized as relatively passive receivers or consumers (as discussed in, e.g., Carnine, 1995, 1997; Fenstermacher, 1983; Kauffman, 1996; Rogers, 1983) rather than active agents in searching for relevant insights from educational research and adopting these new insights into their daily teaching practice. Landry et al. (2001) outline four models of knowledge utilization, a *science push model*, a *science pull model*, a *dissemination model*, and an *interaction model*. The first two models are considered linear models, representing a linear knowledge transfer from researcher to practitioner (the *science push model*) or situations in which practitioners give direction to new research (the *demand pull model*). The *dissemination model* focuses on identifying useful knowledge and purposefully disseminating this knowledge to practitioners. The *interaction model* considers knowledge utilization as a non-linear



process and a result of researcher-practitioner interaction. This fourth model links to the *knowledge production* problem, because RPPs are expected to produce ‘useable’ knowledge (see also Van Schaik et al., 2018).

Rogers (1995) states in his diffusion of innovations theory that practitioners’ research use is shaped by their perceptions of the compatibility, observability, complexity, relative advantage, and trialability of the innovation (i.e., new ideas or practices). More recent work based on Rogers’ framework revealed that perceived compatibility—i.e. the extent to which research fits with practitioners’ experiences, values, settings, and needs—was most important for practitioners (Neal, J. W., Neal, Z. P. et al., 2018; Neal, J. W., Mills et al., 2018). Similarly, Carnine (1995) suggests that research use by practitioners depends on the extent to which they consider the research findings to be trustworthy, usable, and accessible. Landrum et al. (2002) conducted interviews with student teachers in special and general education teacher training programs and found that they evaluated information from professional journals as significantly less trustworthy, less usable, and less accessible than information from fellow teachers. Moreover, information from conferences/workshops were evaluated as significantly more trustworthy, usable, and accessible than information from, for example, college courses and professional journals. In a later publication, Landrum et al. (2007) reported on an experiment in which information about reading interventions was either presented as data-based (i.e., research findings published in a professional journal) or as personal (i.e., written personal experiences of an experienced teacher). Findings revealed that the participants generally found the information presented via the personal format more useable, despite the fact that exactly the same information was presented.

When delving deeper into the issues of *who* should transfer knowledge and *how* knowledge should be transferred, the science-practice gap has also been labelled as a communication gap (Ginsburg & Gorostiaga, 2001; Neal, J. W. et al., 2019), indicating that lack of information exchange might explain the limited research use among practitioners. Hence, the knowledge transfer problem does not only refer to knowledge transfer from researchers to practitioners, but more generally to information exchange between various stakeholders such as researchers, policymakers, and practitioners, between as well as within their respective communities. Hence, *knowledge mobilization* is proposed in the literature as a solution to address the communication gap and thereby the knowledge transfer problem (Fenwick & Farrell, 2012; Levin, 2011; Mosher et al., 2014). *Knowledge mobilization* can be defined as “the multiple ways in which stronger connections can be made between research, policy and practice” (Levin, 2011, p. 15; see also Baier-Mosch, & Kunter, 2024; Cooper et al., 2009). Similarly, the concept of *knowledge brokerage* is used, referring to “a dynamic and complex set of actors, activities, motivation within which research is exchanged, transformed, and otherwise communicated” (Farley-Ripple & Grajeda, 2020, p. 67). The labels *knowledge mobilization* and *knowledge brokering* are used interchangeably in the literature (Rycroft-Smith, 2022). Research into *knowledge brokerage* has basically developed as a separate strand, with many recent studies focusing on brokerage and boundary work (e.g., Edelenbosch et al., 2015; Hopkins et al., 2019; Neal, J. W. et al., 2015; Neal, J. W., Milles et al., 2018; Neal J. W. et al., 2019; Penuel et al., 2015; Rycroft-Smith, 2022). Brokerage is a process “by which intermediary actors facilitate transactions between other actors lacking access to or trust in one another” (Marsden, 1982, p. 202). These studies employ typologies of brokers and/or brokerage relations, including such types as the local broker/coordinator, the itinerant/cosmopolitan broker, the



gatekeeper, the representative, and the liaison (Gould & Fernandez, 1989; see also Neal J. W. et al., 2015; Neal J. W. et al., 2019), or combinations thereof (Hopkins & Penuel, 2018). These brokers ('research translators' according to Hirschhorn & Geelan, 2008) are "adept at speaking the language of both practitioners and researchers and would be able to translate researcher findings into a form that is comprehensible, plausible, and appears potentially fruitful to practitioners" (Hirschhorn & Geelan, 2008, p. 11).

Although existing studies into knowledge brokerage investigated the information transfer chains between brokers, practitioners, and researchers, I observed that it remains unclear *what* exactly is being brokered or transferred. A very welcome exception is the work of Rodway et al. (2021), who explored knowledge exchange patterns among teachers, instructional coaches, and administrators, distinguishing knowledge brokering of advice, materials, new ideas, or differentiation strategies. Drawing on the work of Wenger (1998), one could argue that *knowledge* is a boundary object that through boundary crossing can be transferred from one practice to another, but this is typically either not addressed or superficially in studies on knowledge brokerage. Neal J. W. et al. (2019), for example, report that their study concentrated on the transfer of simple information (e.g., talking about social skills programs) rather than complex knowledge (e.g., talking about how to implement a social skills program).

Meyer (2010) states that "knowledge brokers do not only move knowledge, but also produce a new kind of knowledge: brokered knowledge" (p. 118), which confused me even more and underscores my claim that especially conceptual clarity is needed regarding the *knowledge conceptualization* problem. Ward (2017) did attempt to answer more fundamental questions in her review study, for example, why knowledge is mobilised, whose knowledge is mobilised, what type of knowledge is mobilised, and how knowledge is mobilised, but did not incorporate studies in the field of educational sciences. Important to note here is the study of Rycroft-Smith (2022) who synthesized the literature on knowledge brokering in education and concluded—rather surprising, in my view, considering the popularity of knowledge brokers—that there is a lack of empirical evidence for the effectiveness of knowledge brokering. Moreover, although implementation science (e.g., Fixsen et al., 2015; Joyce & Cartwright, 2019; Meyers et al., 2012) has developed over the past decade as a new scientific field to address the *knowledge transfer* problem and advance our understanding of factors associated with successful implementation of evidence-based interventions (Tabak et al., 2012), this scientific knowledge has not yet found its way to practitioners (e.g., in health care; Westerlund, 2018). Thus, paradoxically, implementation science is also confronted with the science-practice gap.

3. What knowledge do we need?

The claim of Cook and Cook (2004) that "knowing what works and doing what works are two very different issues" (p. 242) illustrates the need for conceptual clarity as to *what* kind of knowledge is needed in order to be 'usable' knowledge. As early as the start of the 1980's, researchers considered research use as a multidimensional construct (see Huberman, 1983, 1990; Weiss, 1979, and in later studies such as Bogenschneider et al., 2019; Ginsburg & Gorostiaga, 2001; Lysenko et al., 2016), comprising conceptual/enlightenment use of knowledge (i.e., changes in understanding, awareness, or attitude),



instrumental use of knowledge (i.e., changes in behaviours and practices) and strategic use of knowledge (also labelled symbolic, persuasive or legitimising use, e.g., to influence or justify actions; Lysenko et al., 2016). Recall that Mausethagen et al. (2025) are critical about the underlying assumption that research use by practitioners is expected to improve their teaching practices and decision-making processes.

Tricot (2024) explains that it is impossible to develop (and thus successfully implement) educational practices that would work everywhere, but that we can develop *knowledge* that is highly transferable and that teachers can translate this knowledge to their own educational practice. Cordingley (2008) takes a somewhat different perspective, stating that “practitioners need to connect, intellectually, practically and emotionally with the knowledge they are offered in research accounts if they are to take it on board and use this to inform their practice” (p. 37). As stated in paragraph 2.1, I am not convinced that practical knowledge and propositional knowledge are fundamentally different, though they may be gained via different practices, such as educational practices (e.g., teacher experience) and research practices (e.g., research findings). Thus, in my view, it is key to examine the concept of *knowledge* more closely to develop a better understanding of the *knowledge conceptualization* problem. This goes beyond the rather superficial continuum with practical and formal knowledge at both extremes, which has not really proven to be helpful for educational change and innovation. Likewise, a simplistic distinction can be easily made between declarative knowledge (the ‘what’) and procedural knowledge (the ‘how’). Tenkasi (2011) argues that both are needed for narrowing the science-practice gap, whereas McKenney and Reeves (2014) distinguish declarative knowledge (describing products, concepts or theories), procedural knowledge (informing how to take action), and observable knowledge (empirical findings or experiences) produced by educational design research (see also Ormel et al., 2012). In contrast, De Jong and Ferguson-Hessler (1996) developed a more elaborate matrix that takes types and qualities of knowledge as its dimensions. They distinguish four types of knowledge, namely situational, conceptual, procedural and strategic knowledge, as well as categorizing each knowledge type by different qualities, such as level of knowledge (deep or surface), generality of knowledge, level of automation of knowledge, modality of knowledge, and structure of knowledge. Other researchers such as Krathwohl (2002) describe four types: factual, conceptual, procedural, and metacognitive knowledge. Although these categorizations may help us to understand what types of knowledge are needed to solve specific educational challenges, and thus addressing the *knowledge conceptualization* problem in specific contexts, we also need to take into account the different views on the knowledge creation process if we are to address the *knowledge conceptualization, production and transfer* problems simultaneously.

In this theory synthesis, I reviewed, critiqued, and synthesized three fundamental problems that need to be addressed to reduce the science-practice gap in education. For further exploration and examination, they can be translated into six leading questions: (1) What types of knowledge are needed to improve educational practice?, (2) Who should (or could) produce or develop knowledge?, (3) How should knowledge production be organized?, (4) What kind of knowledge should be transferred?, (5) Who should transfer knowledge?, and (6) How should knowledge be transferred? In the remainder of this paper, I share some theoretical reflections that may help to find new leads to find answers to these questions.

Organizational theorists have distinguished propositional and embodied forms of knowledge. This quote from Nonaka (1994) illustrates the complexity of the different views on knowledge creation in light of the science-practice gap:



While the former [knowledge of traditional epistemology] naturally emphasizes the absolute, static, and nonhuman nature of knowledge, typically expressed in propositional forms in formal logic, the latter [the theory of knowledge creation] sees knowledge as a dynamic human process of justifying personal beliefs as part of an aspiration for the "truth". (Nonaka, 1994, p. 15).

This dissection of propositional and embodied forms of knowledge draws upon the work of Polanyi (1966), who classified knowledge into two categories: (a) *explicit (or codified) knowledge*, referring to transmittable knowledge in formal, systematic language, and (b) *tacit knowledge*, which is nonverbalized, intuitive, and unarticulated knowledge, in other words, embodied, personal knowledge (the 'knowing how'). Research-based or formal knowledge can be considered *explicit knowledge*, whereas practical knowledge can be considered both *tacit knowledge* and *explicit knowledge*. For instance, Lillejord and Børte (2016) explain that teachers' professional knowledge draws on their practical and personal knowledge as well as knowledge from research.

To refine the new leading questions I distilled in this synthesis, I therefore propose we should disentangle what kinds of *explicit knowledge* need to be produced and transferred. Yet, we also need to better understand how *explicit knowledge* may develop into *tacit knowledge* (see e.g., Anderson, 1983; Cain, 2015; Van Schaik et al., 2019). Or as Neuweg (2006) states it: "explicit knowledge must rely on being tacitly understood and applied in order to be knowledge at all" (p. 70). Another point of attention is to further our understanding as to how *tacit knowledge* can be converted into *explicit knowledge* and be shared with other practitioners (see also Hiebert et al., 2002; Nonaka, 1994). From an organizational sciences perspective, Nonaka (1994) hypothesized that a 'knowledge spiral' is created through four interactive knowledge conversion methods: internalization (explicit to tacit), externalization (tacit to explicit), combination (explicit to explicit), and socialization (tacit to tacit). According to Nonaka (1994) knowledge creation is a social process, spiralling from the individual levels to the group and organizational levels, and finally between organizations. In the context of schools, externalization would, for example, entail the social and interactive process of converting teachers' personal knowledge into shareable knowledge (see also Hargreaves, 1999). Hence, evidence-informed practice might as well require an integration of knowledge gained from scientific research and knowledge gained from practitioners' experience (e.g., Ratcliffe et al., 2005).

There are more insights we can draw from prior work on *knowledge management* in organizational sciences (e.g., Boisot, 1995, 2013; Brauner & Becker, 2006; Tzortzaki & Mihiothis, 2014; Wiig, 1997; Wong & Aspinwall, 2004). For example, Boisot (1995, 2013) developed the Information Space framework for *knowledge management*, represented by three dimensional cube with dimensions from concrete to abstract, from uncoded to coded, and from undiffused to diffused knowledge that span the 'information space'. Boisot (1995) suggests that the dynamic flow of knowledge in social spaces such as organizations follows six phases known as the 'social learning cycle': scanning, problem-solving, abstraction, diffusion, absorption, and impacting. The cycle models how 'useful' knowledge can be generated. The absorption phase, for example, describes the process of coded knowledge being applied to a variety of situations and producing new learning experiences, and thus becoming uncoded or tacit knowledge. The structuring and sharing of information are assumed to be positively related. Boisot (2013) explains that tacit knowledge (low codification and abstraction) flows slowly between agents in, for example, an organization, whereas coded and abstract knowledge can diffuse rapidly. That is, using codification processes, structured knowledge flows



more easily than unstructured knowledge. These dynamics have, to my knowledge, neither been studied extensively in the context educational organizations, nor been empirically tested in these contexts. Moreover, the work on *knowledge management* generally focuses on knowledge flow processes *within* organizations (e.g., Brauner & Becker, 2006), whereas in the context of education, *knowledge transfer* entails knowledge flow *within* and *between* different organizations and different communities (e.g., researchers and practitioners). In the field of physics, the book chapter of Thong et al. (2024) exemplifies how knowledge flow processes could be explored further.

In the educational field, research-practice partnerships (RPPs) are expected to facilitate the production of knowledge that is useful for practitioners by bringing the communities closer together. Engaging practitioners in RPPs and as co-producers of knowledge engenders shared ownership and professional agency that may contribute extensively to sustainable educational change and resolution of the three knowledge problems. Therefore, it is relevant to identify, refine, or develop RPPs that actually produce educational change and innovation and promote evidence-informed decision-making (e.g., Wentworth et al., 2017). RPPs provide more participatory ways of establishing what ‘works’ and a more thorough conceptual understanding of why something should work, through engaging practitioners in the research process. Nevertheless, our understanding of these processes of co-creation is still in its infancy. For example, little is known about the types of knowledge that are shared and valued among participants in order to produce new knowledge (Dingyloudi et al., 2019; Wenger et al., 2011). Hence, developing design templates for RPPs that produce educational change and innovation could lay the foundations for more general models of co-created knowledge production in applied fields and address the *knowledge production* problem.

For adopting evidence-informed practice, various types of knowledge (e.g., factual, situational, conceptual, procedural, strategic, and metacognitive knowledge) should be transferred within and between communities of researchers, practitioners, and policy makers. This also implies that practitioners should have access to all relevant types of knowledge and know how to evaluate its usefulness for their own educational practice and that researchers should collaborate more closely with practitioners –as equal partners– in *knowledge production* and *knowledge transfer* processes. As stated by Christianakis (2010): “Collaborative research should entail a negotiation of roles and responsibilities” (p. 119). RPPs are expected to facilitate knowledge transfer from science to practice as well as from practitioner to practitioner sharing their expertise and experience. Wijarwadi et al. (2025) report in their review that, within the school context, the main objective of teachers’ participation in collaborative activities is to develop their professional practice, such as establishing trust and mutual relationships among teachers, sharing resources and teaching practices, advancing professional knowledge, and achieving teachers’ shared goals. This underlines that both explicit knowledge and tacit knowledge might be equally important to improve the quality of decision-making processes and practices in education. That is, if teachers need to ‘experience the evidence’ themselves, and see that a practice works for them, knowledge from personal experience needs to be taken into account. To better understand the *knowledge transfer* problem, it is important to identify how and to what extent different types of knowledge are transferred from science to practice and are shared among practitioners (e.g., in RPPs), and which type of knowledge transfer activities actually lead to educational change and innovation (see also Bakkenes et al., 2010). Building on the existing body-of-knowledge on teacher professional development, effective professional development requires responsiveness to practitioners’ needs as well as



the contexts in which they teach and learn (Darling-Hammond et al., 2017). Trusting relationships, joined goals and clear expectations are important prerequisites for knowledge sharing and knowledge production in team learning (e.g., Coburn & Penuel, 2016; Desimone et al., 2016; Kolleck et al., 2021; Smith et al, 2020; Wilson & Berne, 1999).

4. Conclusion

We face complex societal challenges that can only be solved by reducing the science-practice gap and thus by collective engagement and collaboration between researchers and practitioners (e.g., Farnell, 2020; Tseng, 2012; Tseng & Nutley, 2014), and in particular in applied fields such as the social sciences, medical sciences, organisational sciences, management sciences, and environmental sciences. While our modern society produces more and more scientific knowledge aimed at finding solutions to these challenges, too little of this production is transferred and implemented into the « real » world, especially in education. At the same time, knowledge from practitioners is often understudied and undervalued by researchers. In teachers' professional practice, research-based knowledge is negotiated in relation to other knowledge sources (Hermansen & Mausethagen, 2023; Mausethagen et al., 2025; Sims et al., 2025). Moreover, teachers' knowledge use and justification of their actions are interwoven with their professional and personal norms and values (Eriksen, 2022) as well as their motivation to change (Kennedy, 2016).

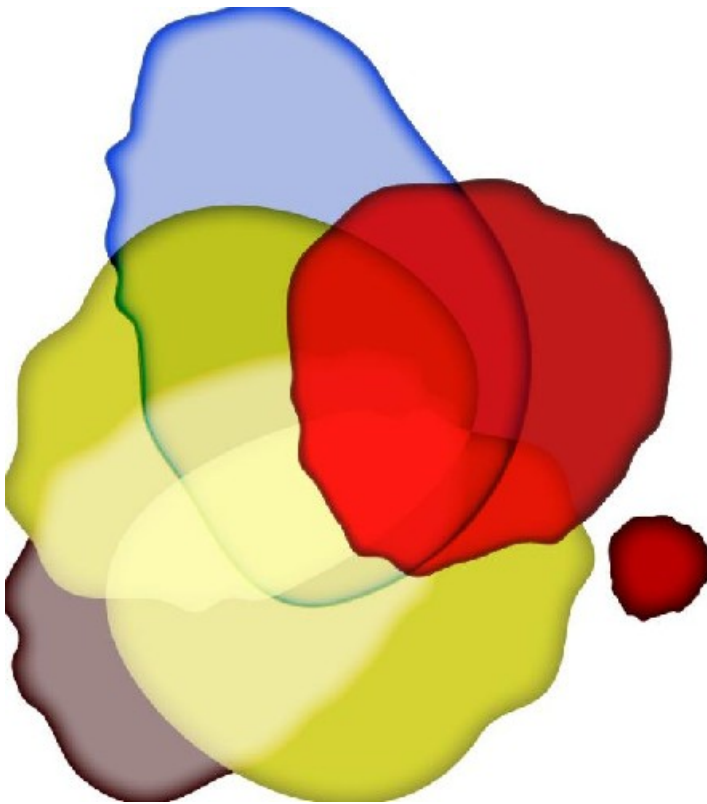
Considering practitioners explicitly as *knowledge workers* might improve their professional identity and promote becoming active agents in evidence-informed decision-making and processes of *knowledge conceptualization*, *knowledge production*, and *knowledge transfer*. Davenport (2005) defined knowledge workers as “having high degrees of expertise, education, or experience, and the primary purpose of their jobs involves the creation, distribution, or application of knowledge.” (p. 9), in which experts are those with high levels of independence and high complex (i.e. non-routine) jobs, which matches the teaching job quite well.

Hence, I advocate to address the *knowledge conceptualization*, *knowledge production*, and *knowledge transfer* problems to improve the quality of decision-making processes in education. This will lay the groundwork for a reduction of the science-practice gap in education. Although the ‘bridging the gap’ metaphor “does not capture what is needed” (Stoiber & Kratochwill, 2000, p. 99) and “at the outset, the metaphors of ‘gap’ and ‘bridge’ may make theory and practice seem like two completely separated entities.” (Kvernbekk, 2012, p. 291), I fully support the statement by Stoiber and Kratochwill (2000) that “the ever-changing contextual demands of schools and communities require a dynamic structure that reflects, and is informed by, the ongoing interchange between science and practice” (p. 100). This interchange should start with the question “What knowledge do we need to improve educational practice?”.

Keypoints



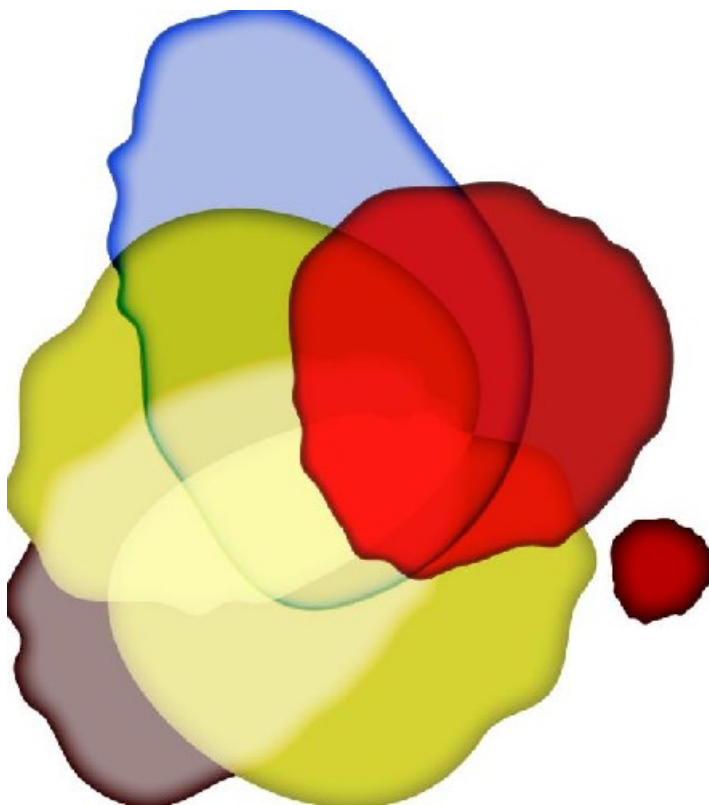
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A fundamental understanding of the science-practice gap is needed to solve complex societal challenges.



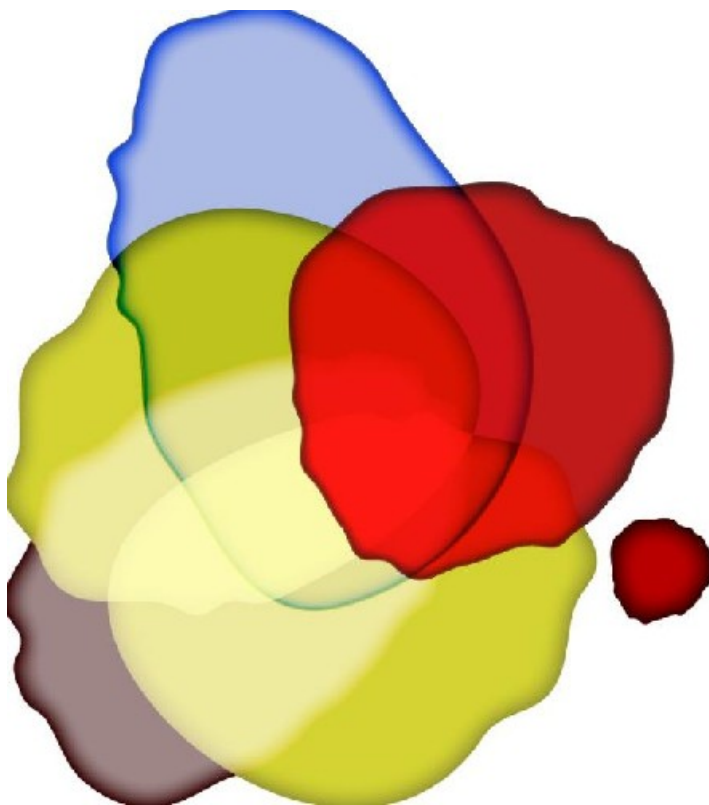
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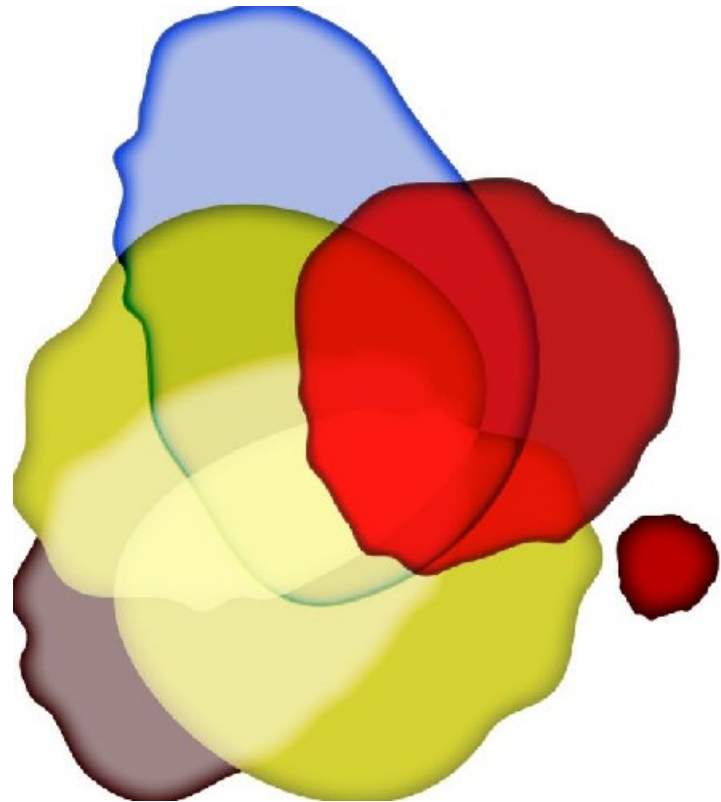
To reduce the science-practice gap, we need to address the knowledge conceptualization, knowledge production, and knowledge transfer problems.



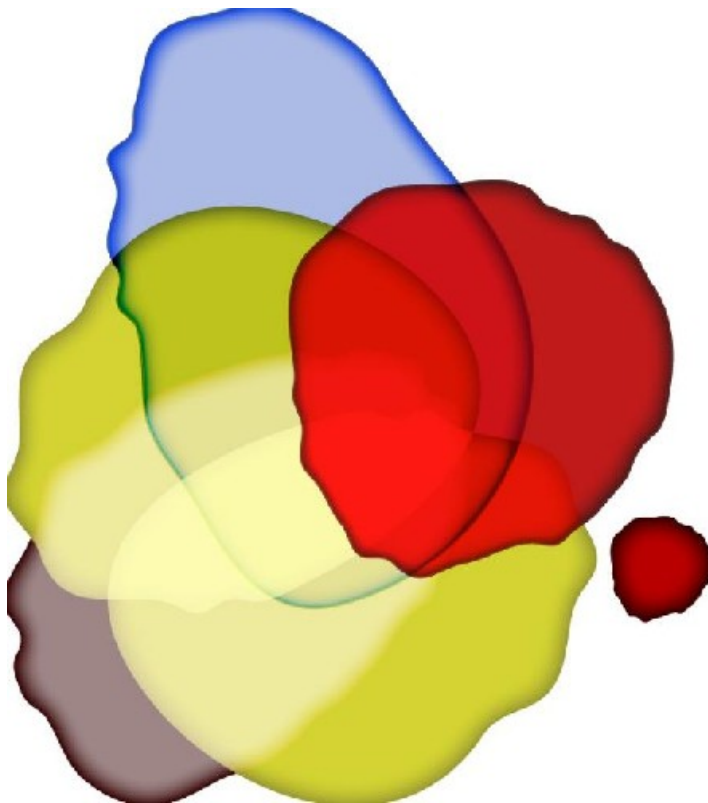
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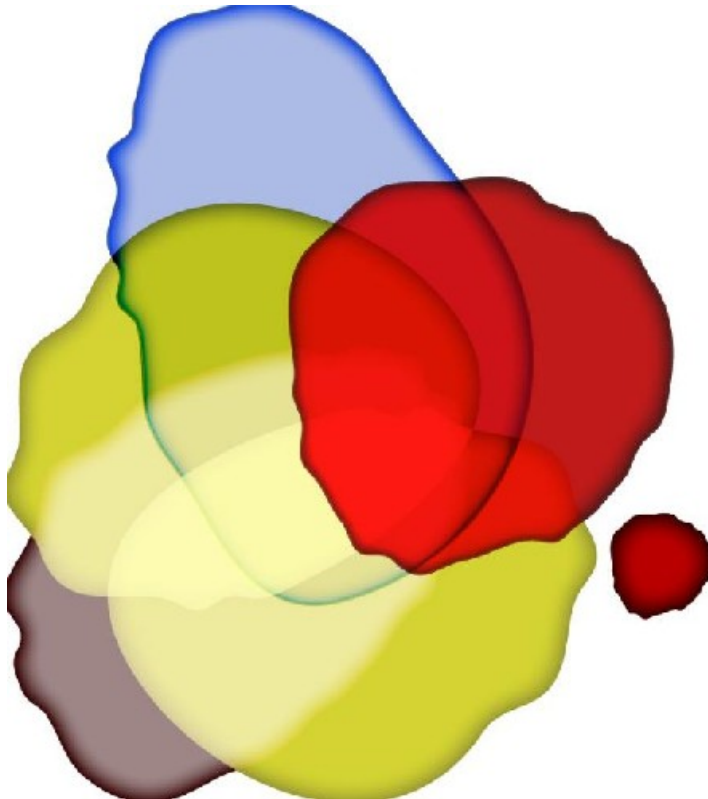
Identifying the different types of knowledge that support educational practitioners to adopt evidence-informed practices is key.



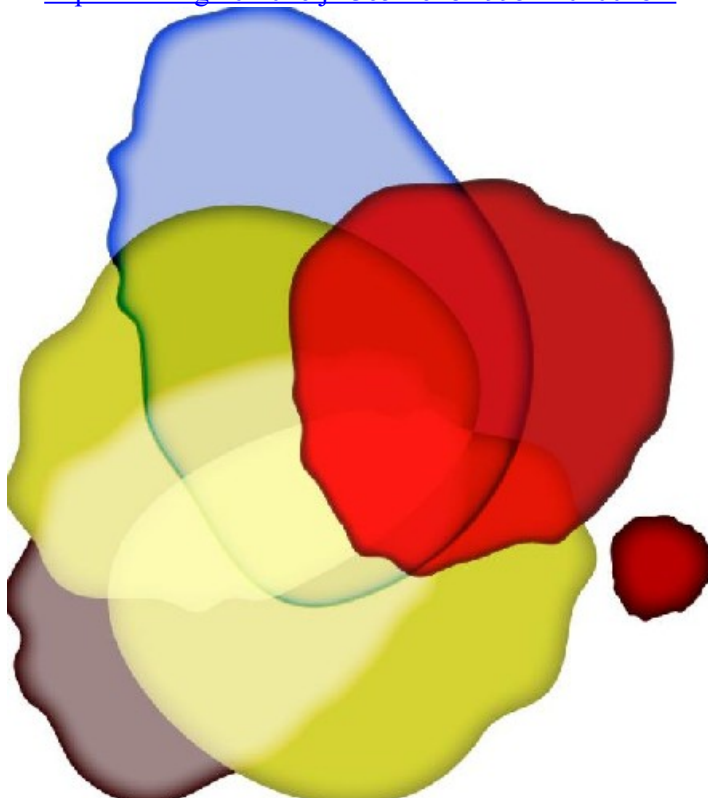
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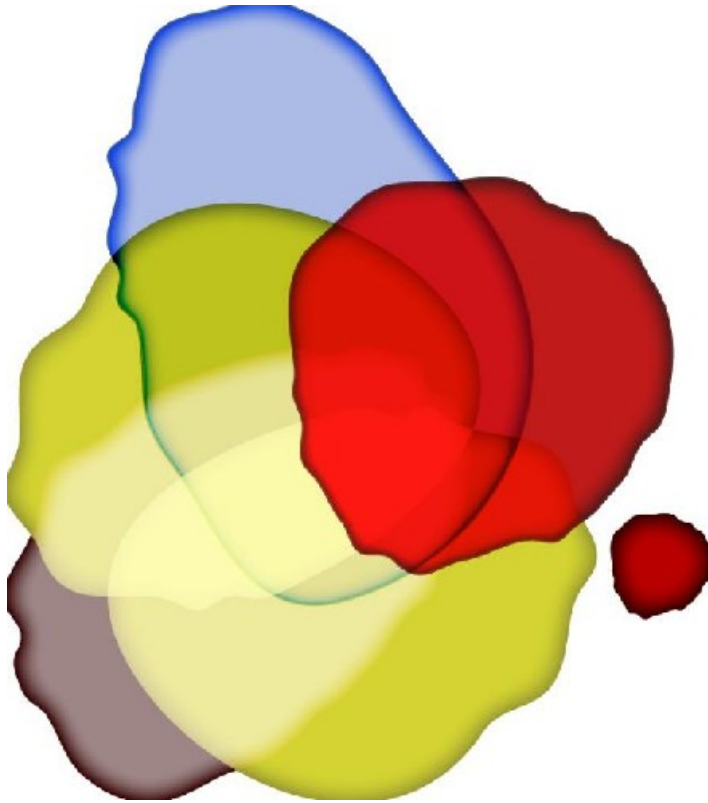


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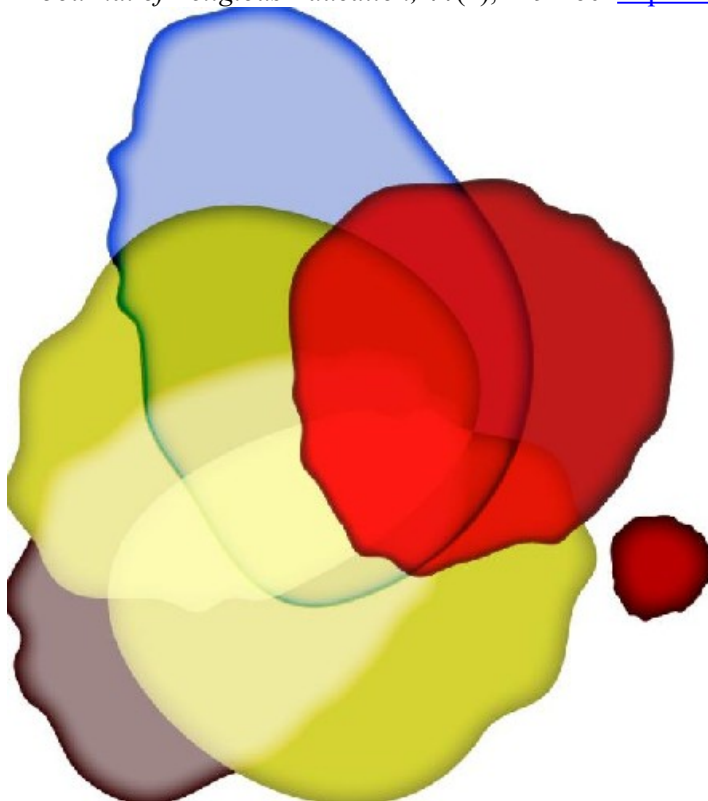


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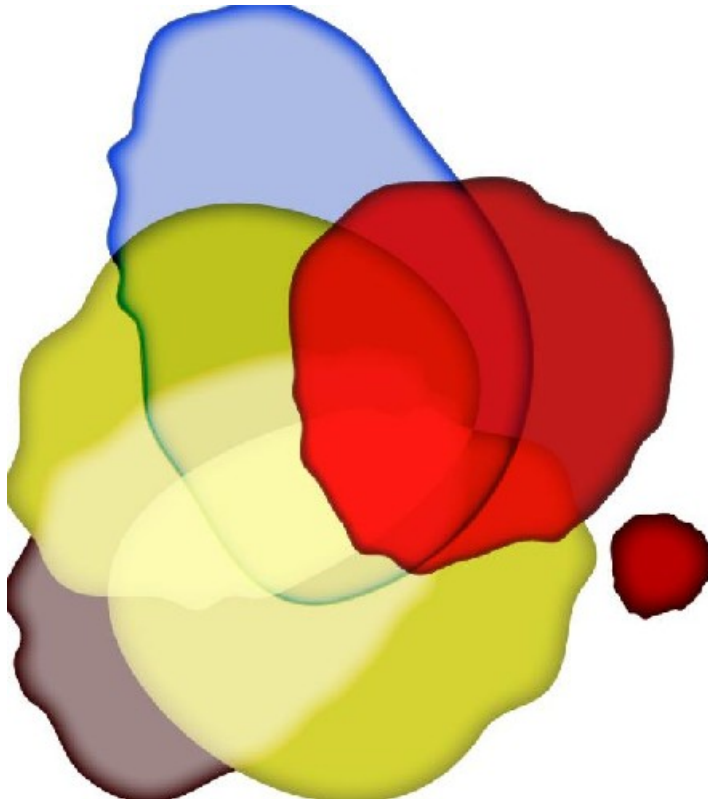
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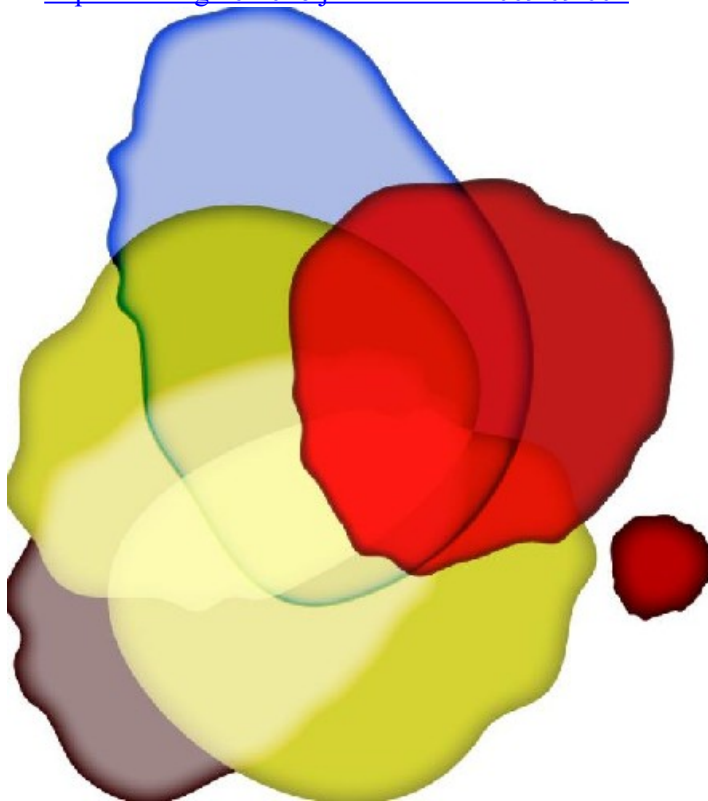
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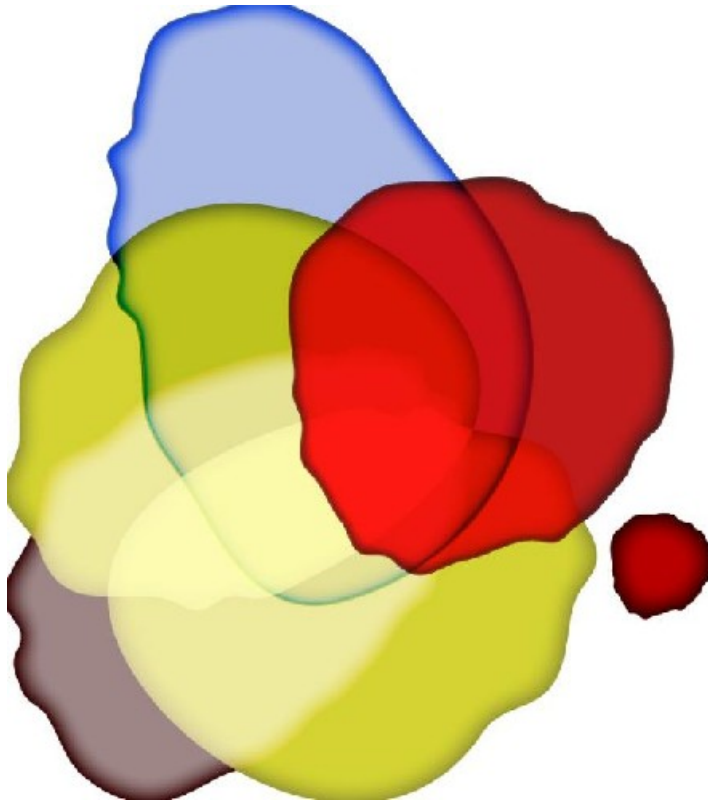
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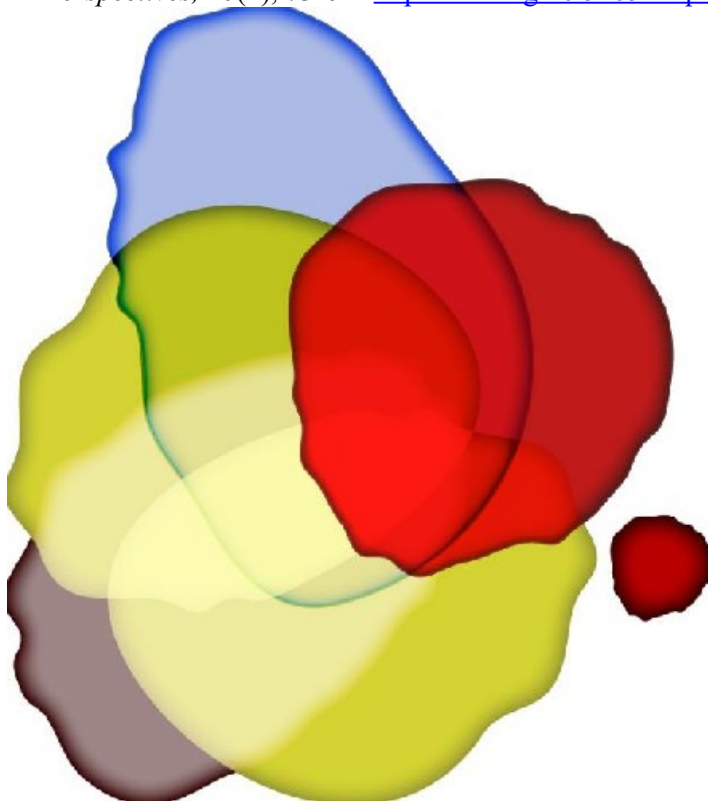
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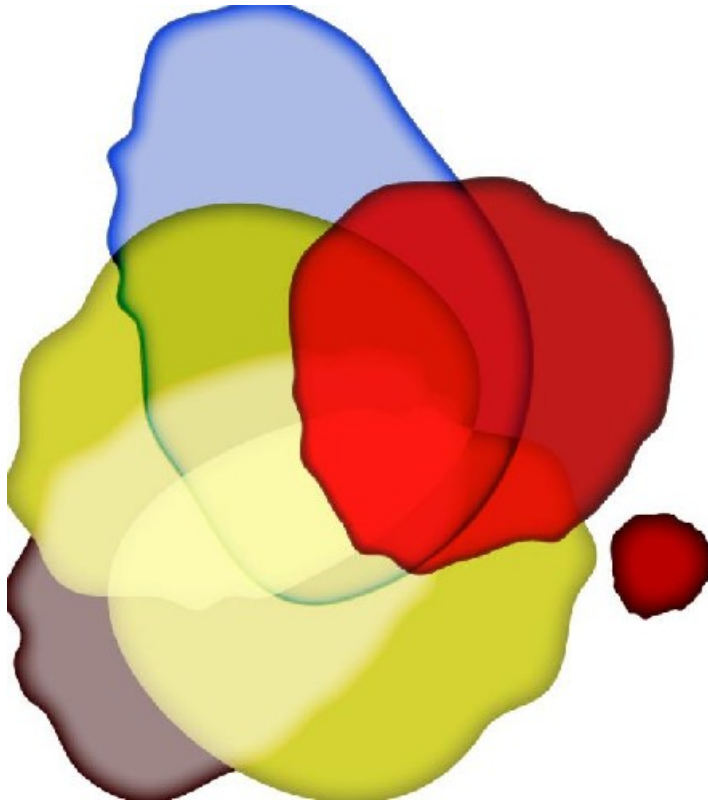
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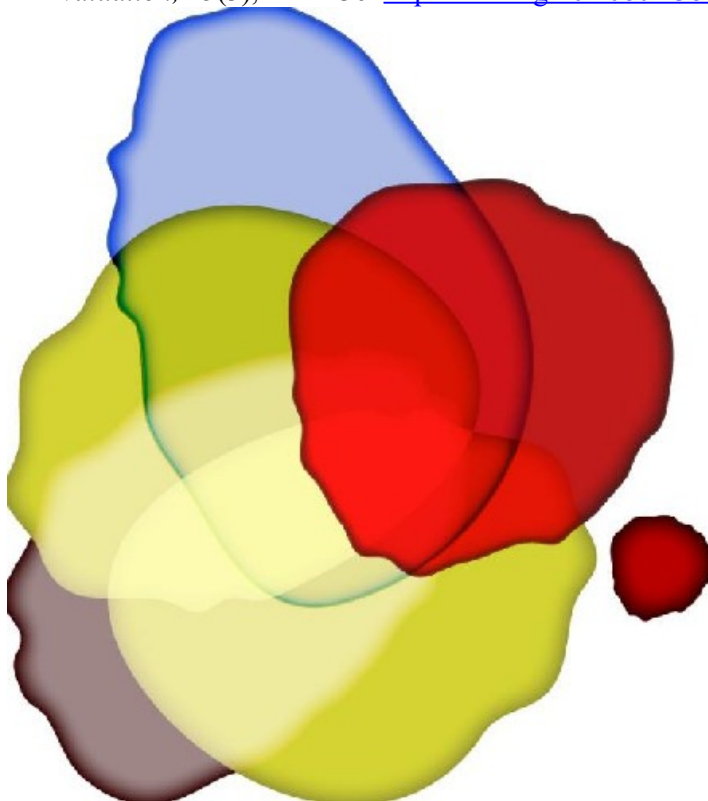
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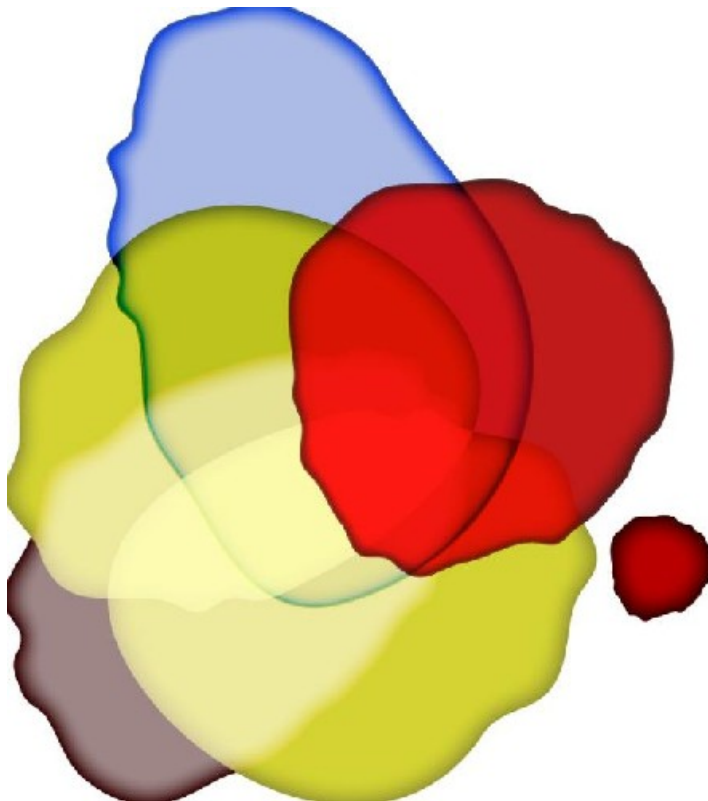
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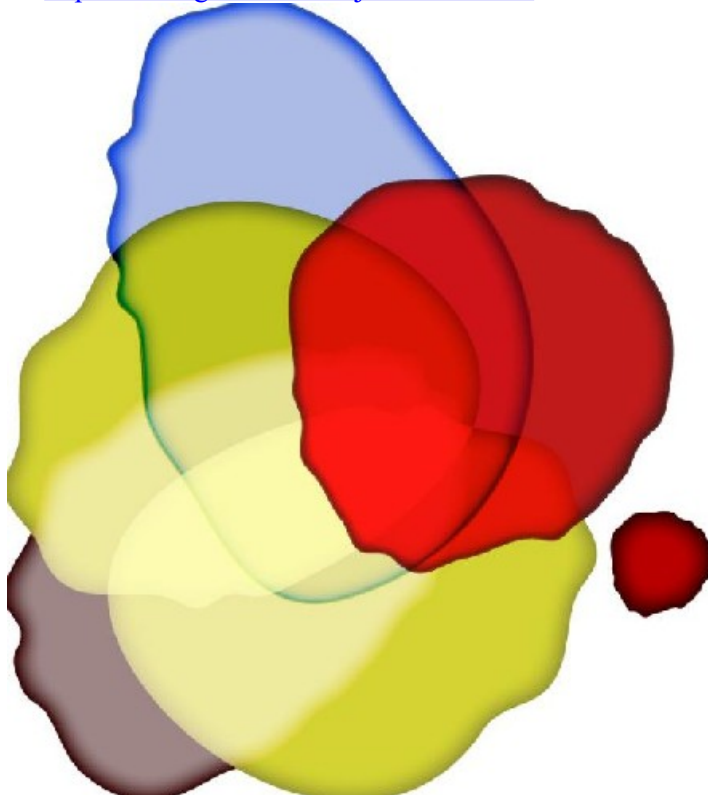
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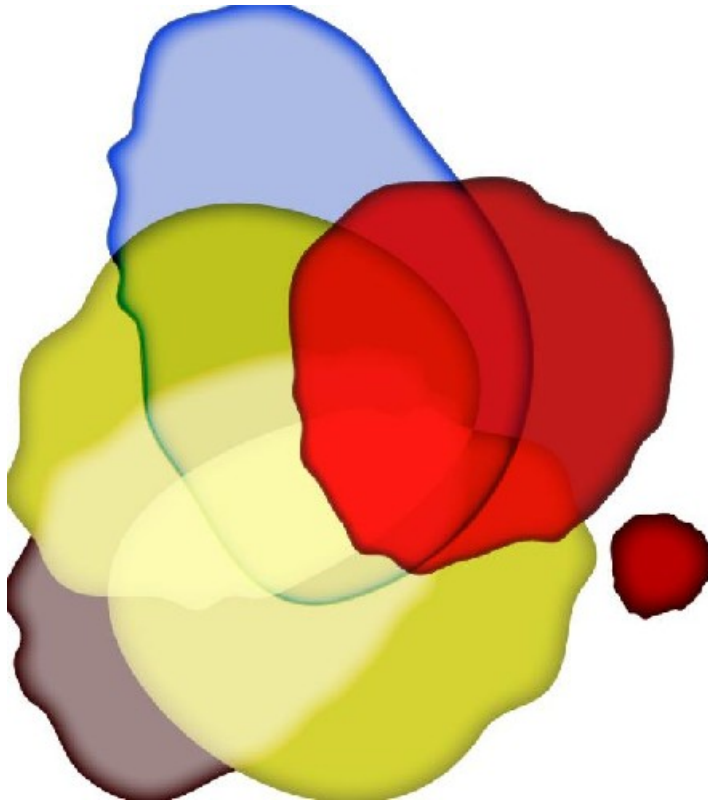
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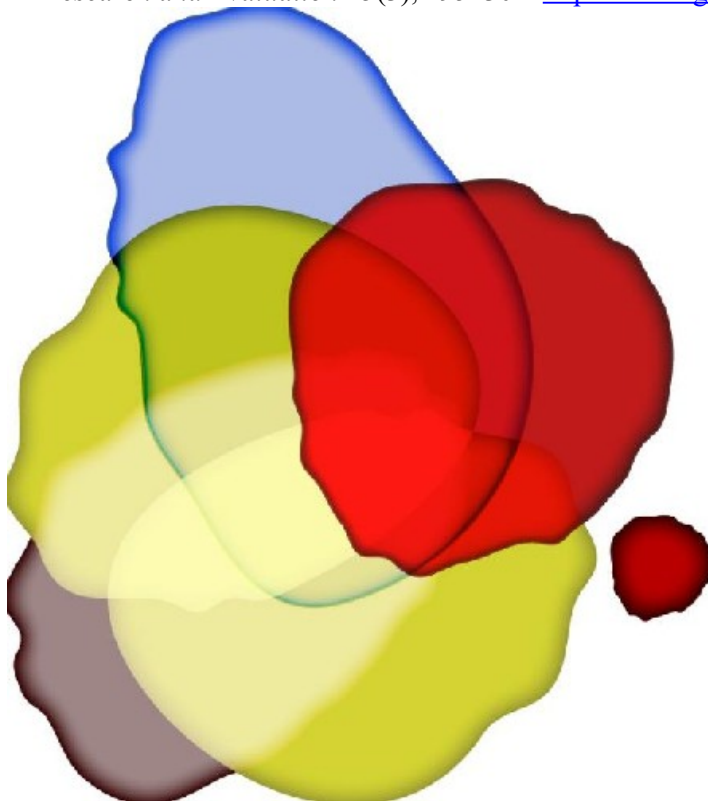
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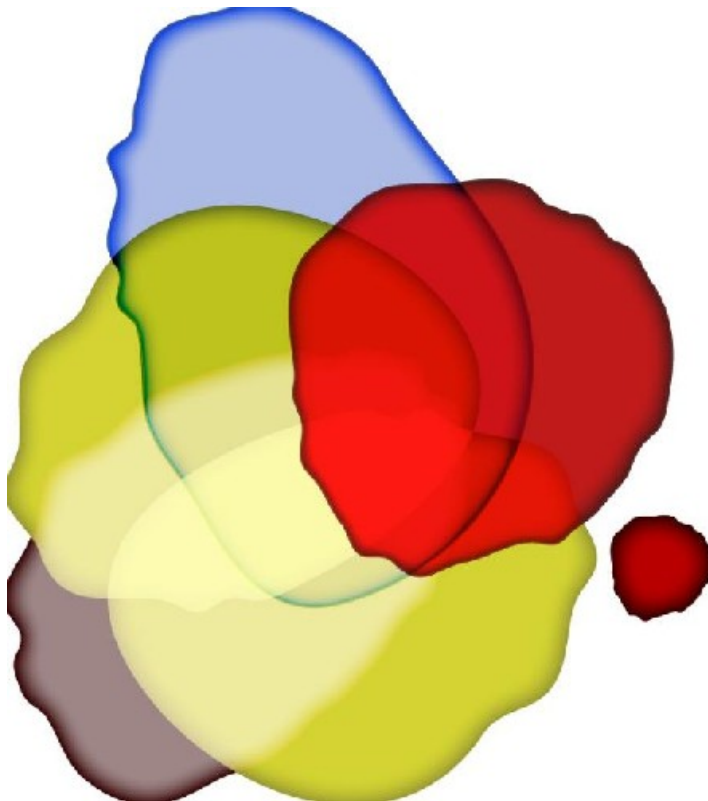
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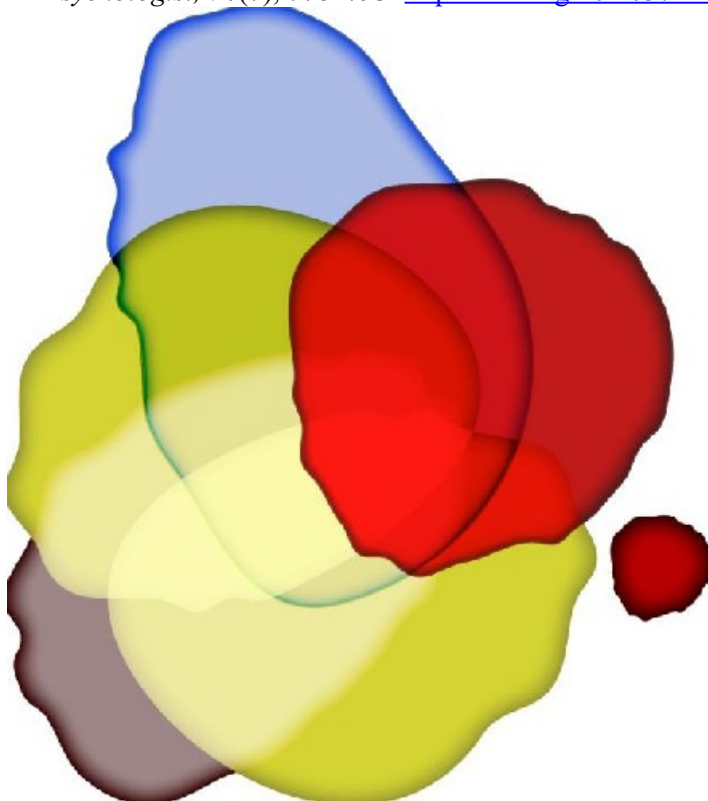
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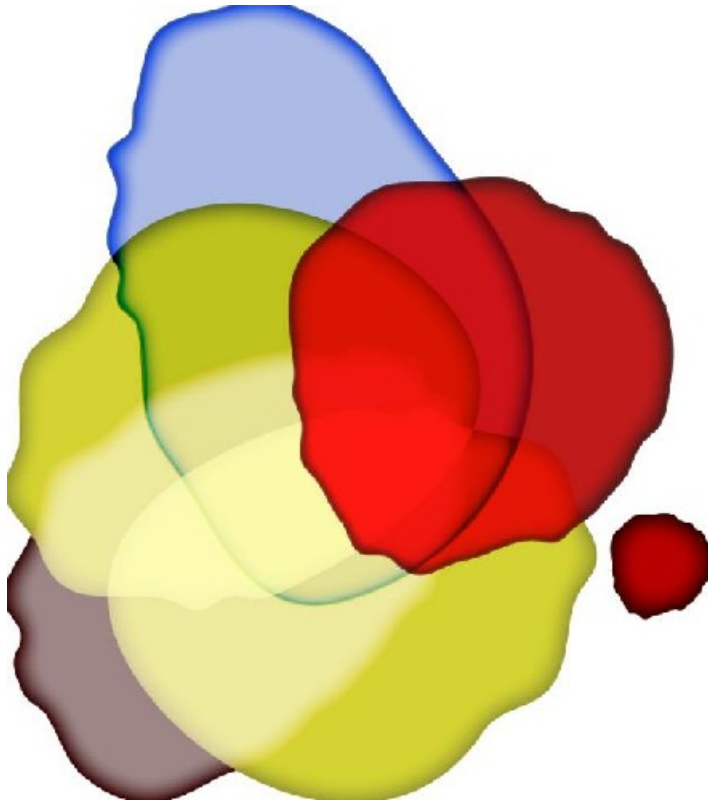
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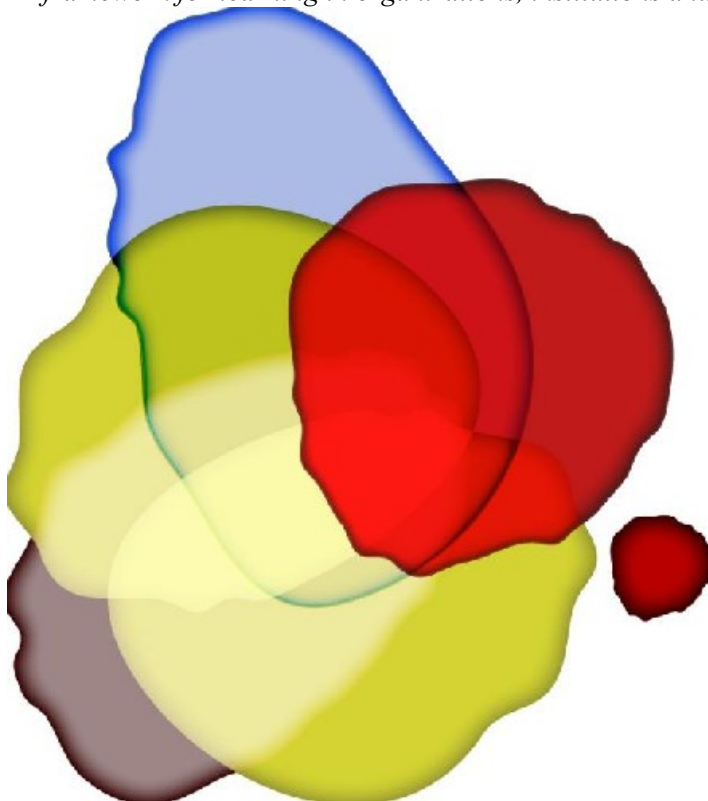
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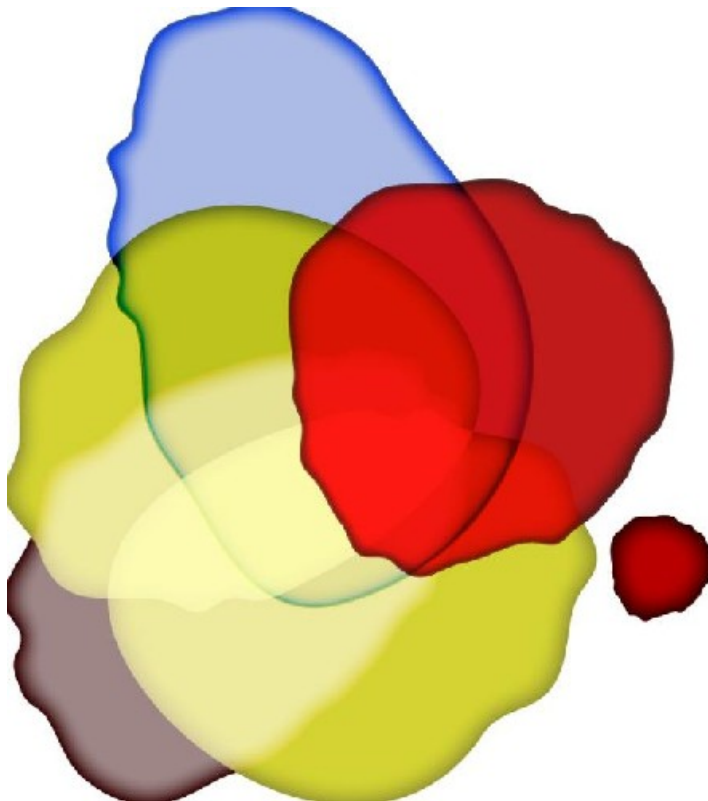
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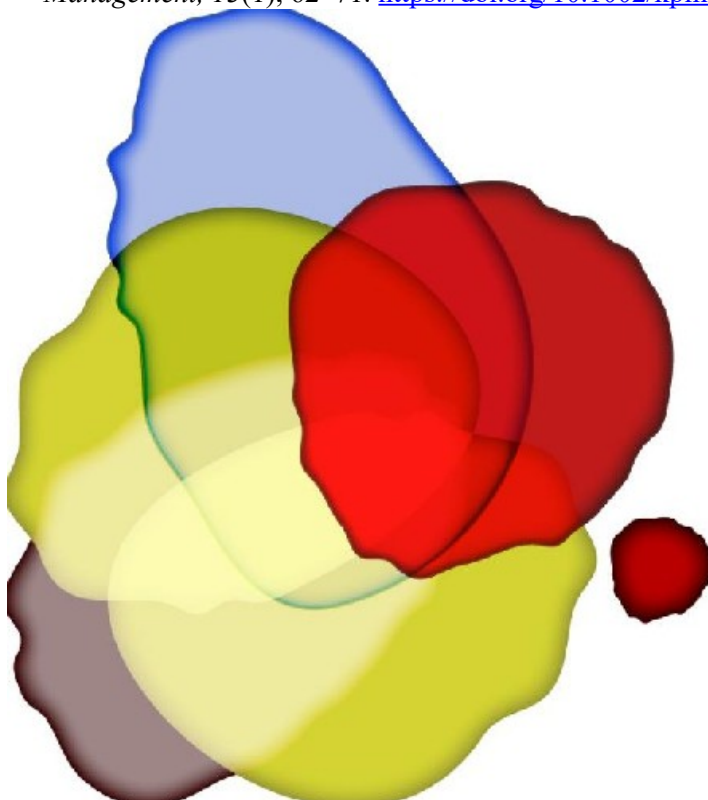
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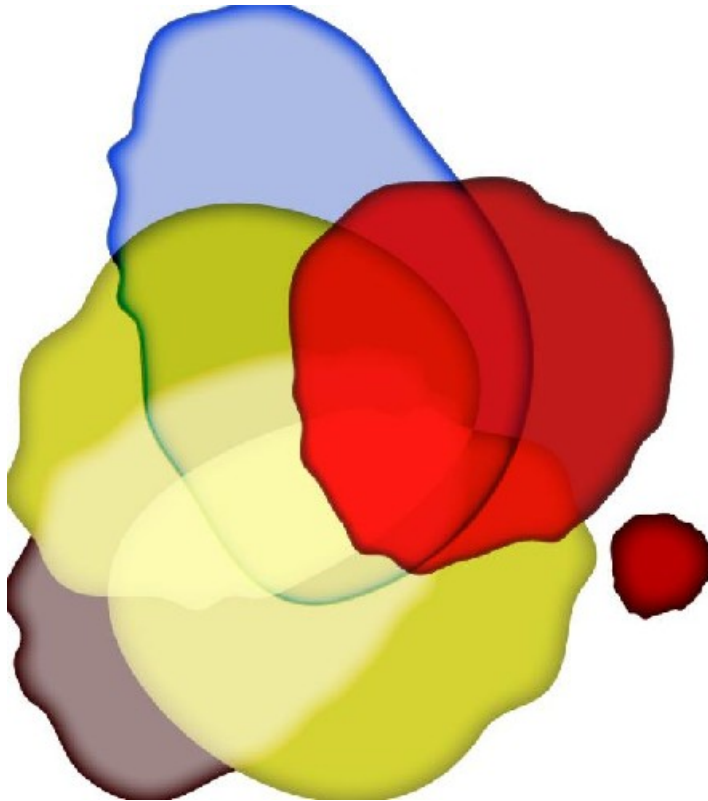
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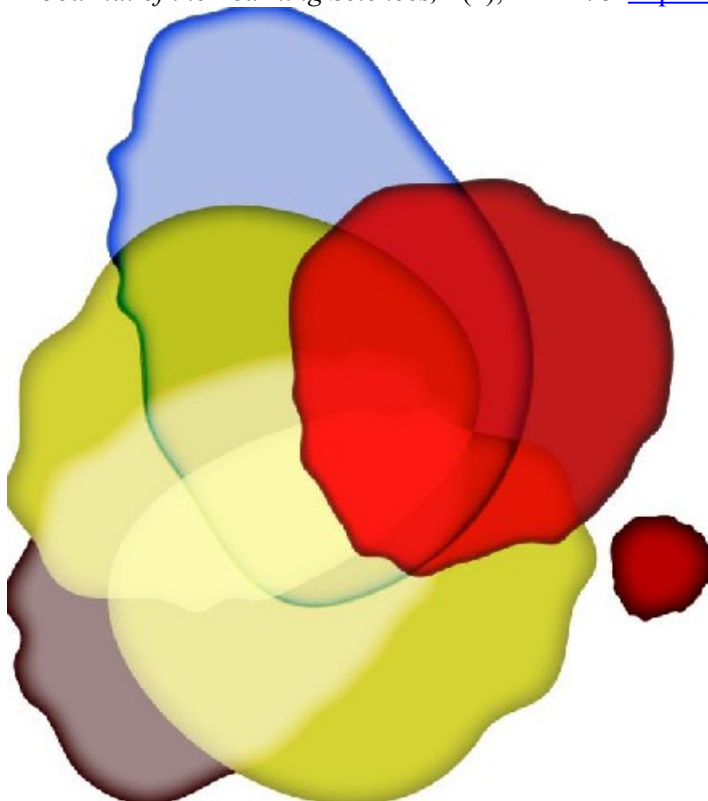
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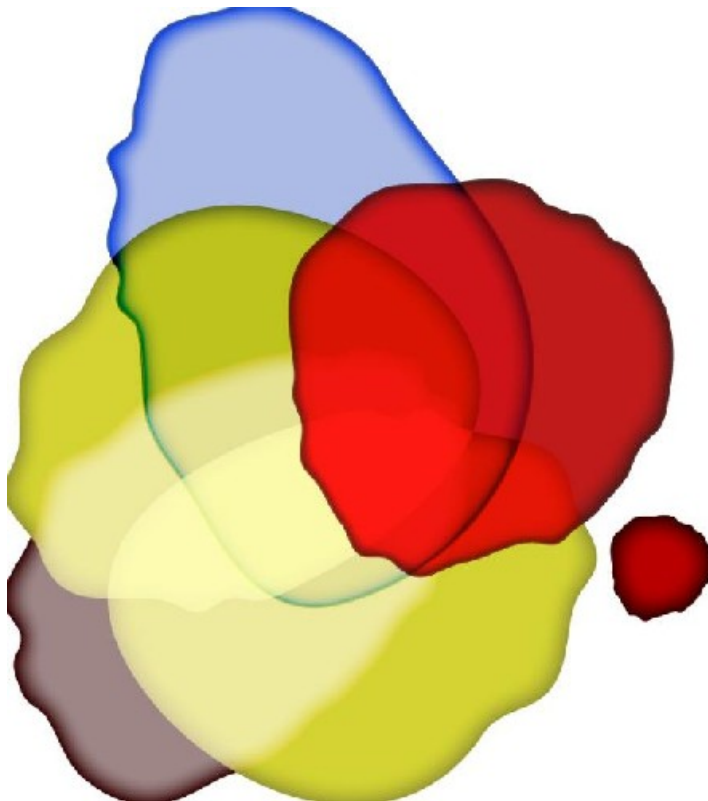
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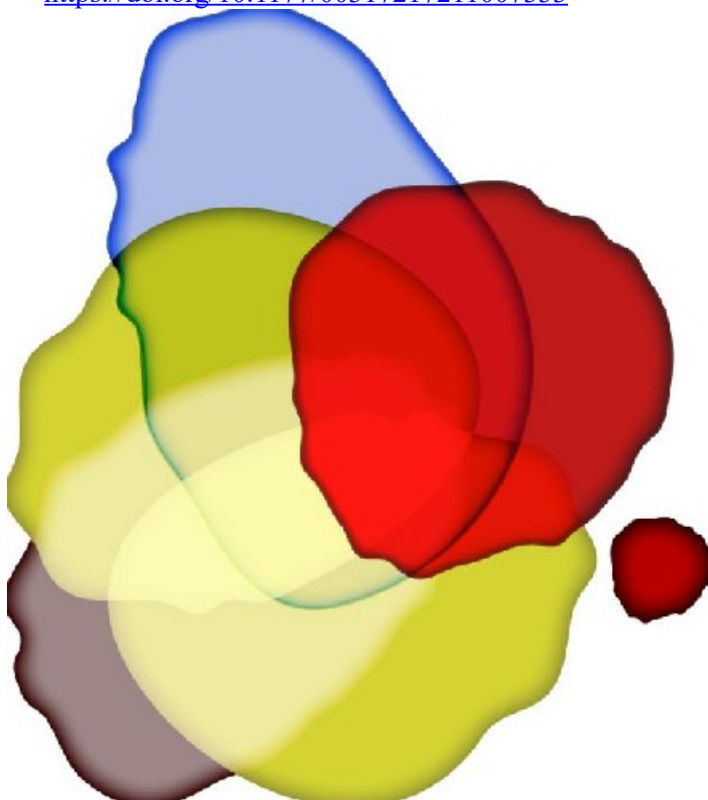
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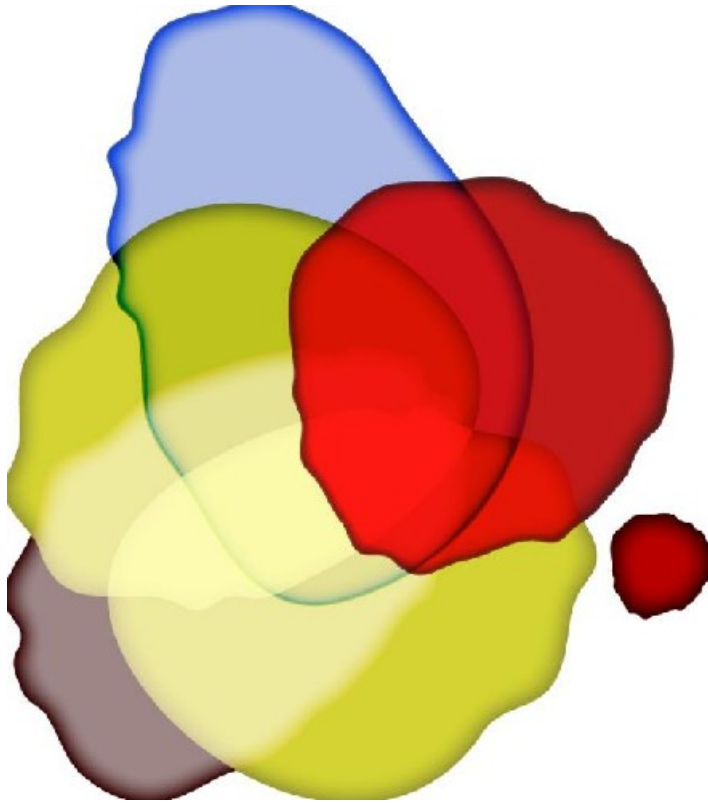
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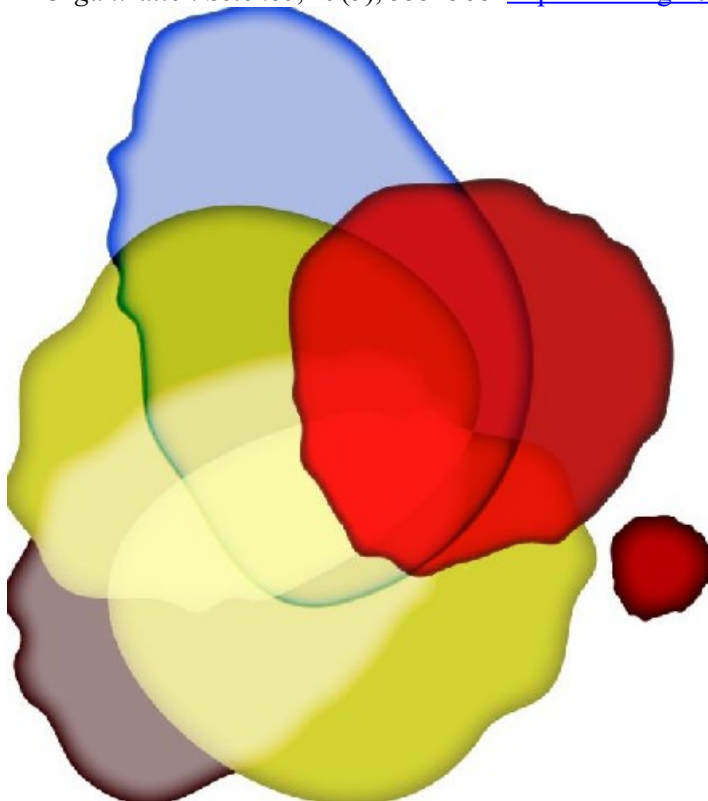
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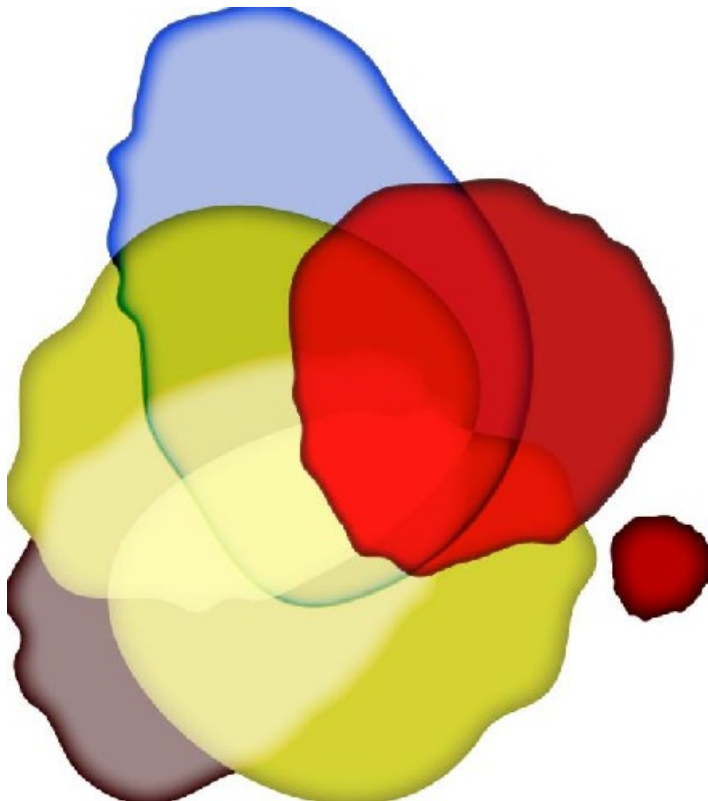
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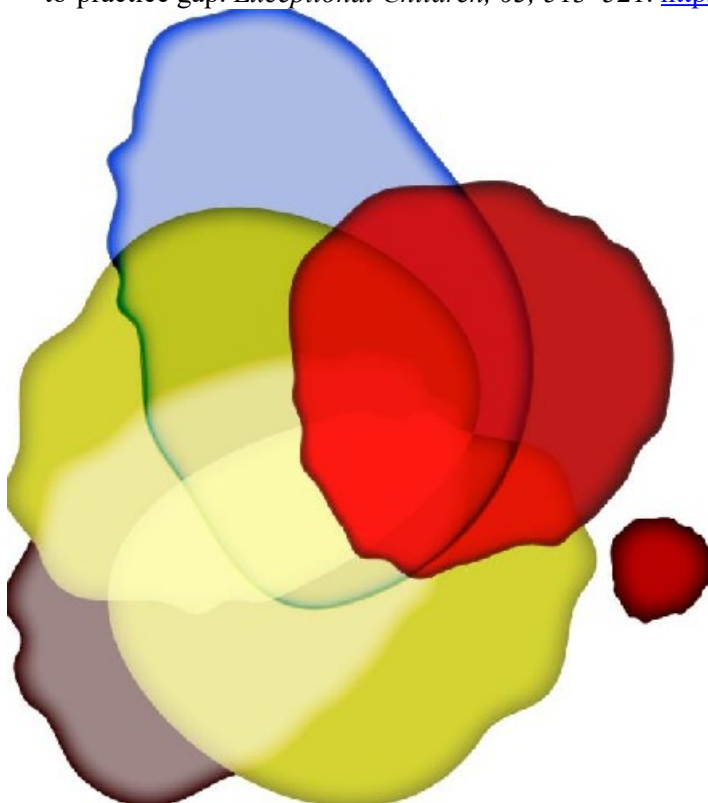
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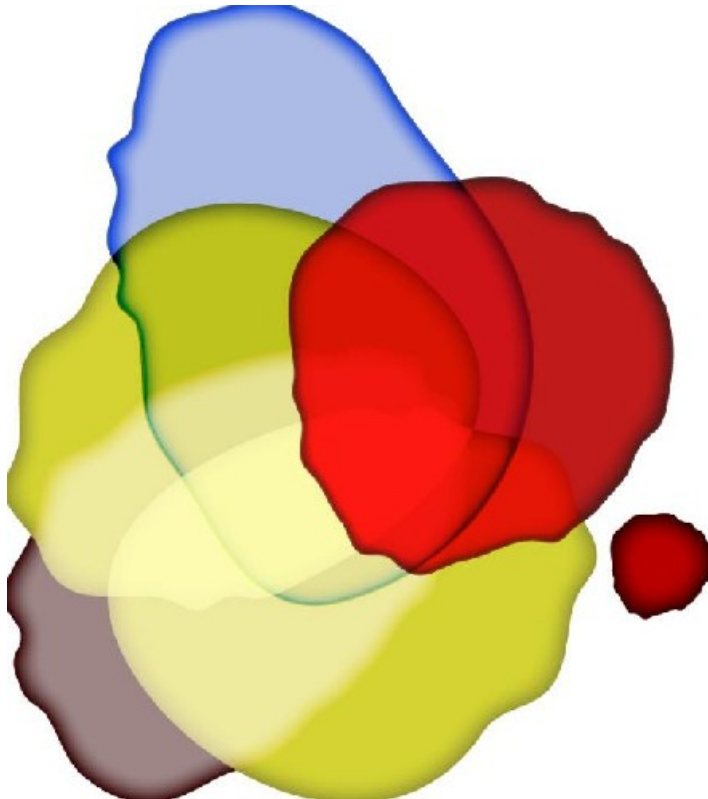
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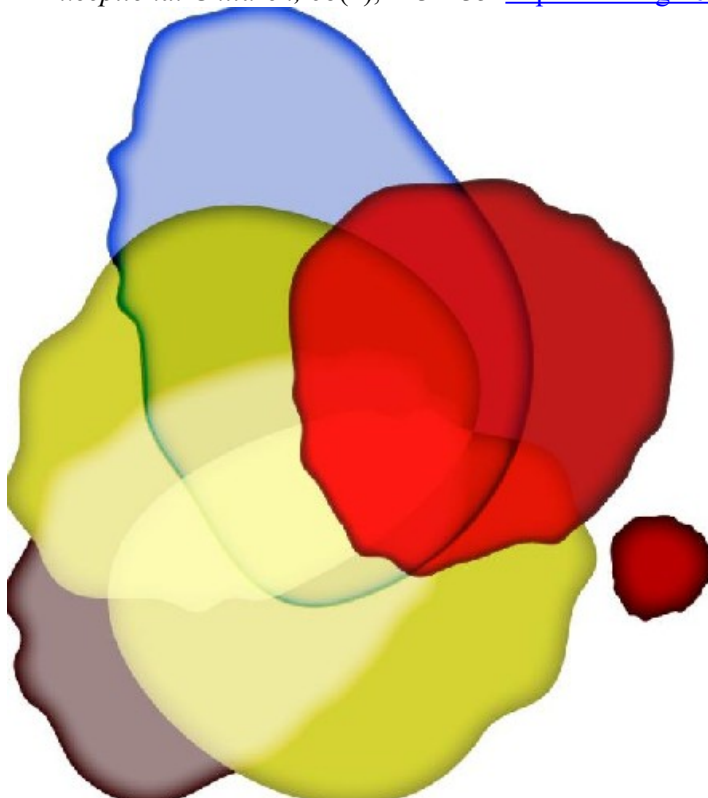
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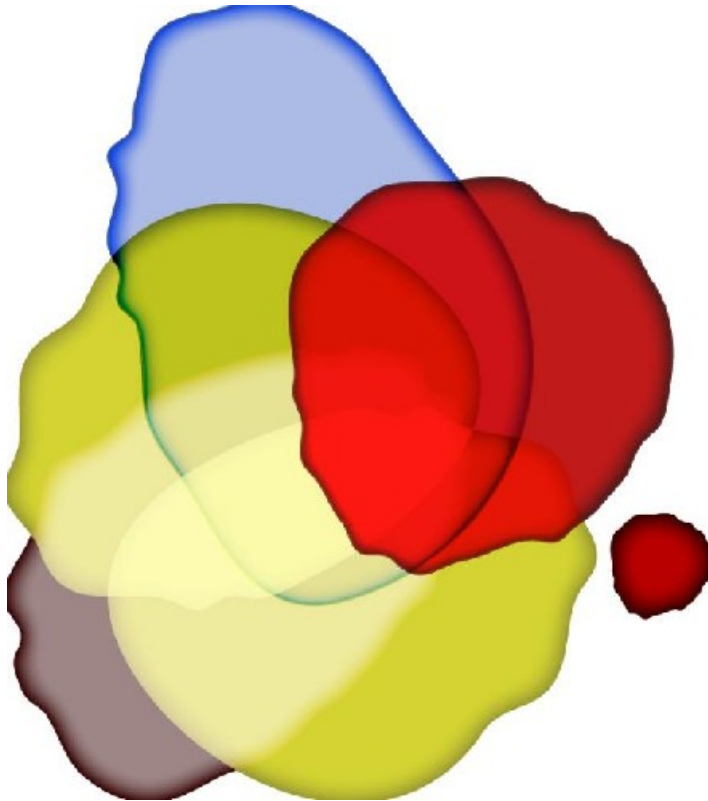
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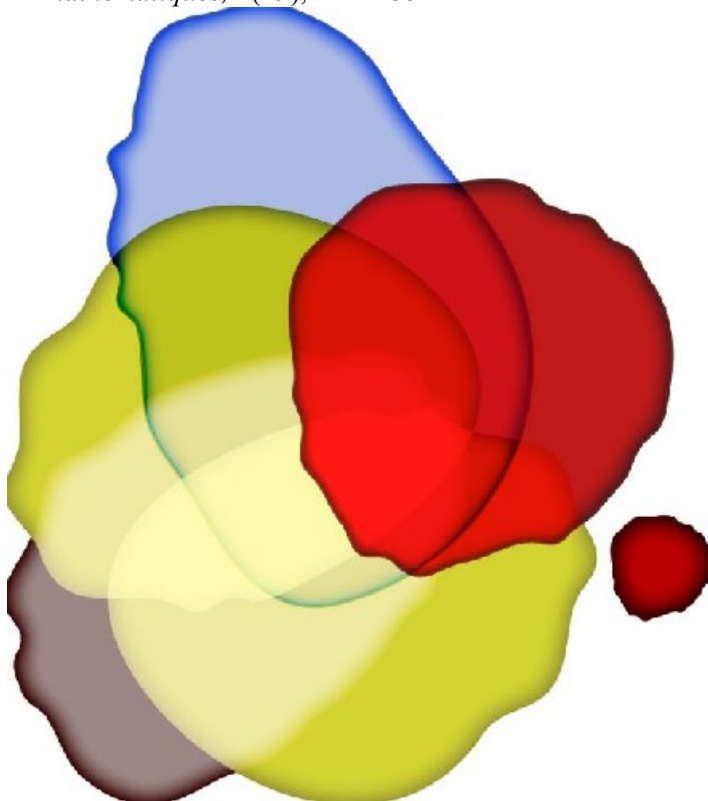
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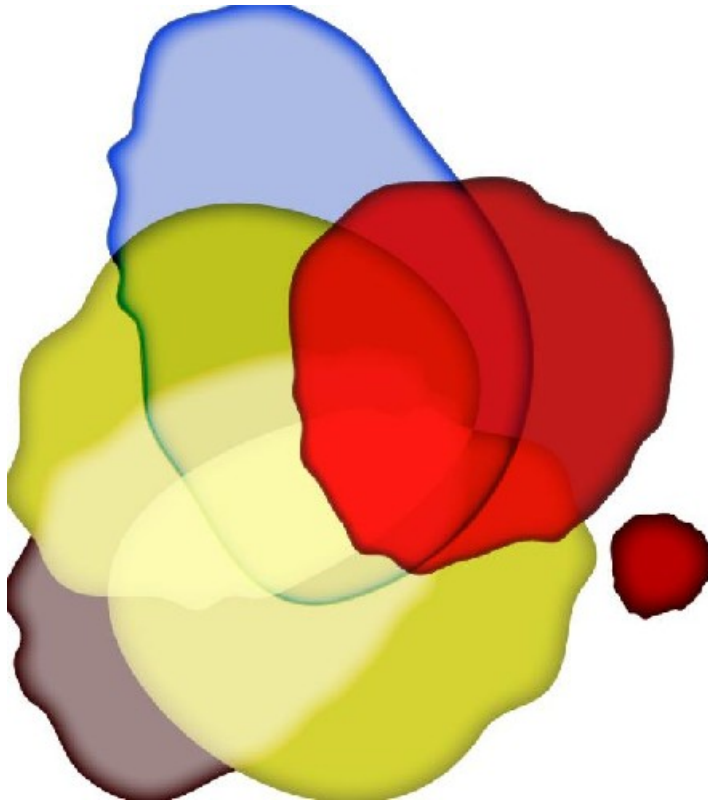
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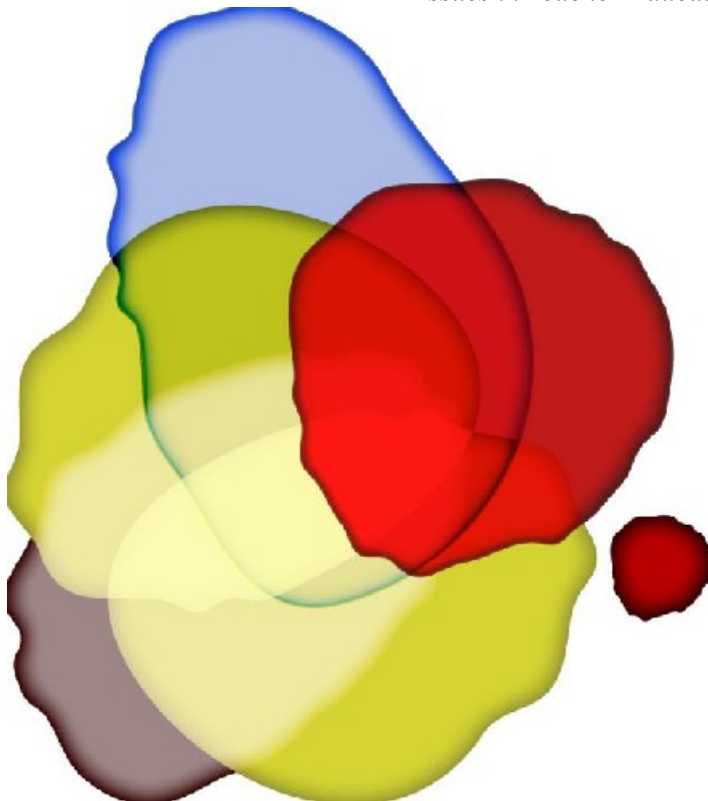
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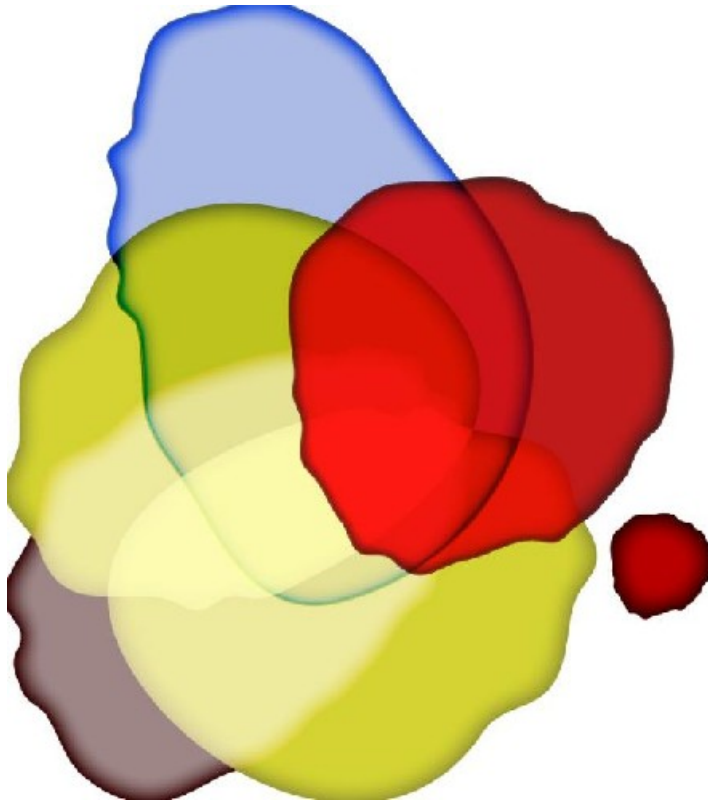
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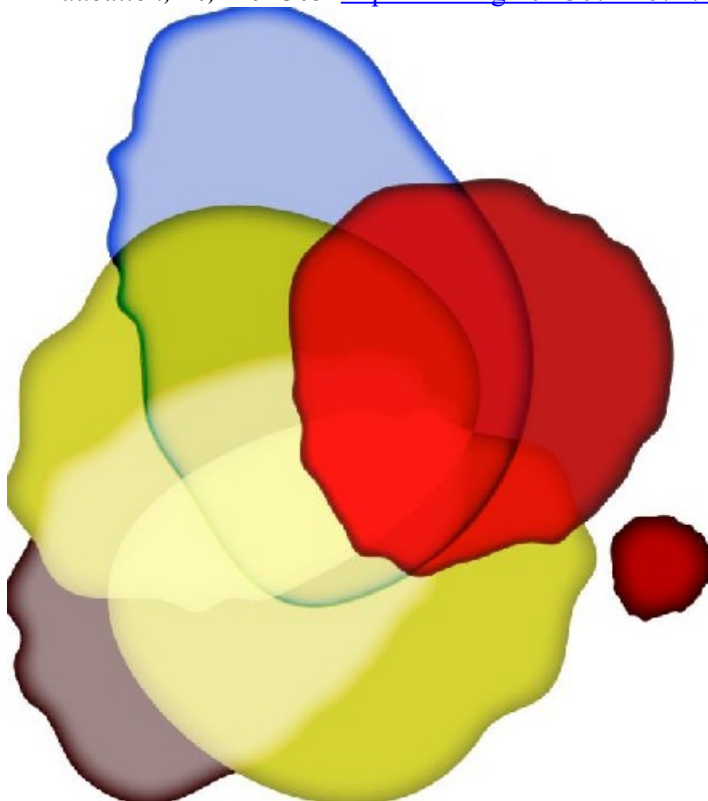
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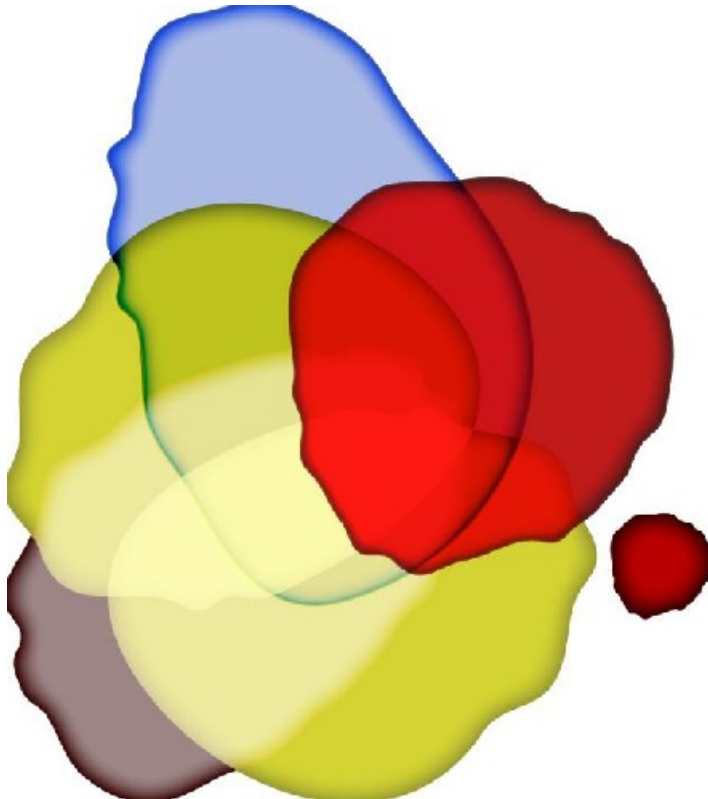
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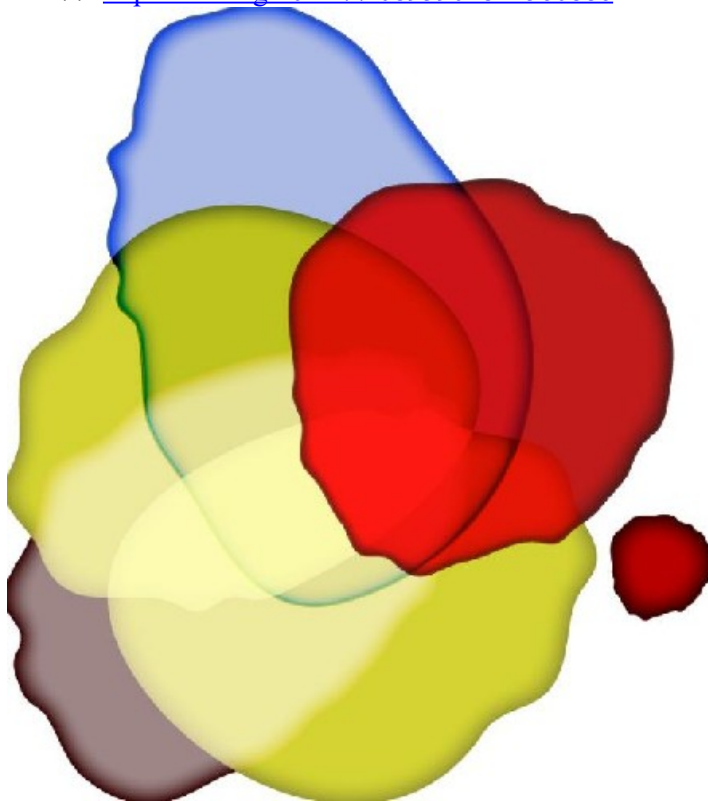
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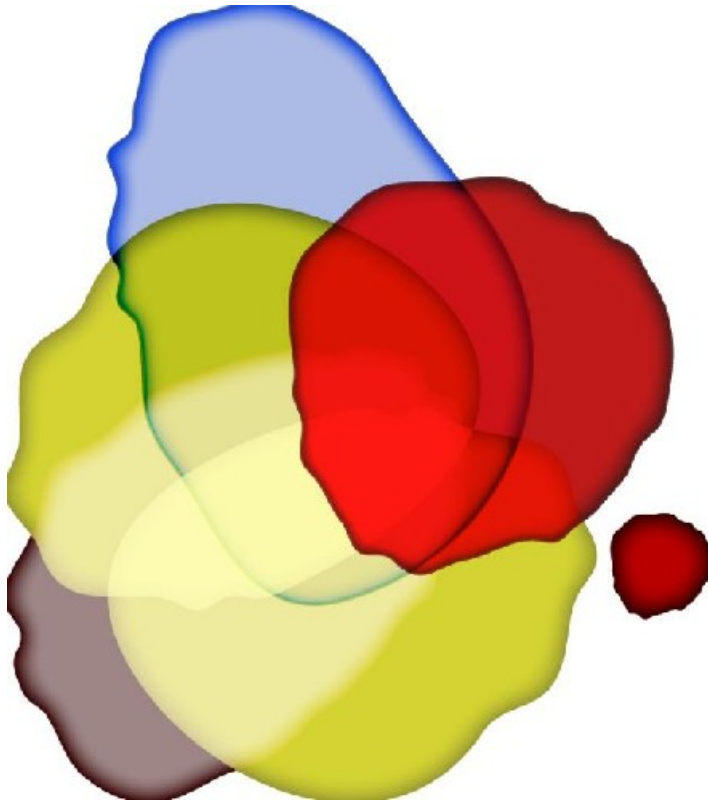
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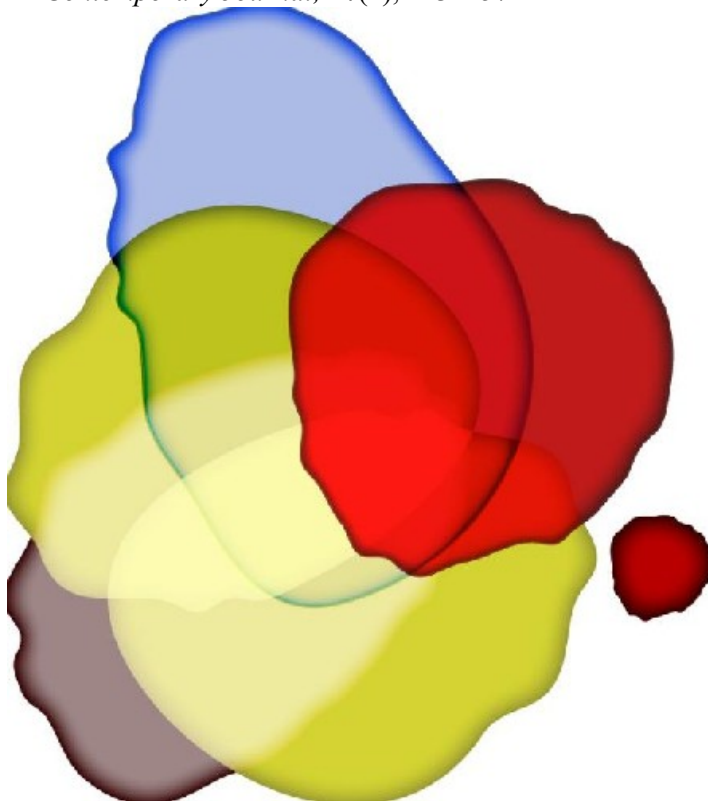
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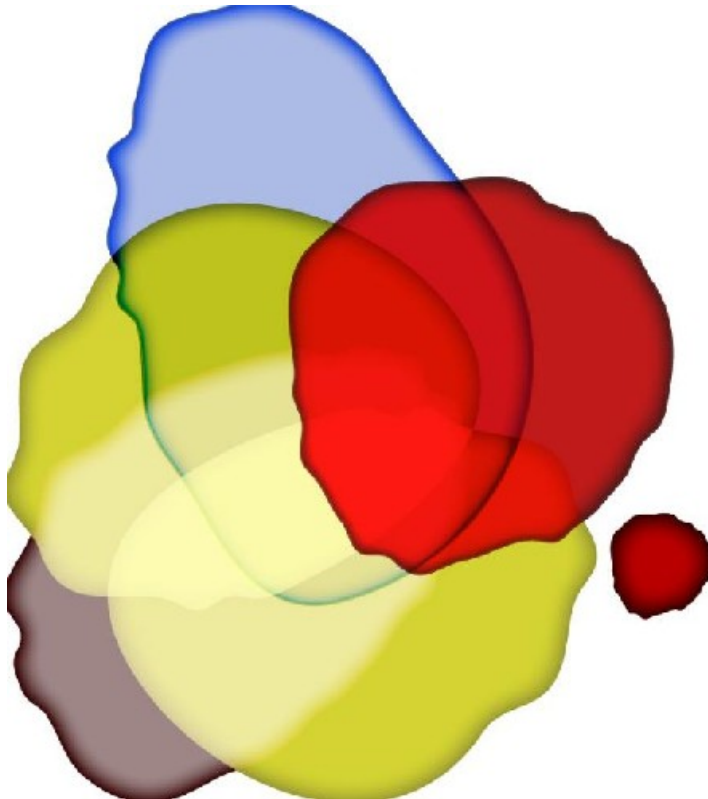
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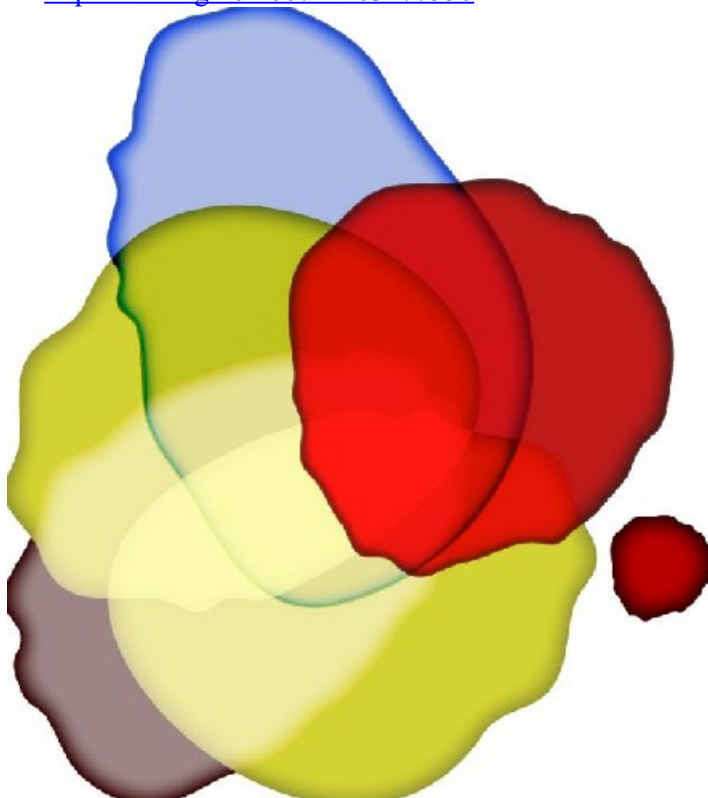
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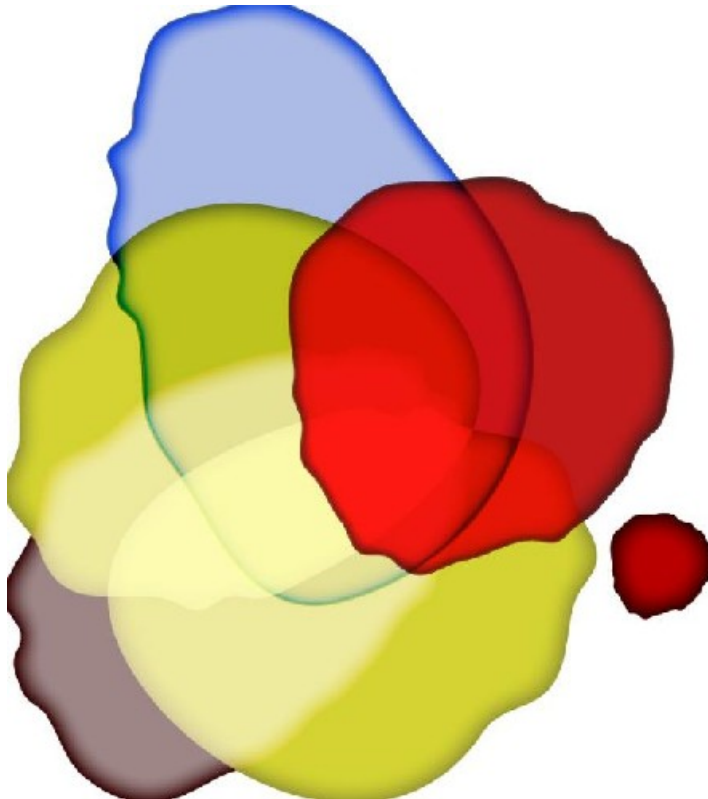
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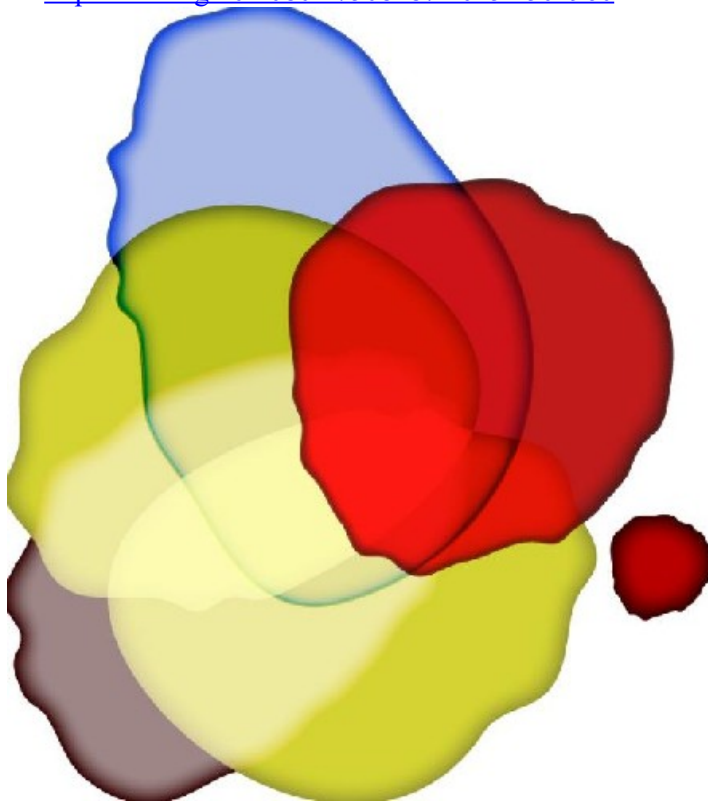
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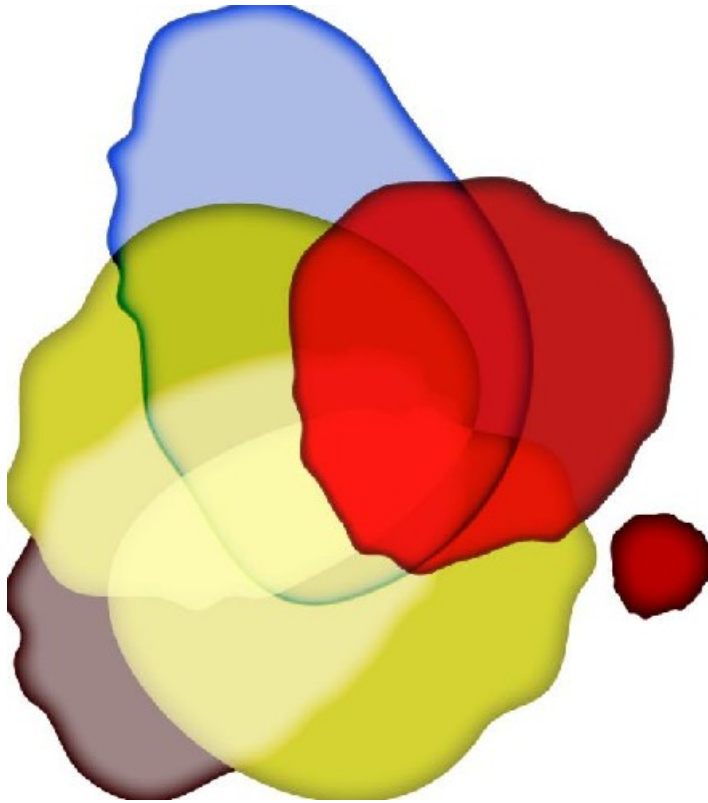
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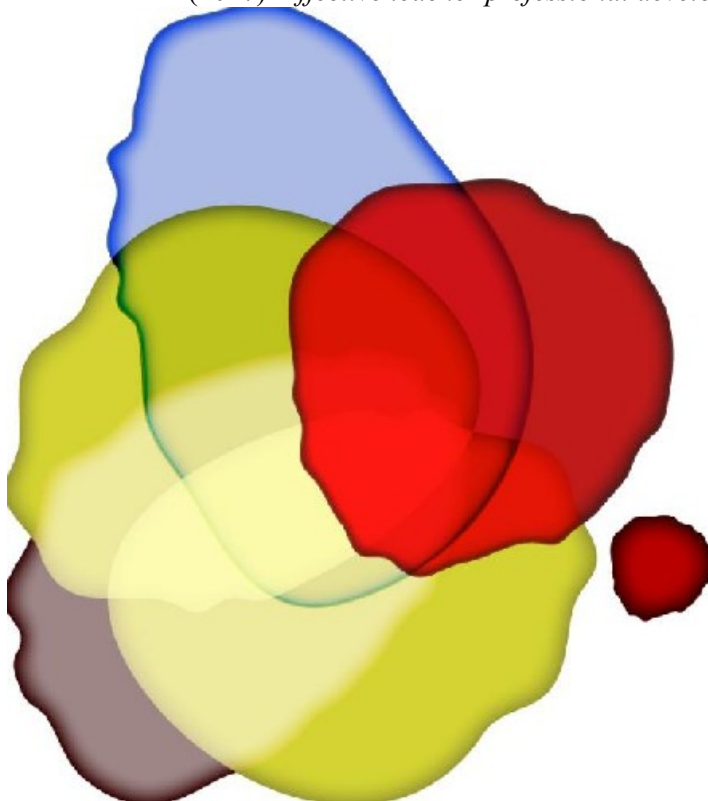
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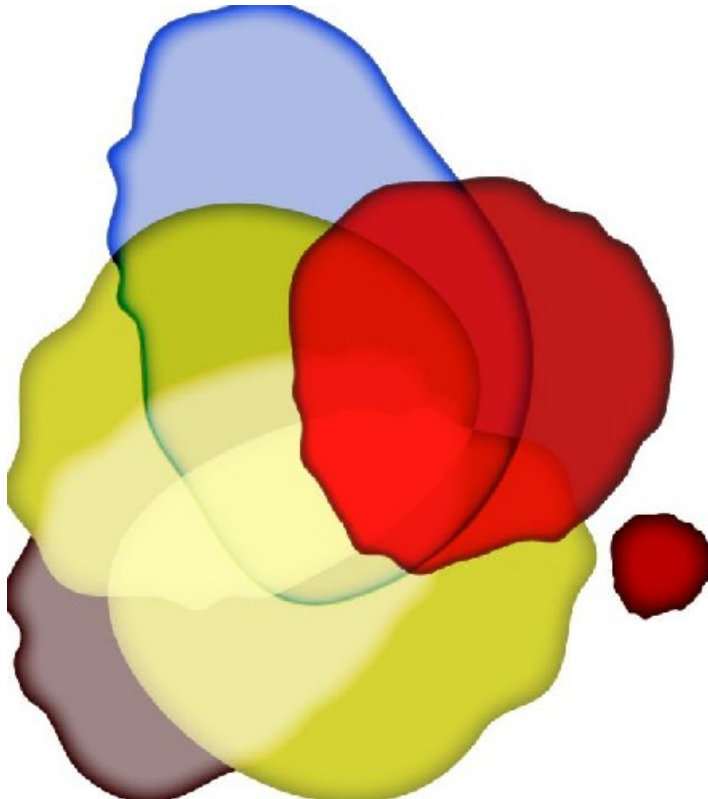
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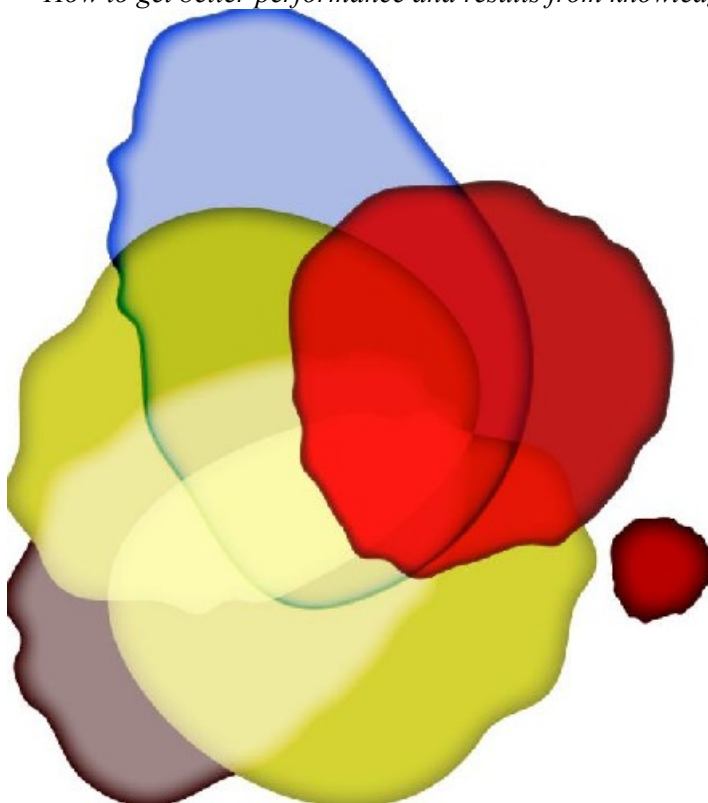
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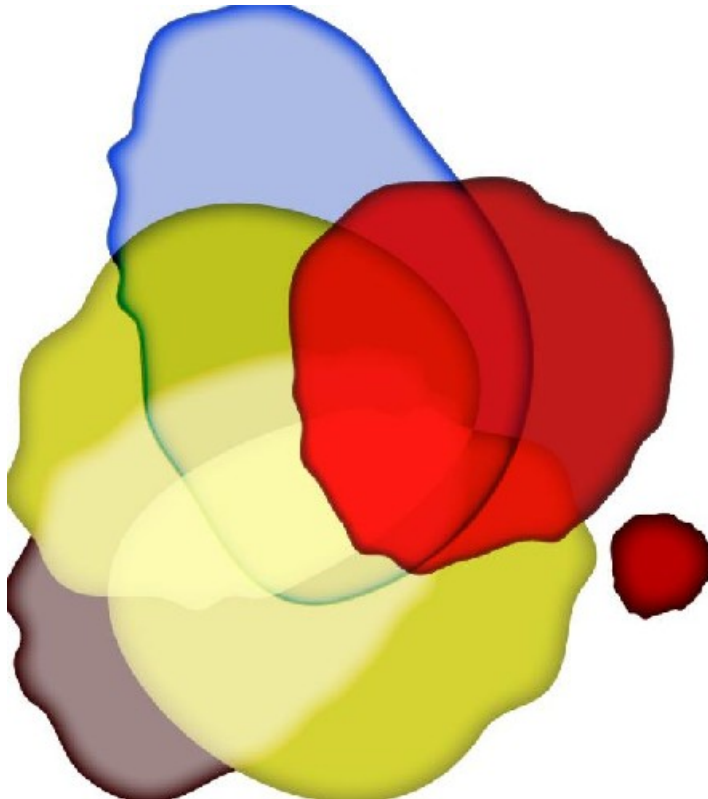
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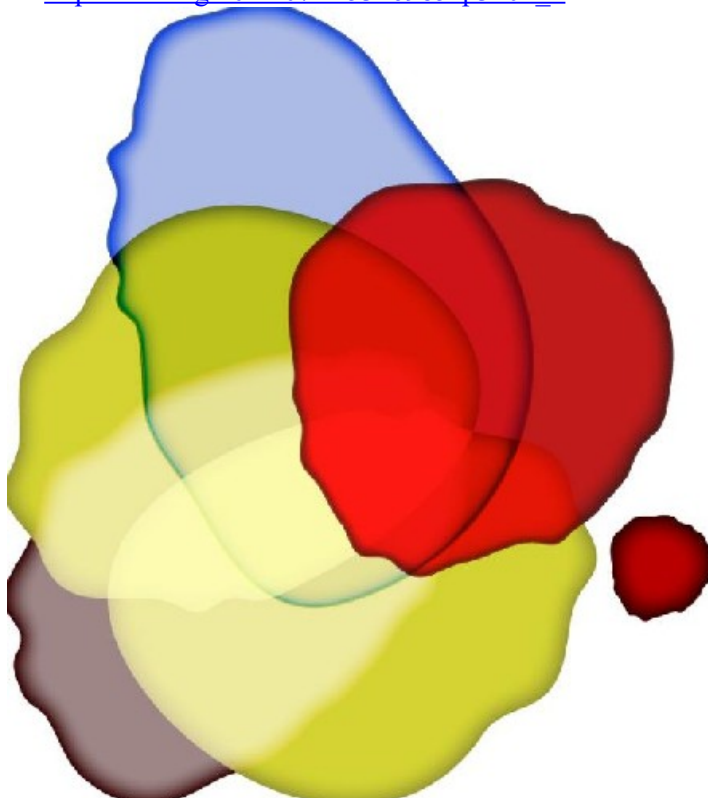
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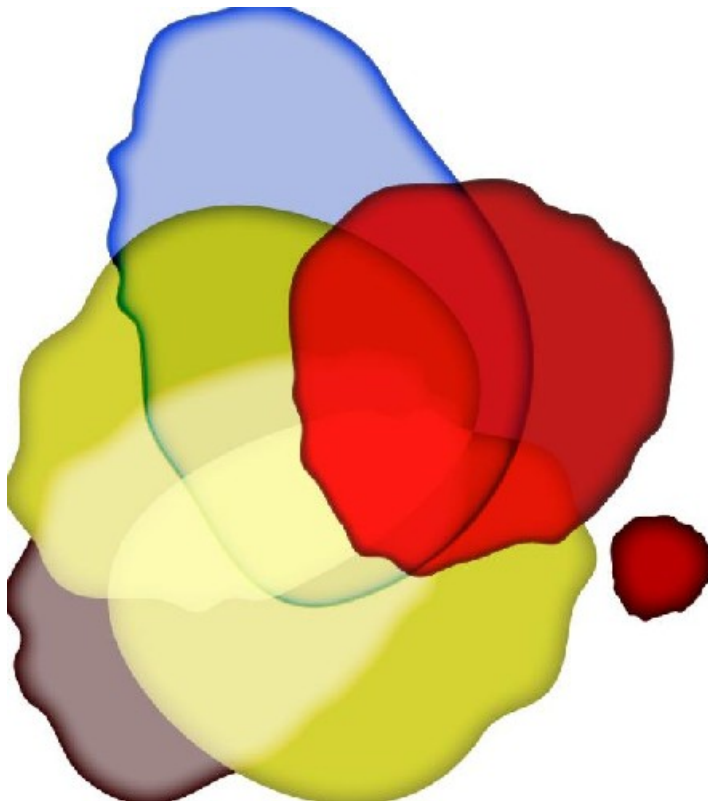
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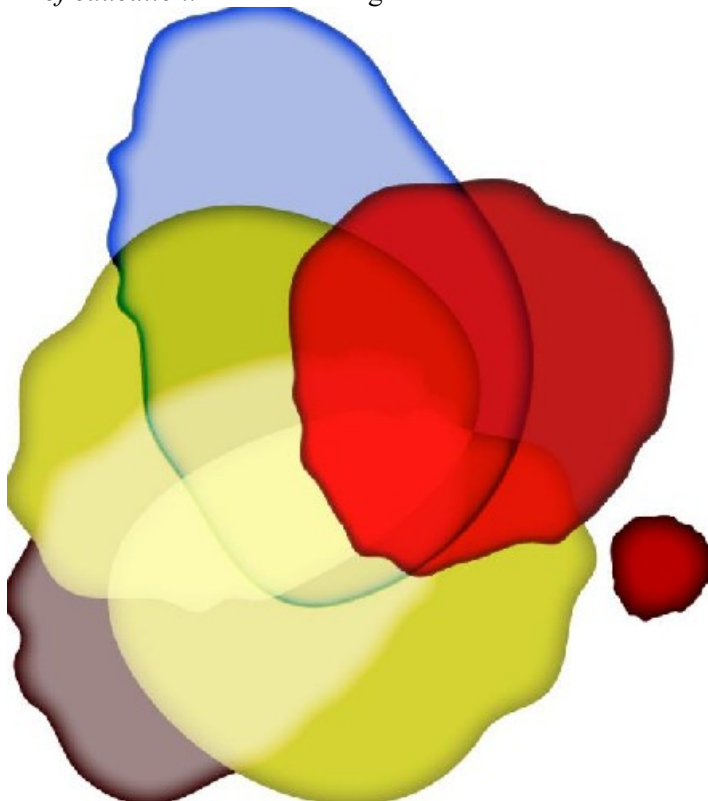


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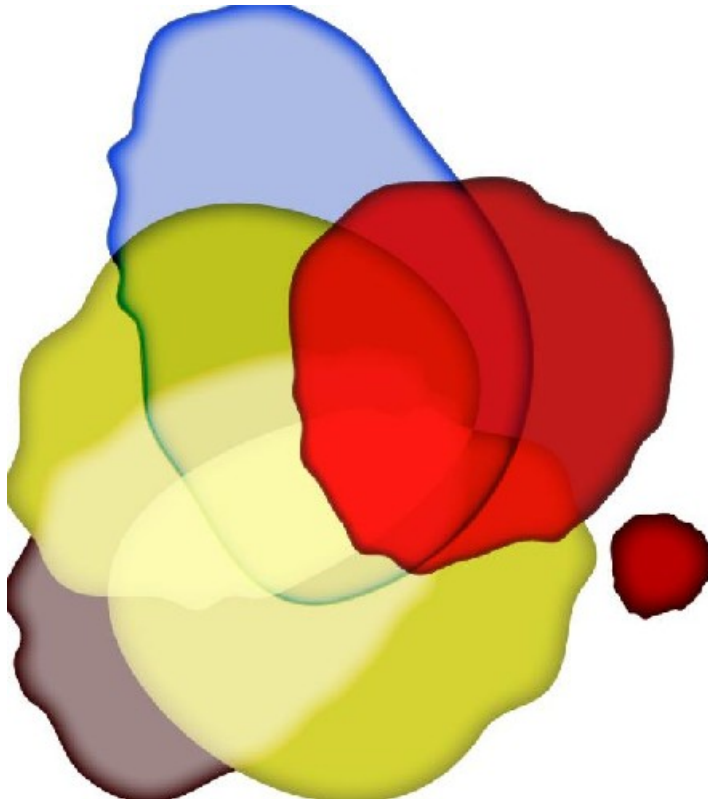


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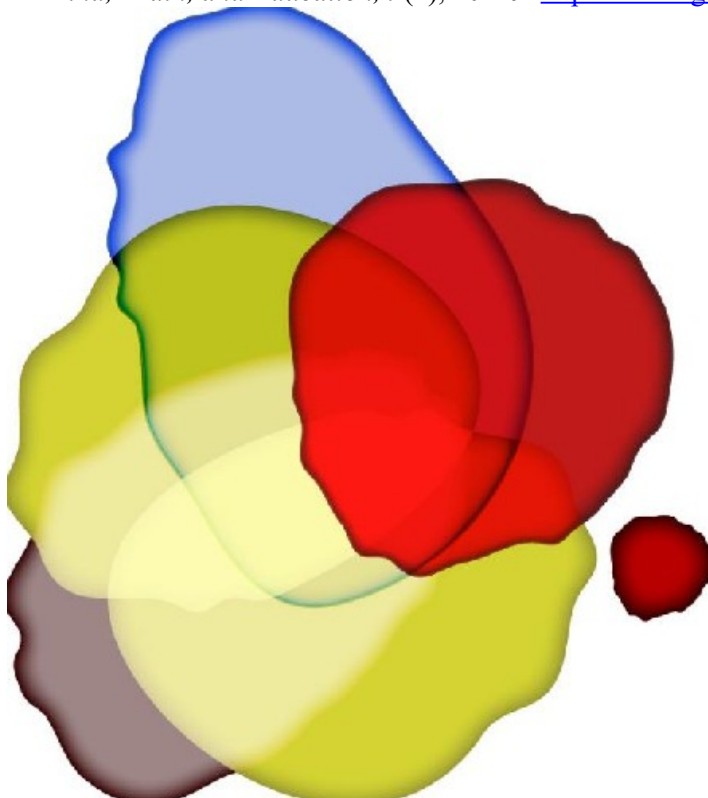
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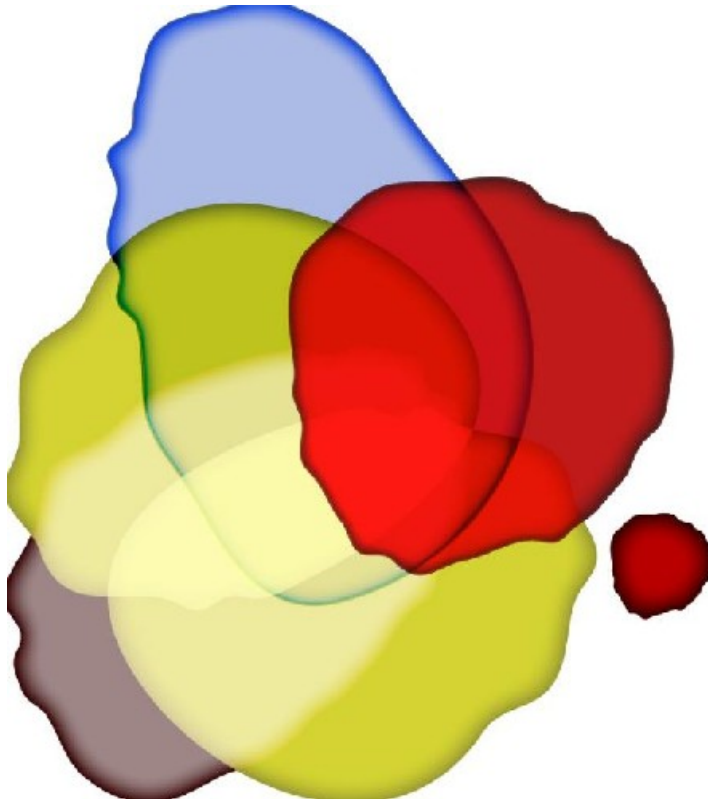
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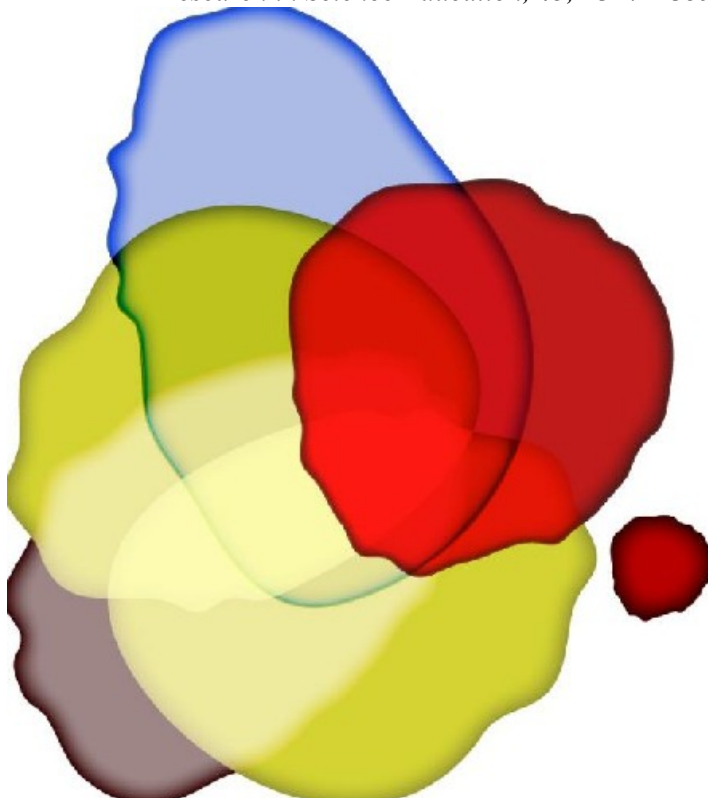
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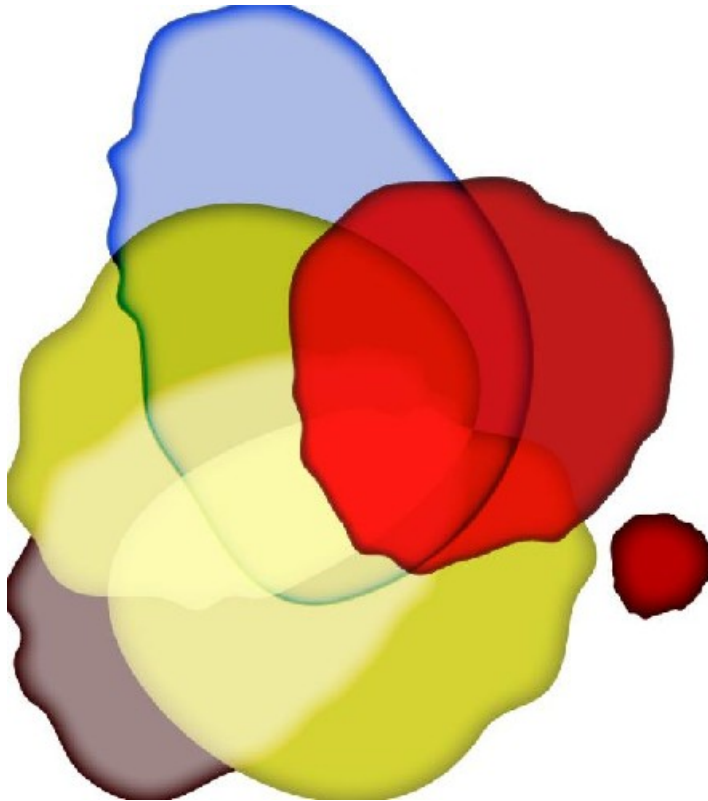
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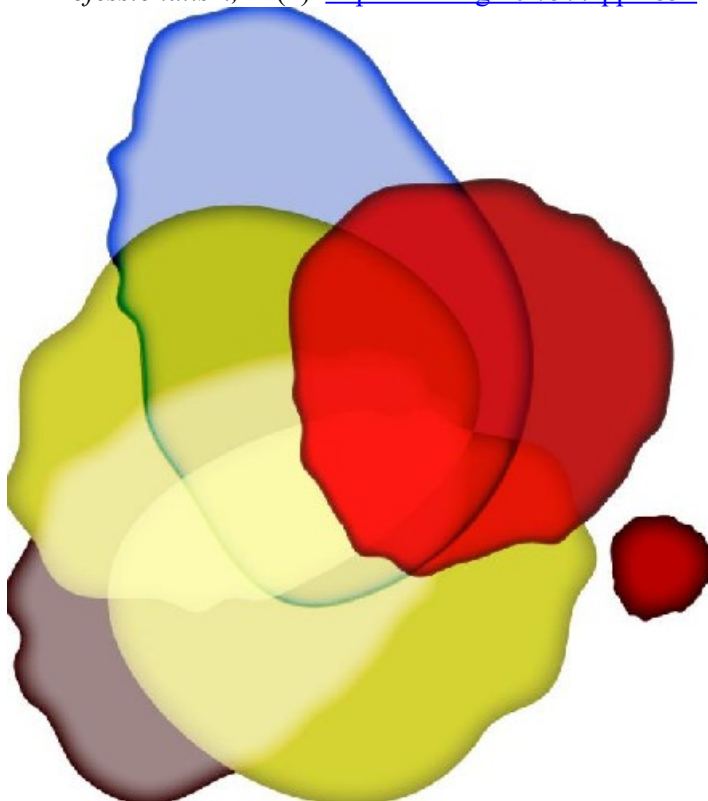


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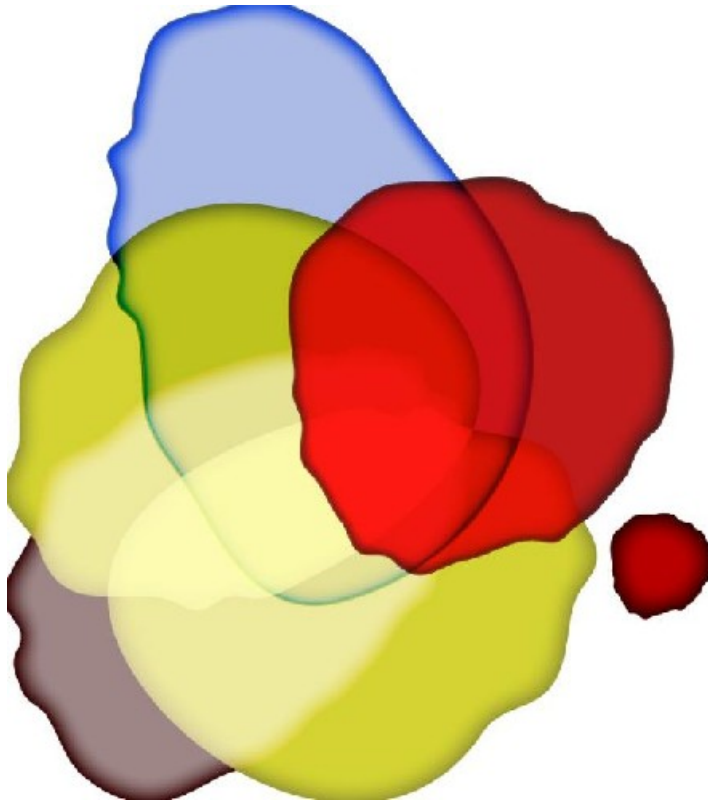
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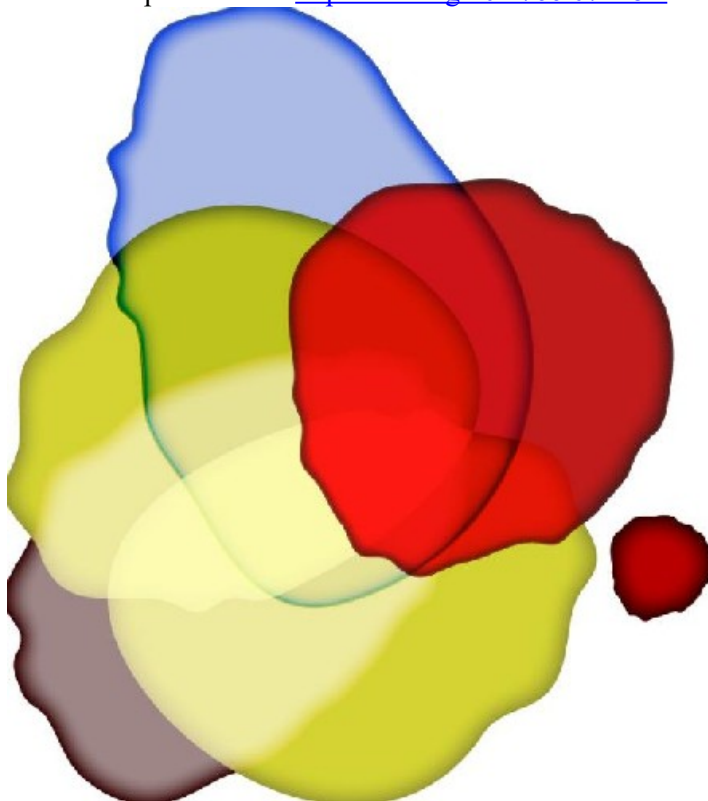


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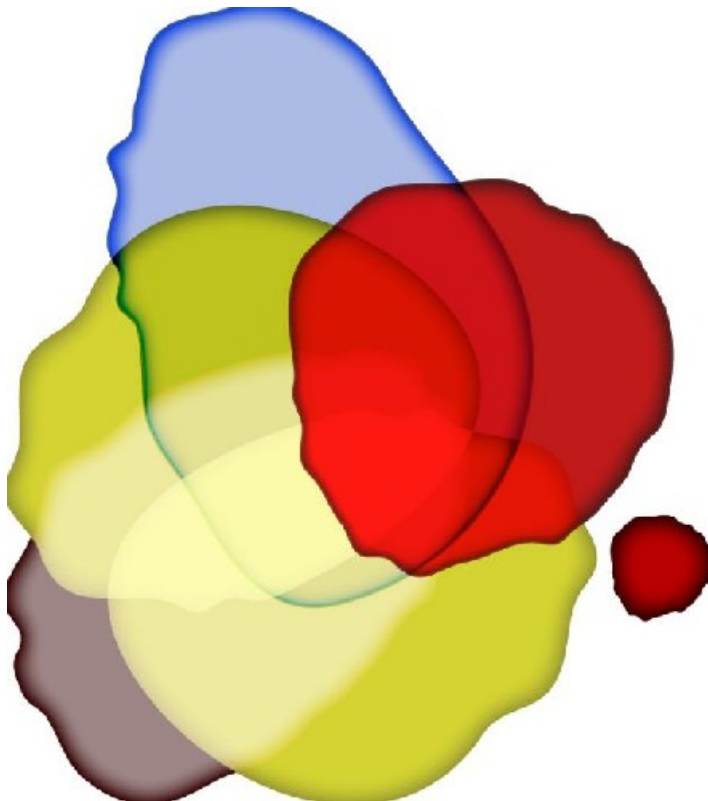
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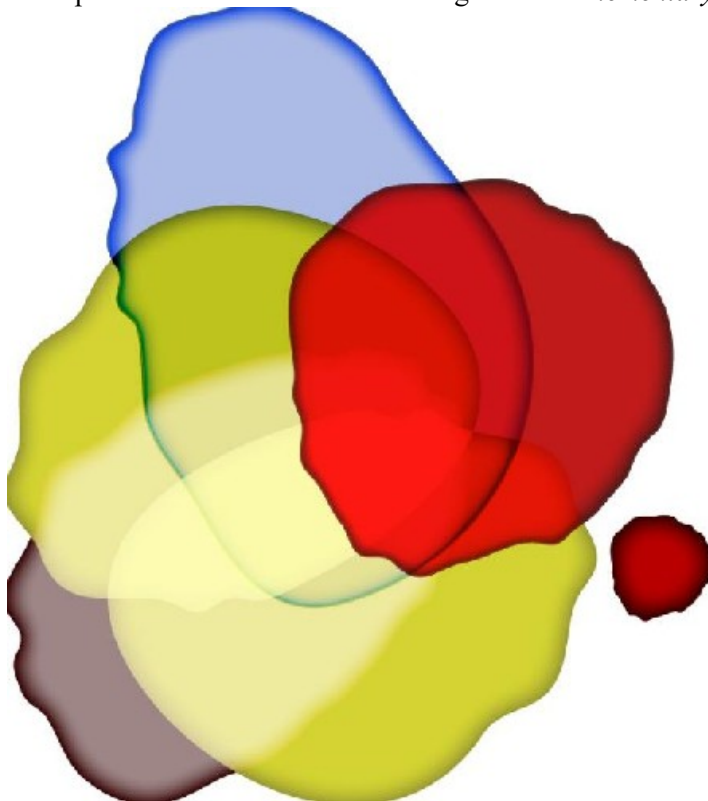
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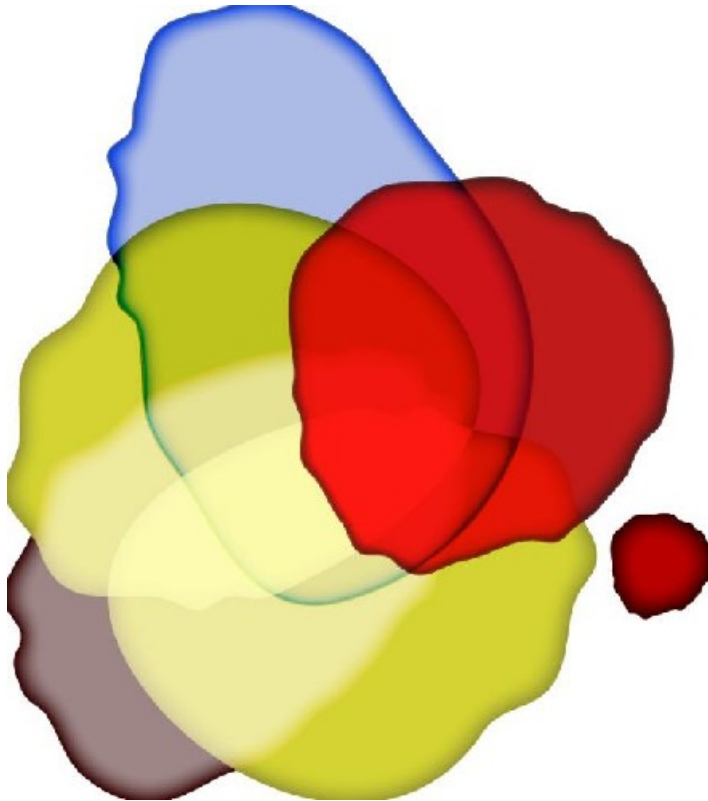
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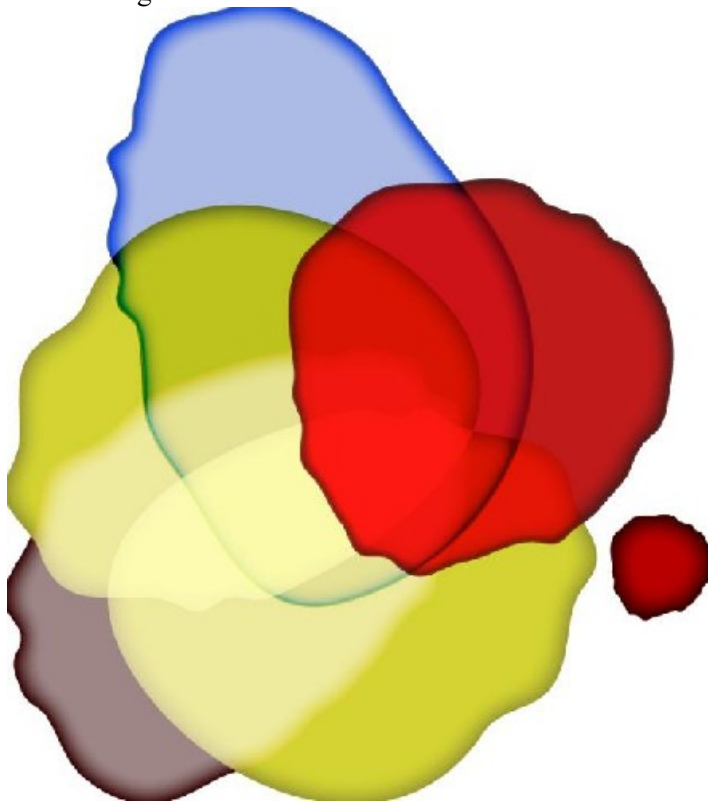
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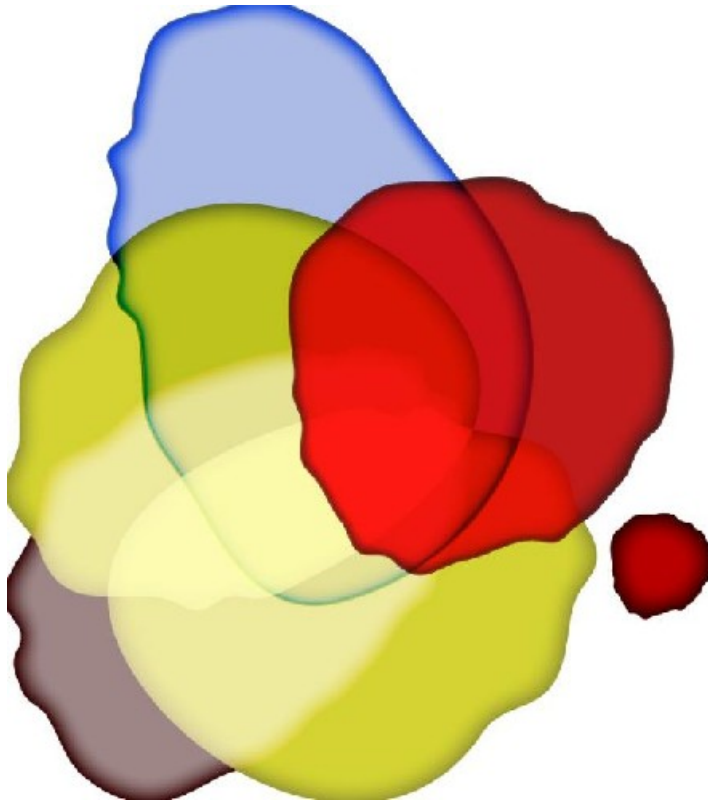
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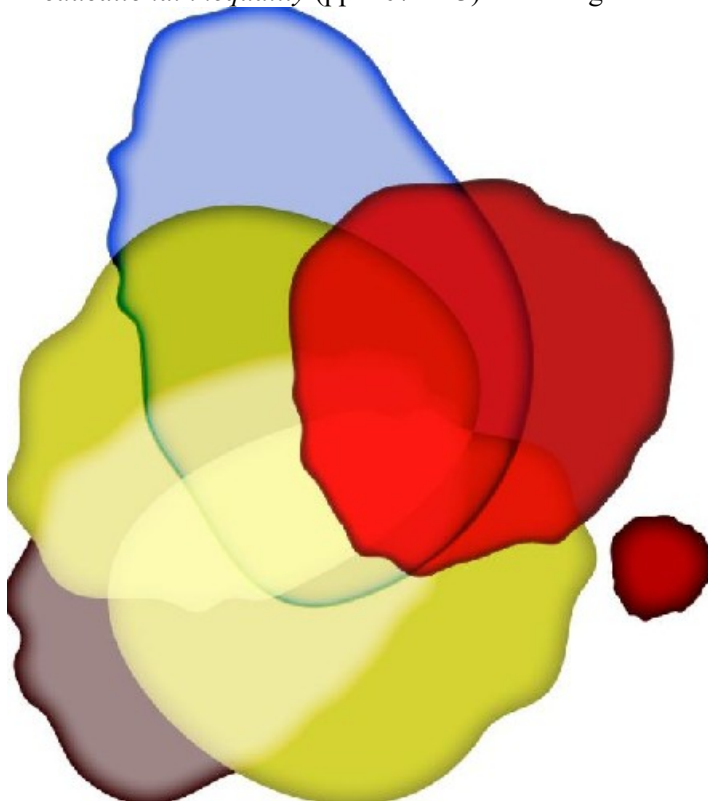
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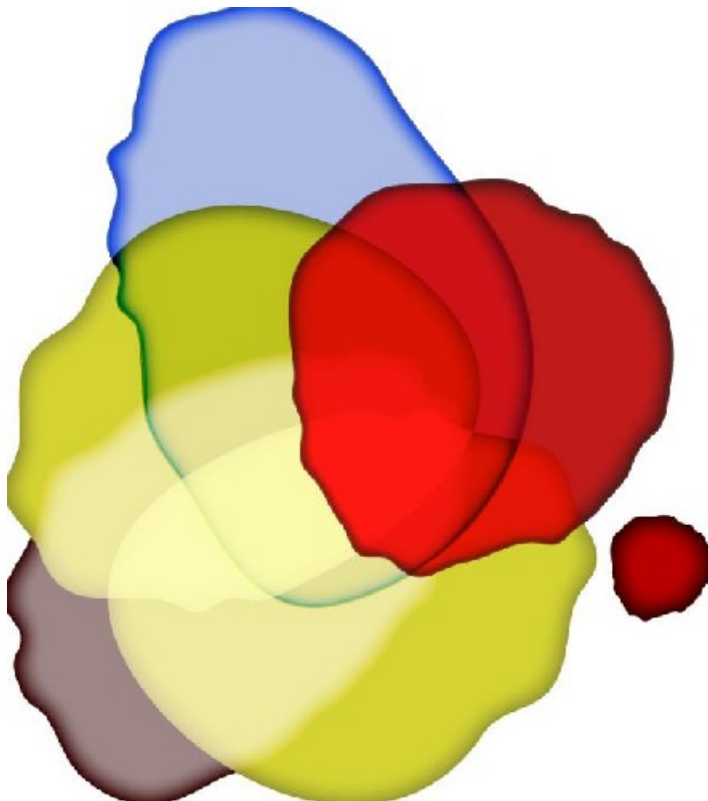
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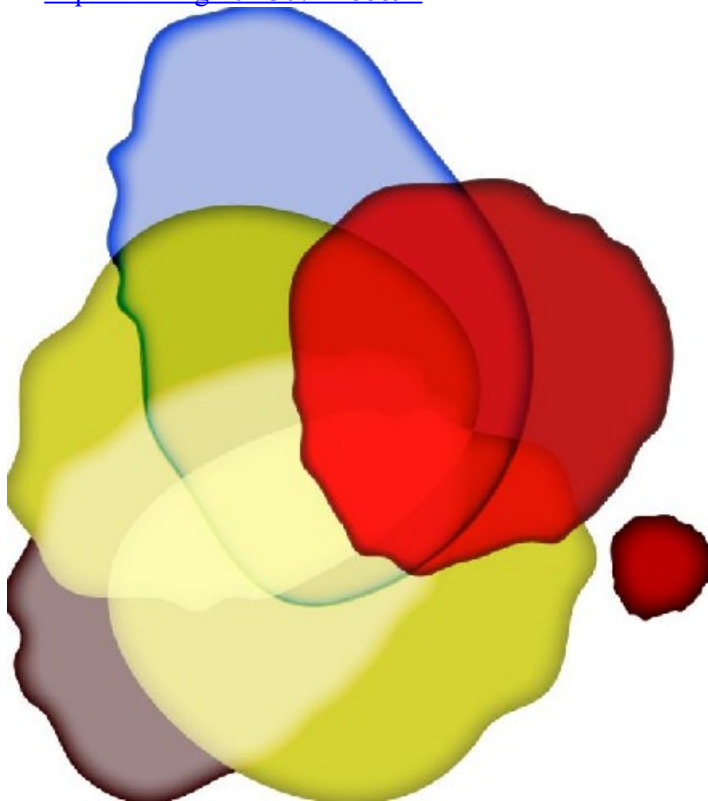
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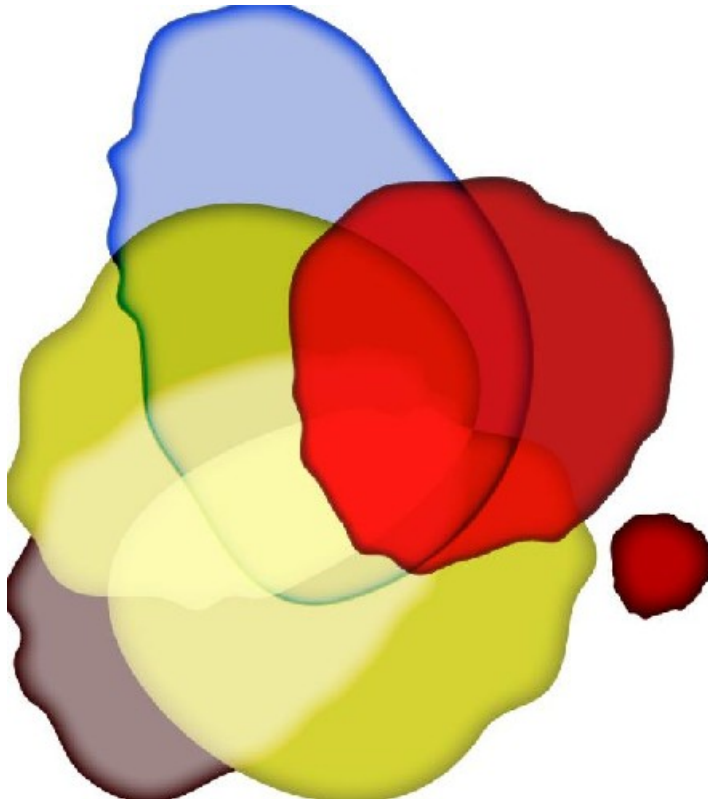
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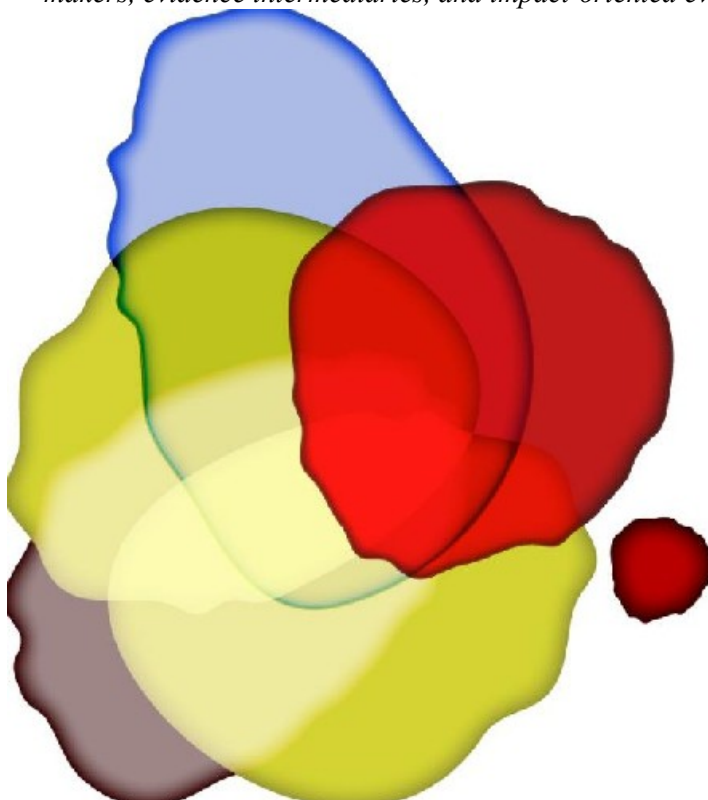
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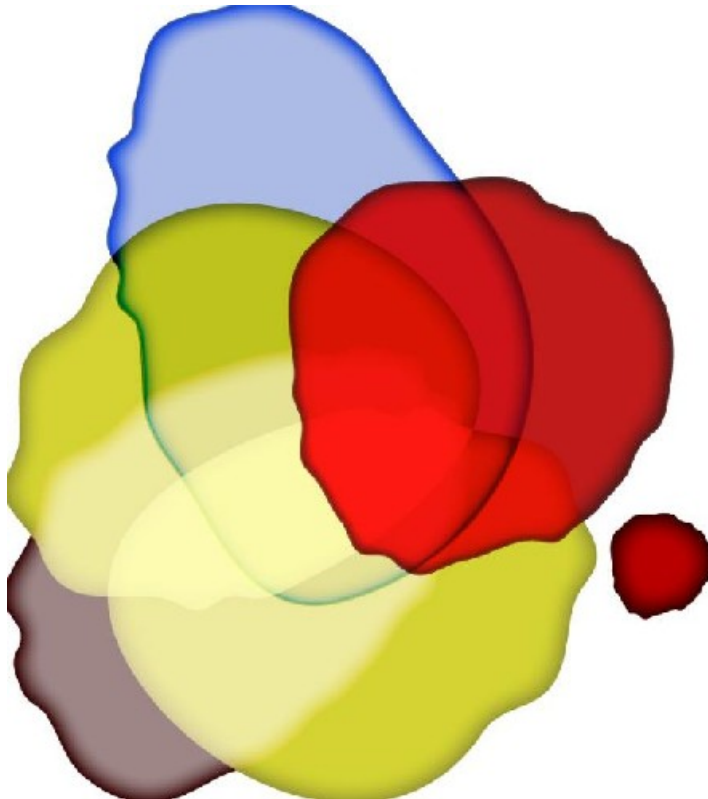
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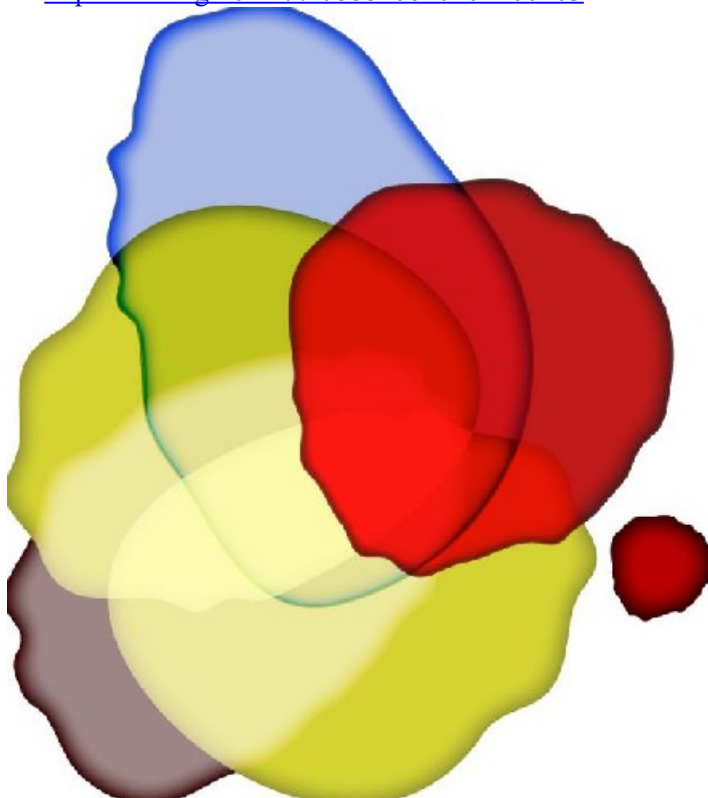
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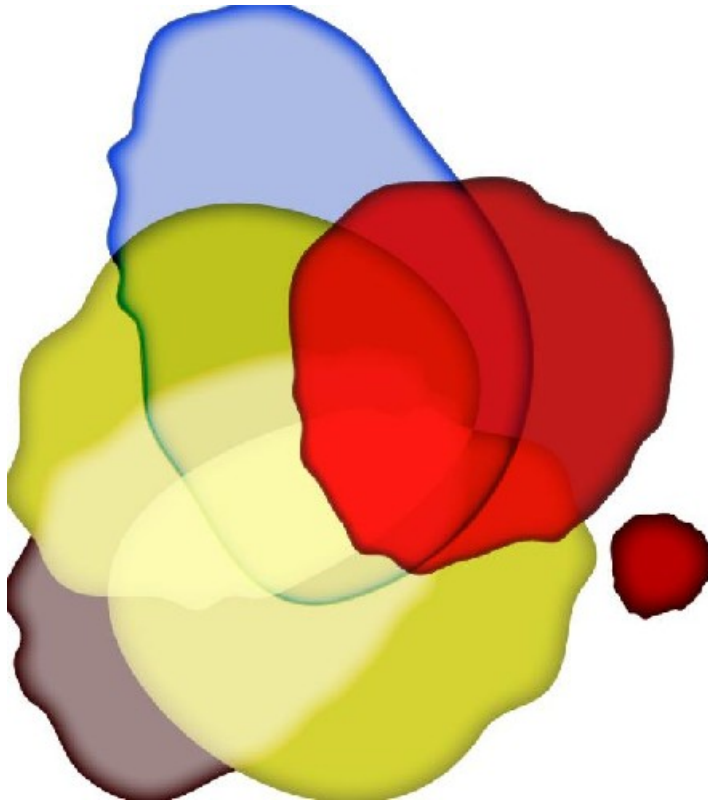
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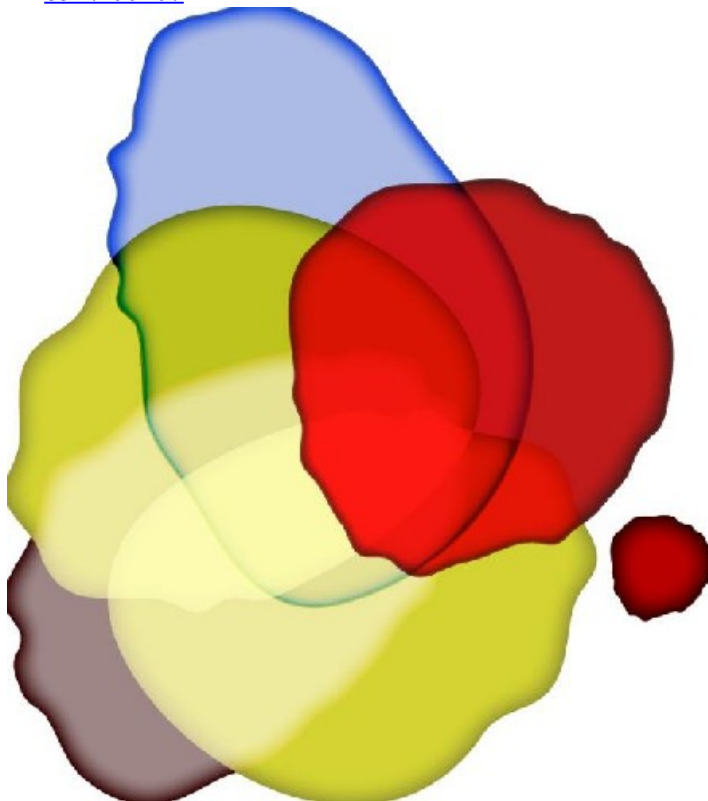
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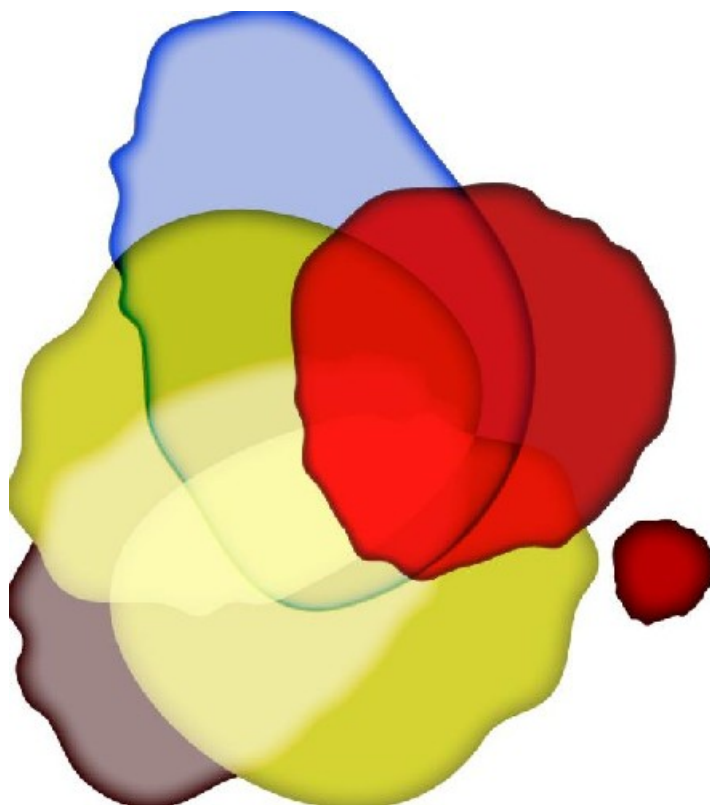
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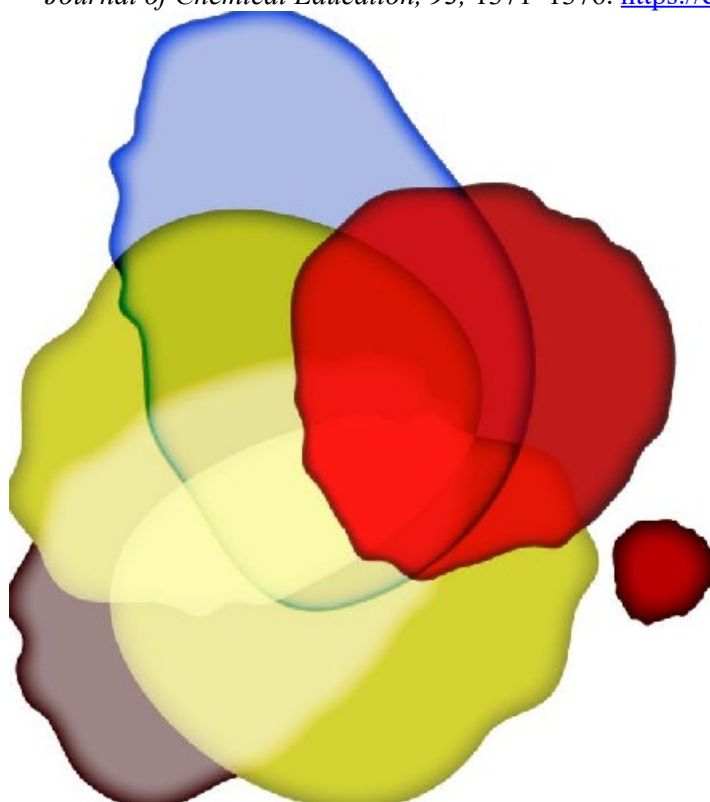
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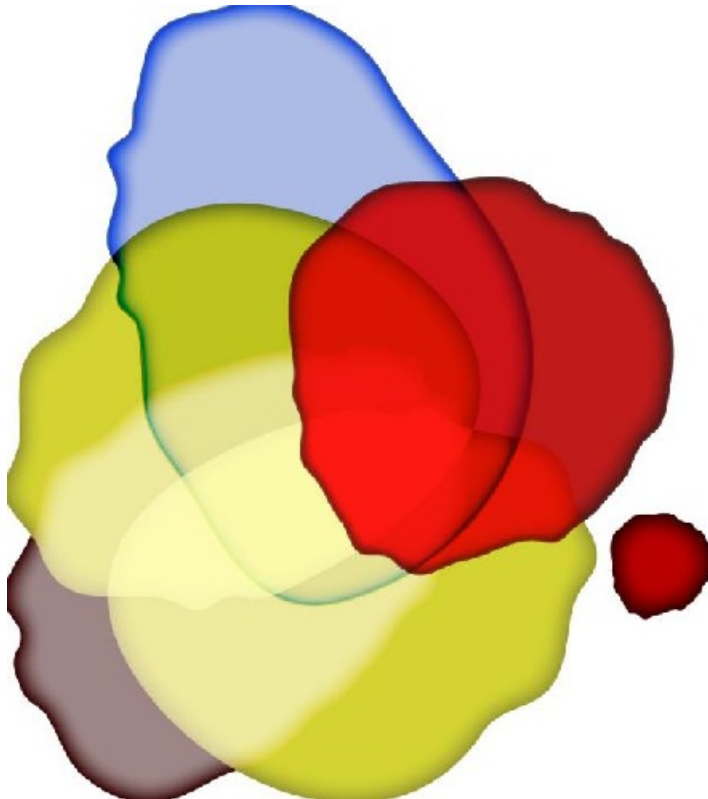
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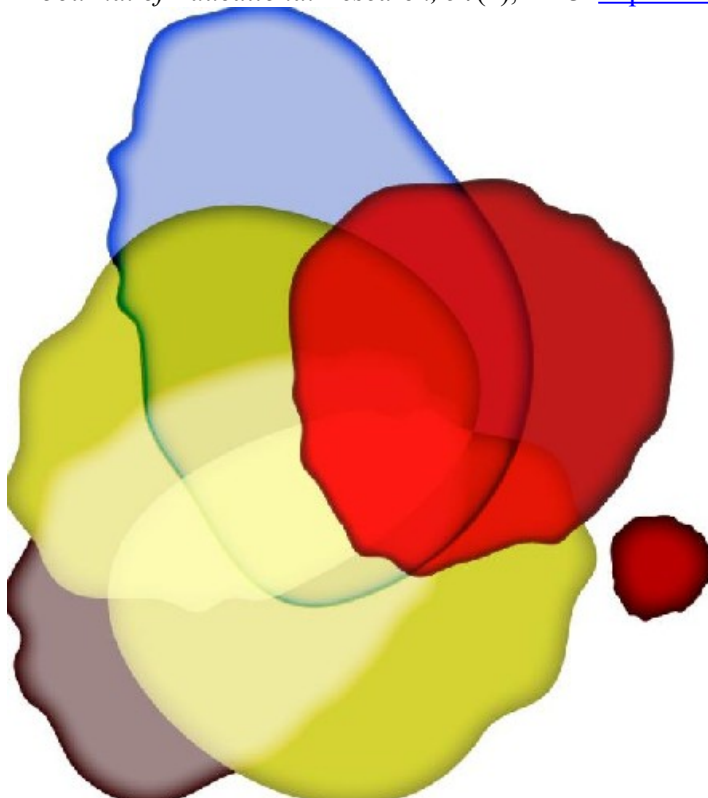
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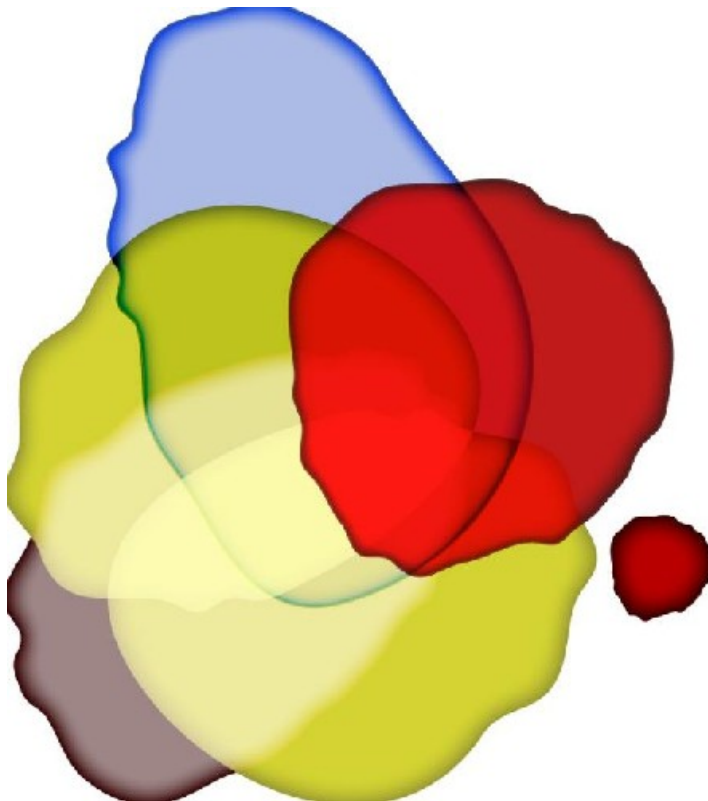
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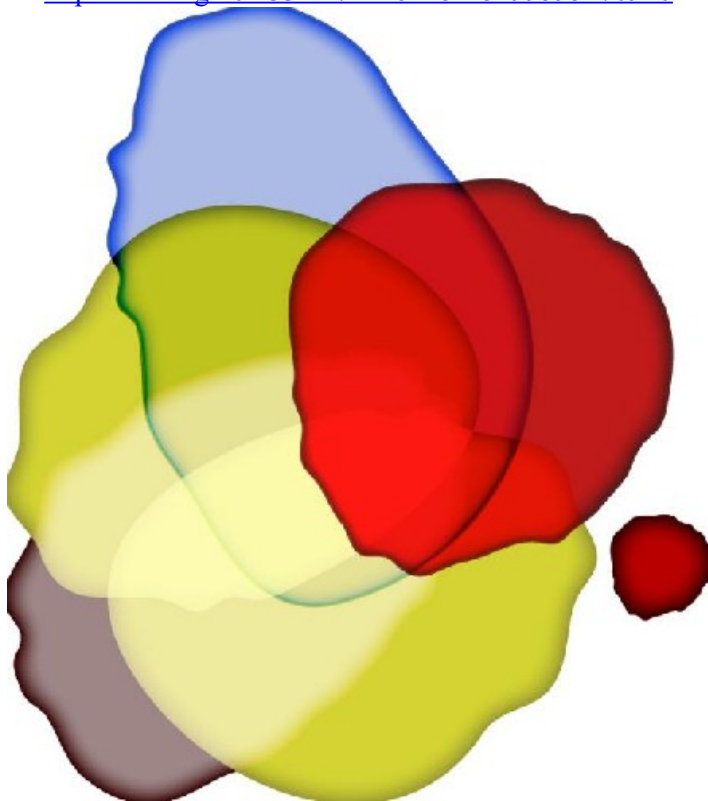
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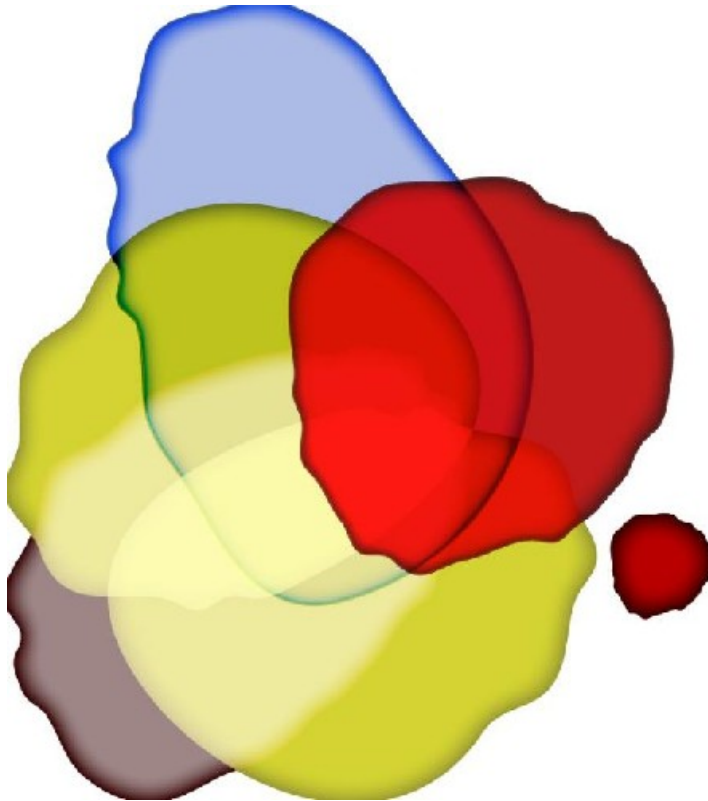
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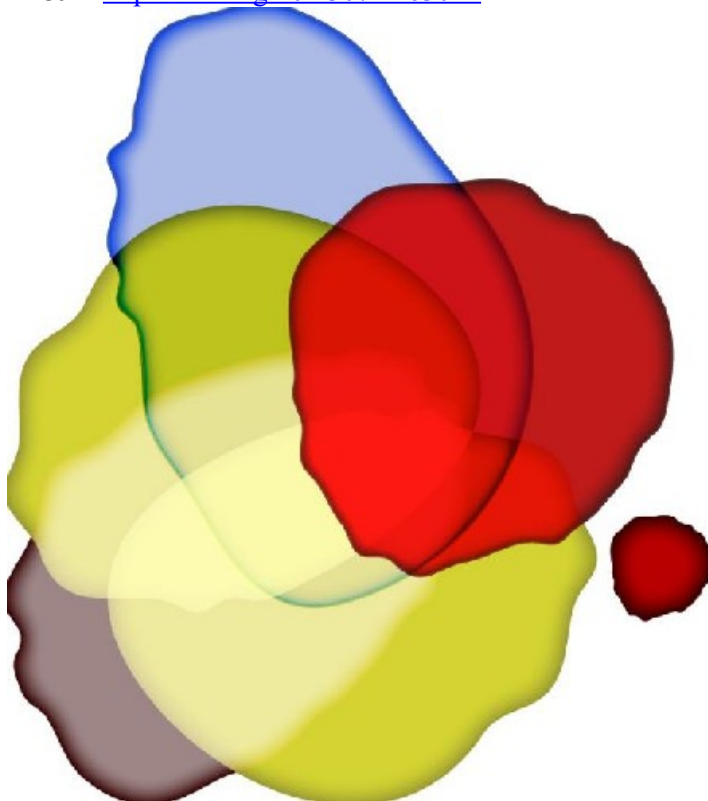
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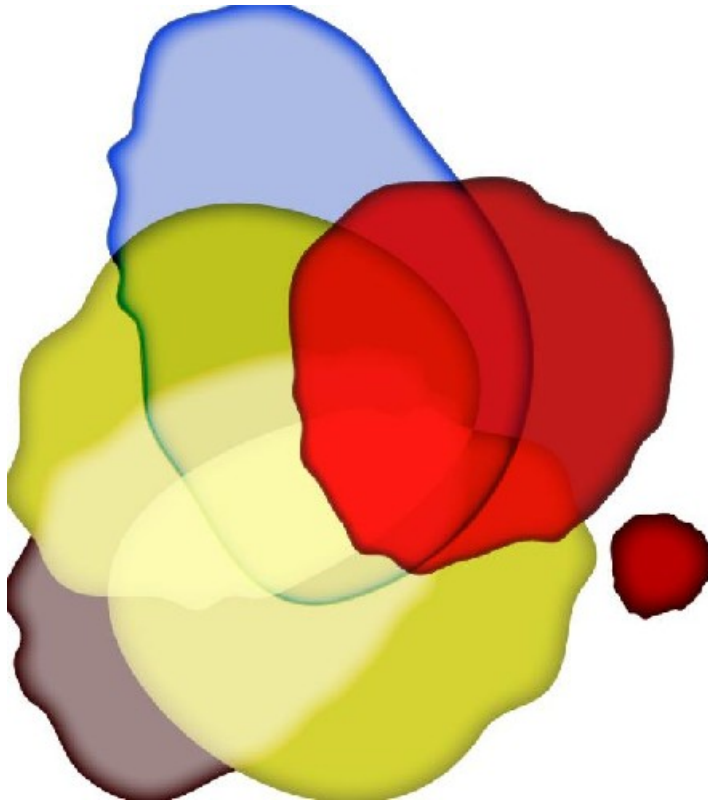
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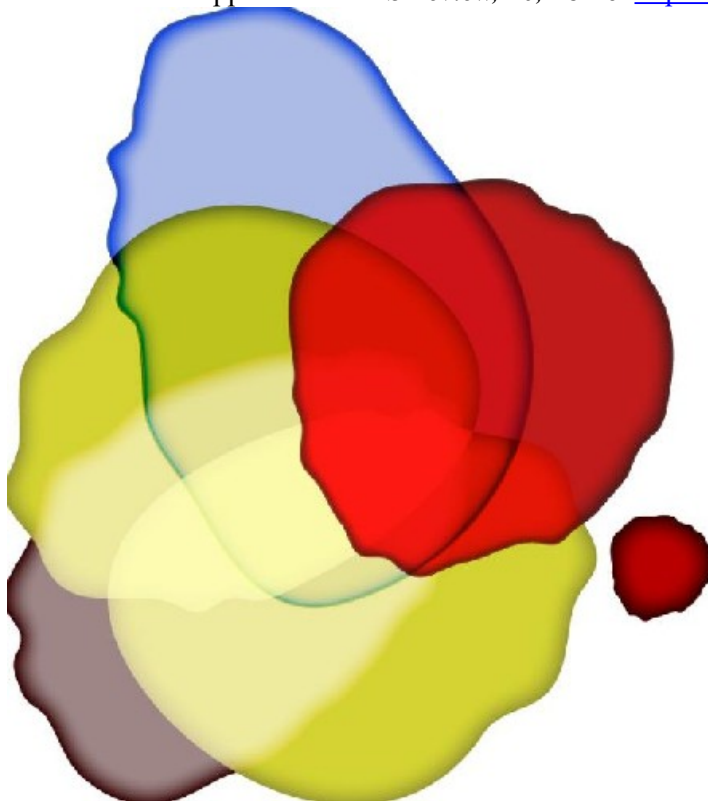
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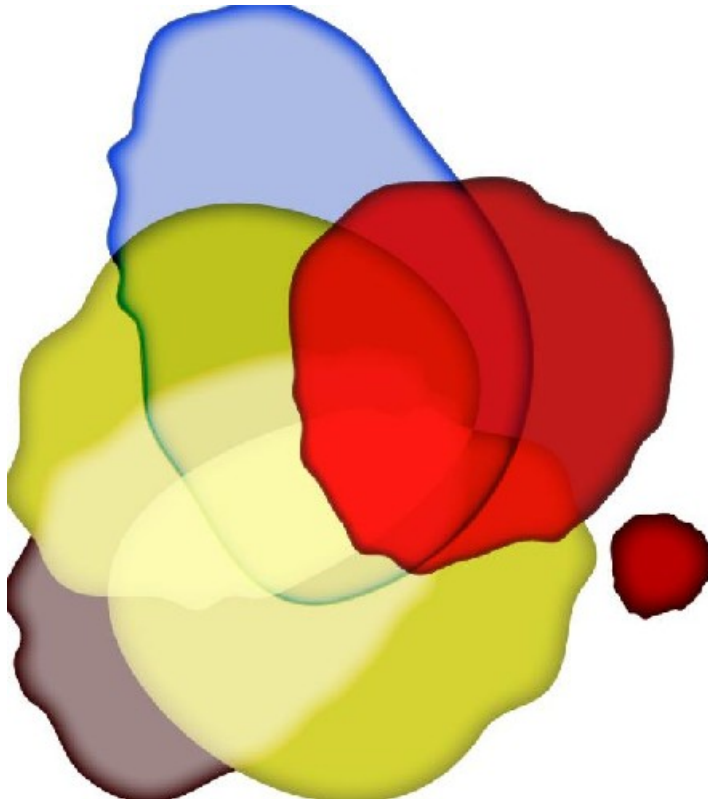
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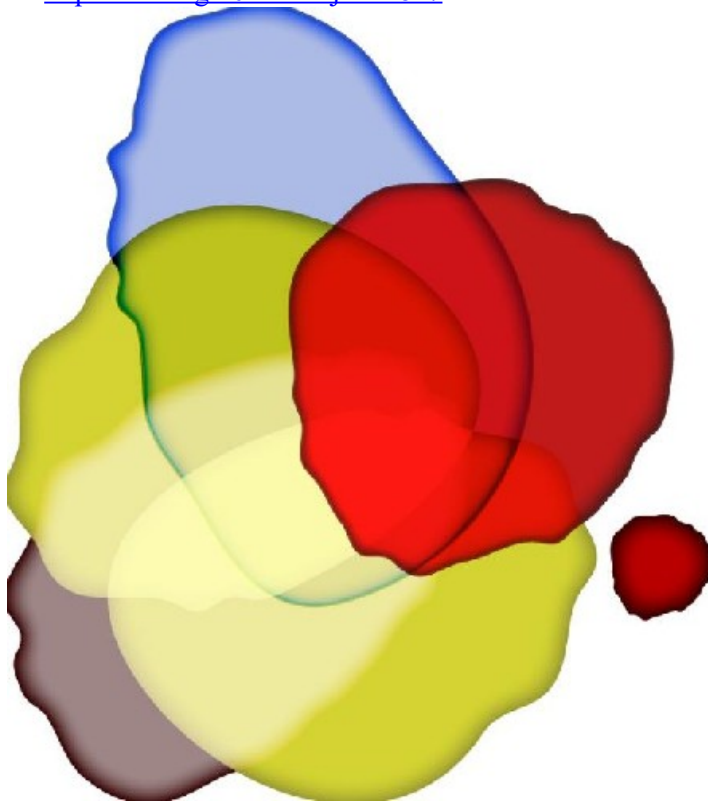
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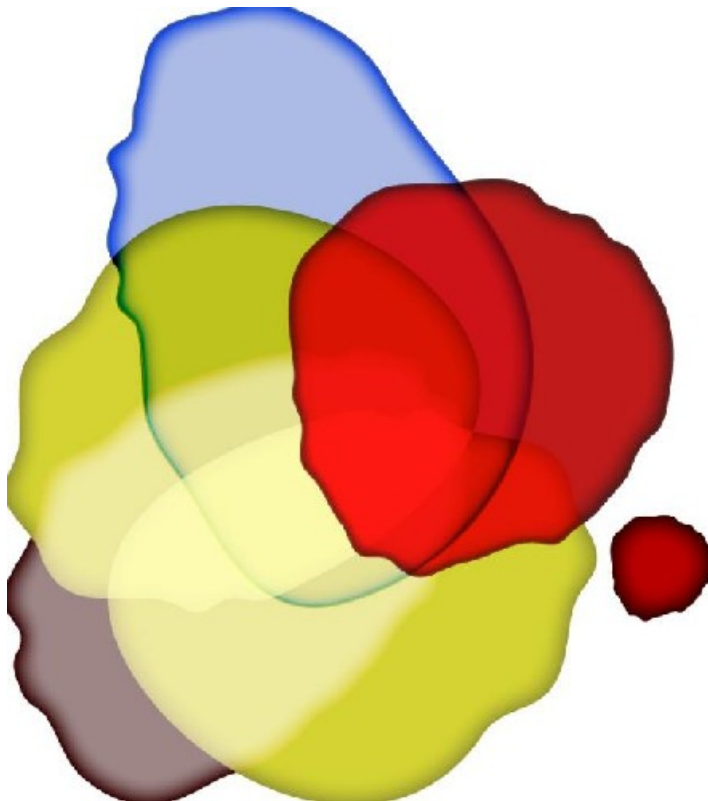
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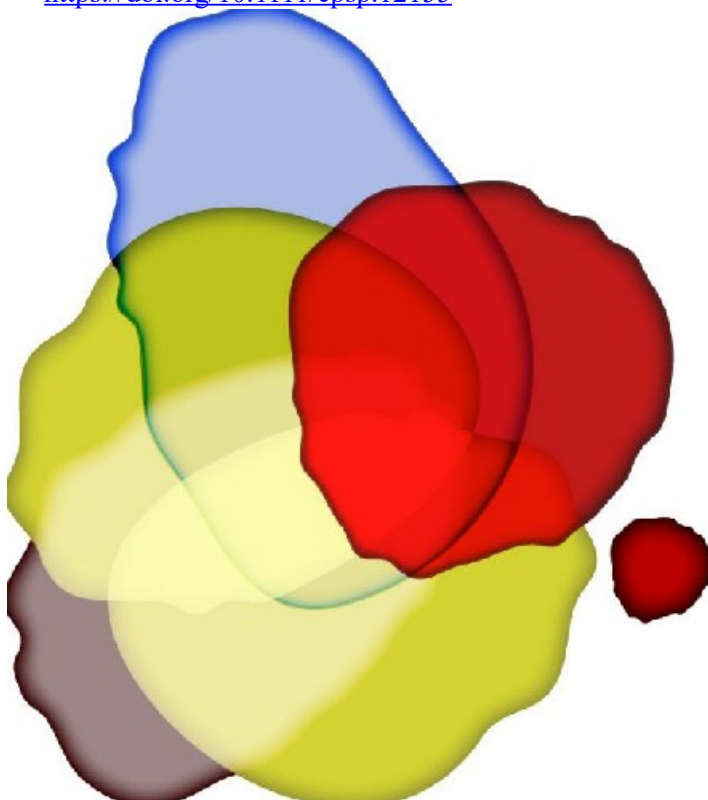
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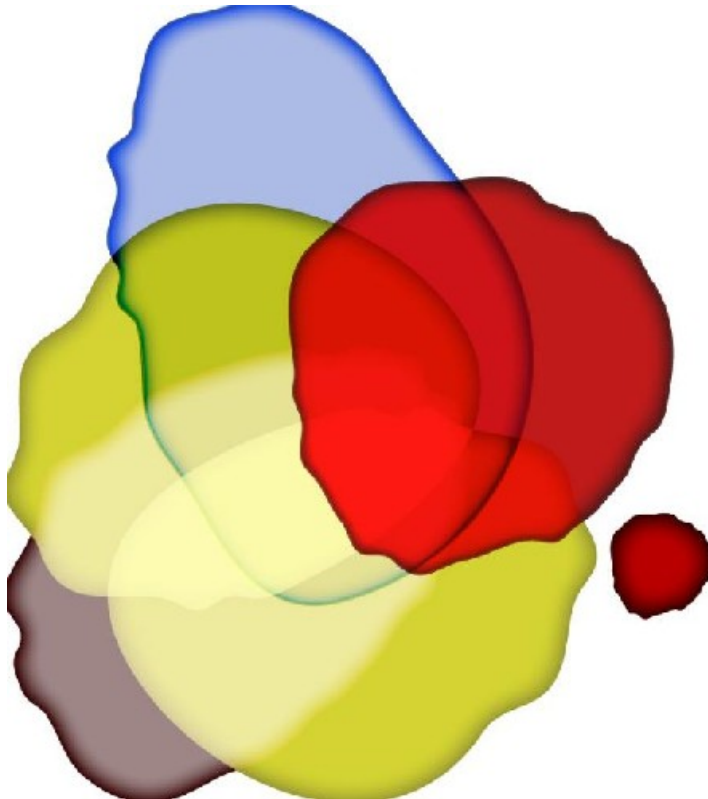
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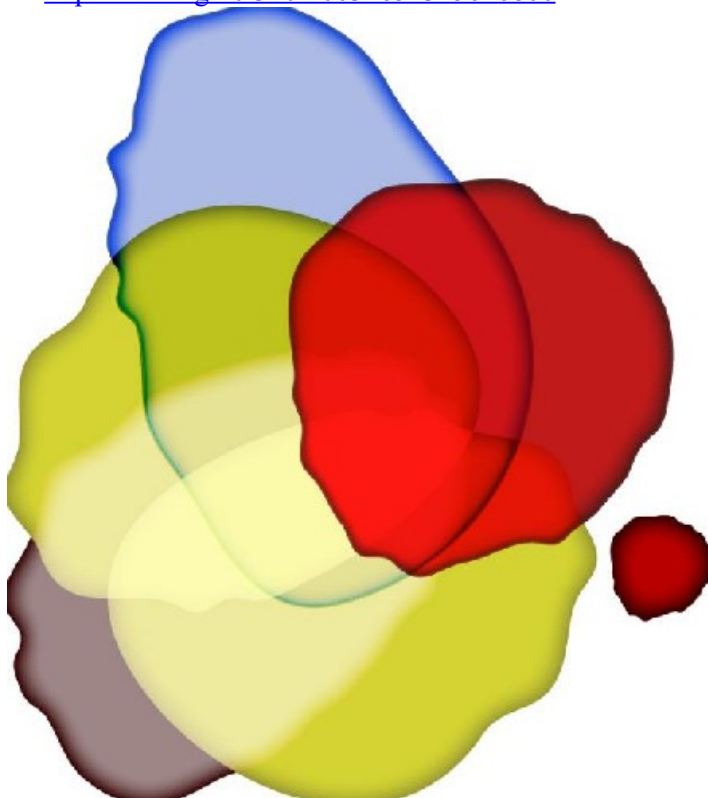
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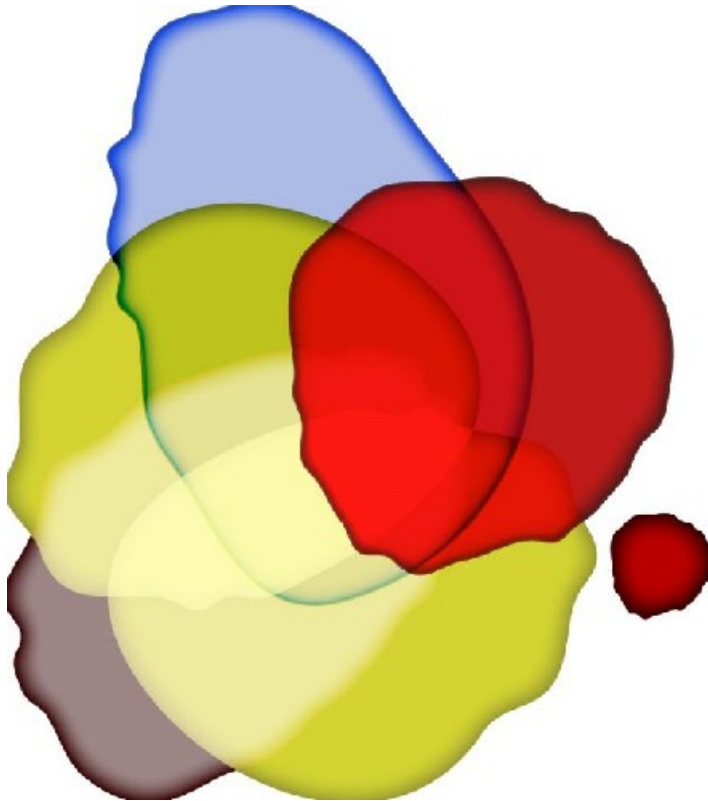
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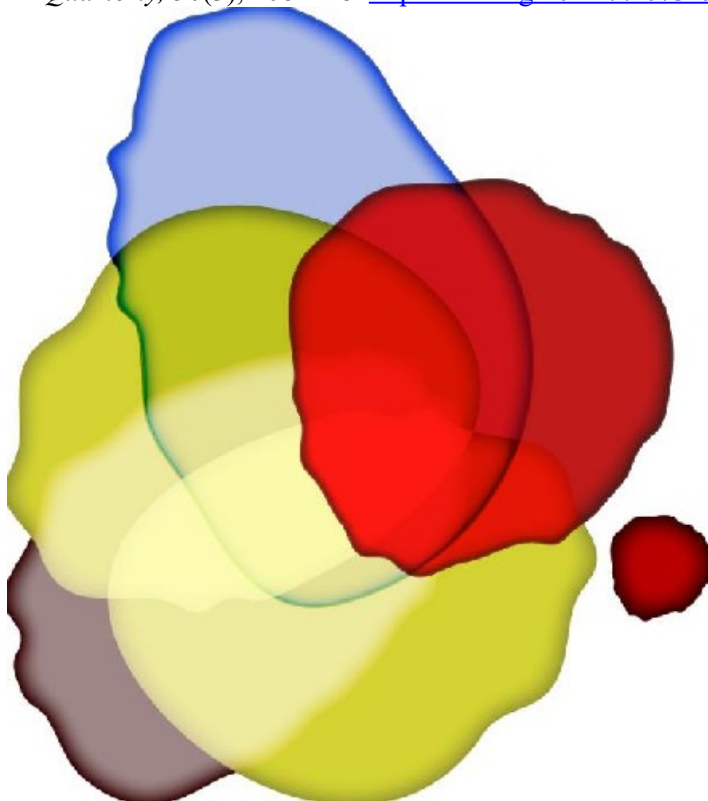
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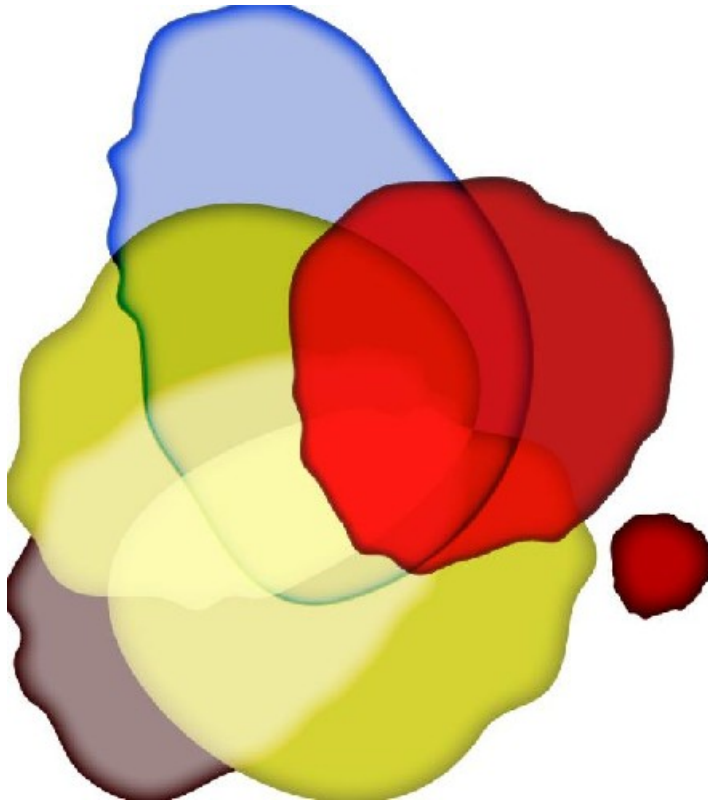
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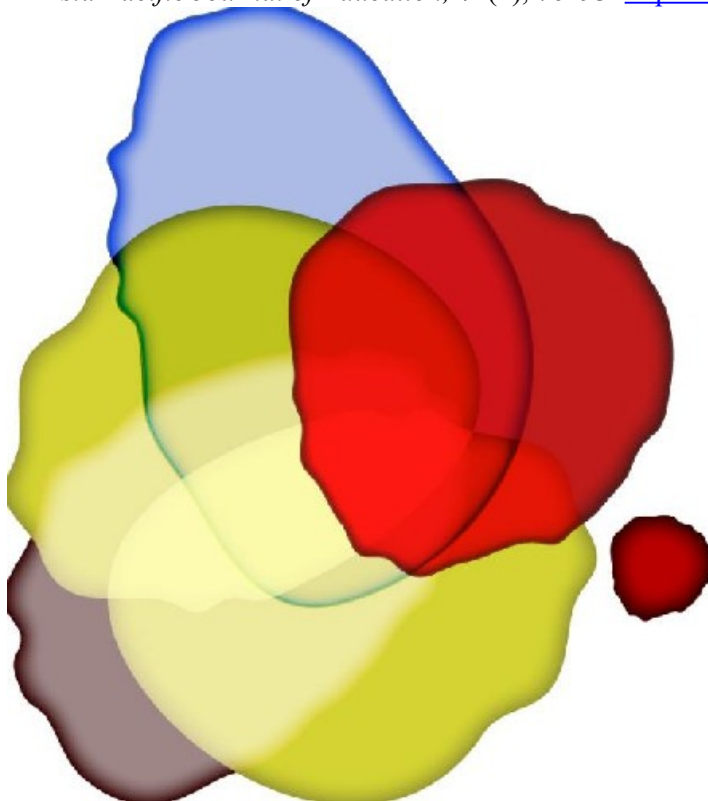
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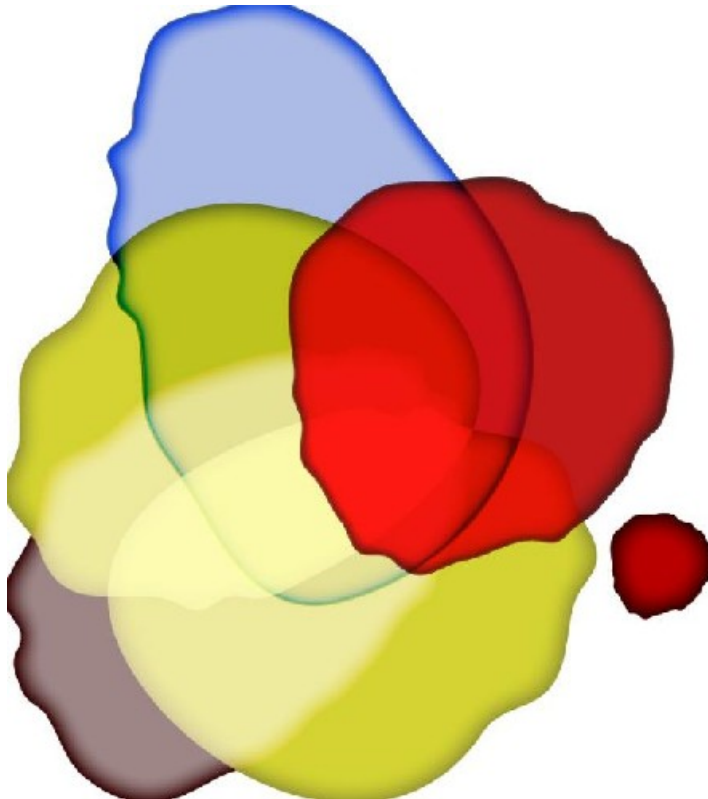
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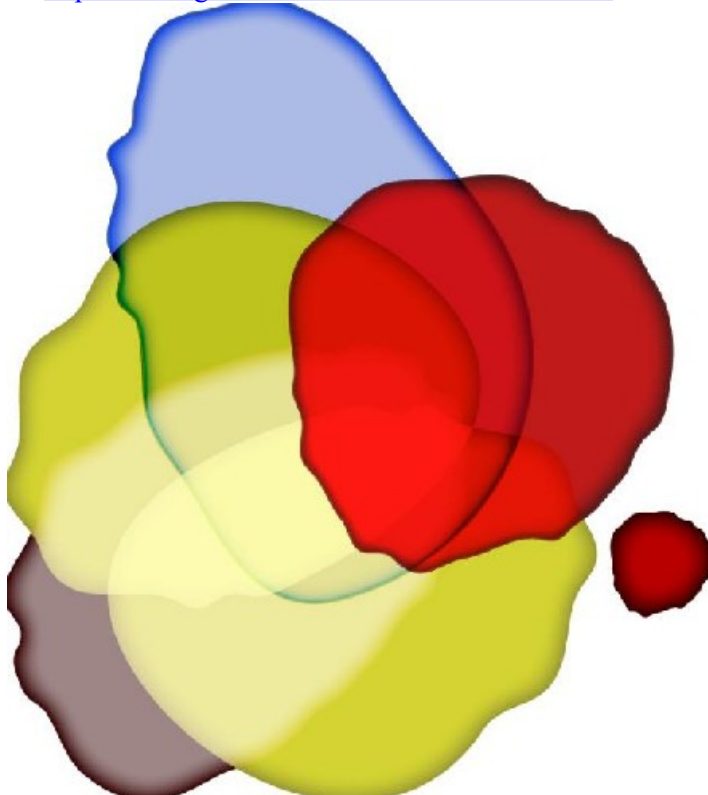
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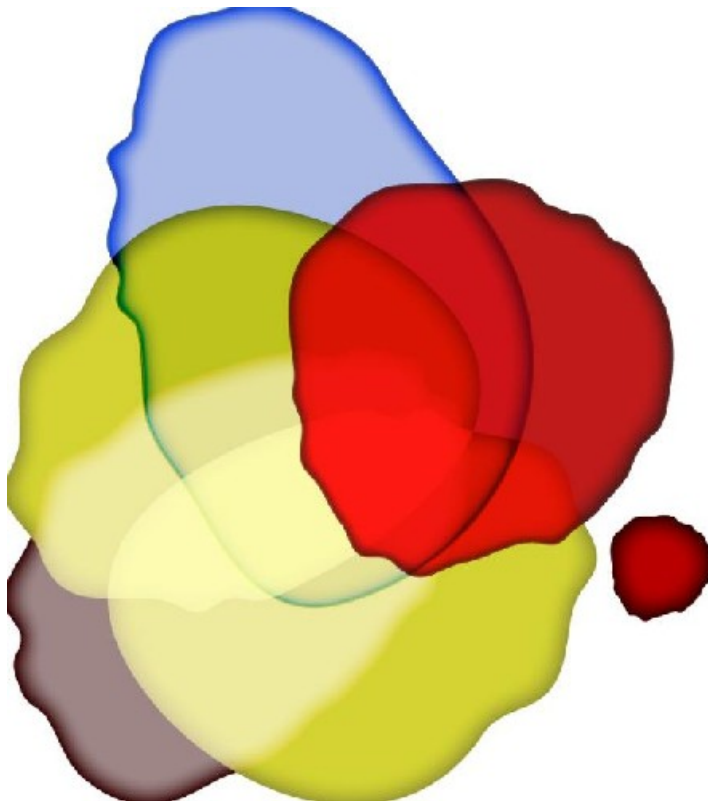
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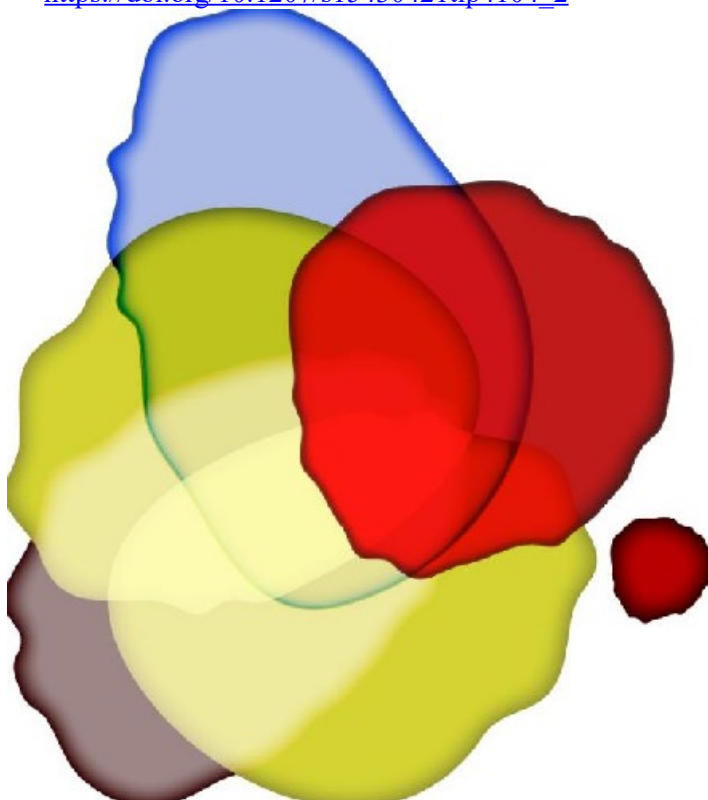


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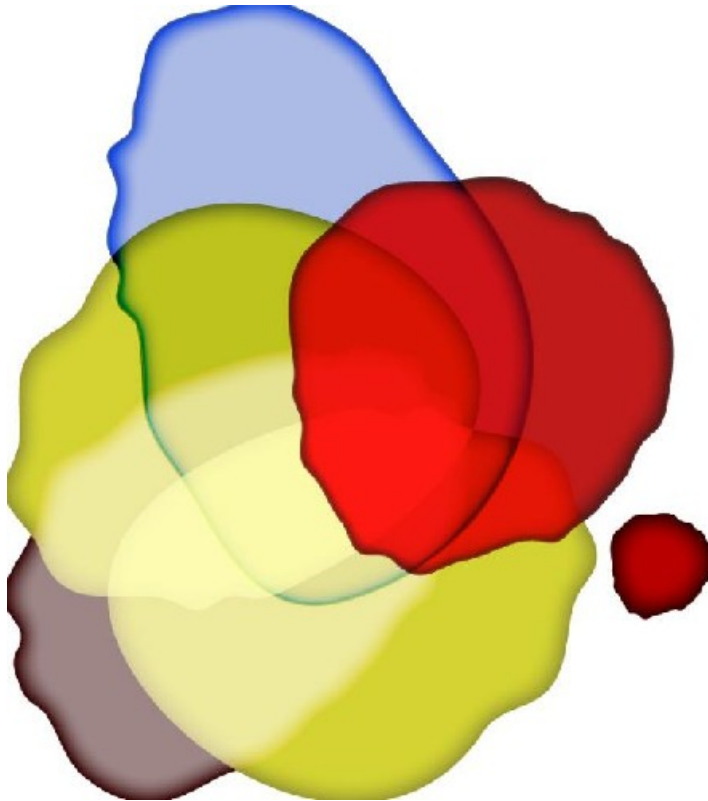
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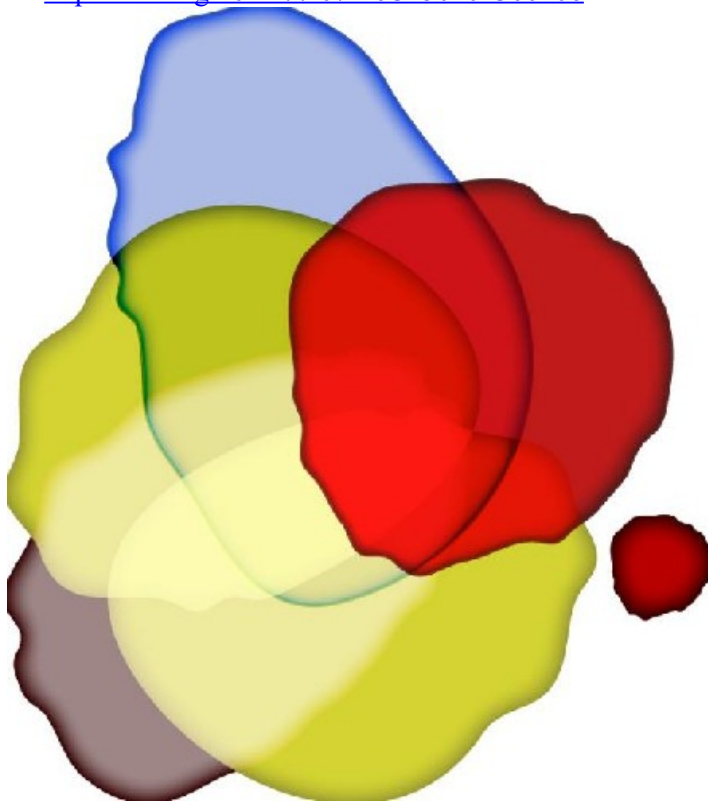


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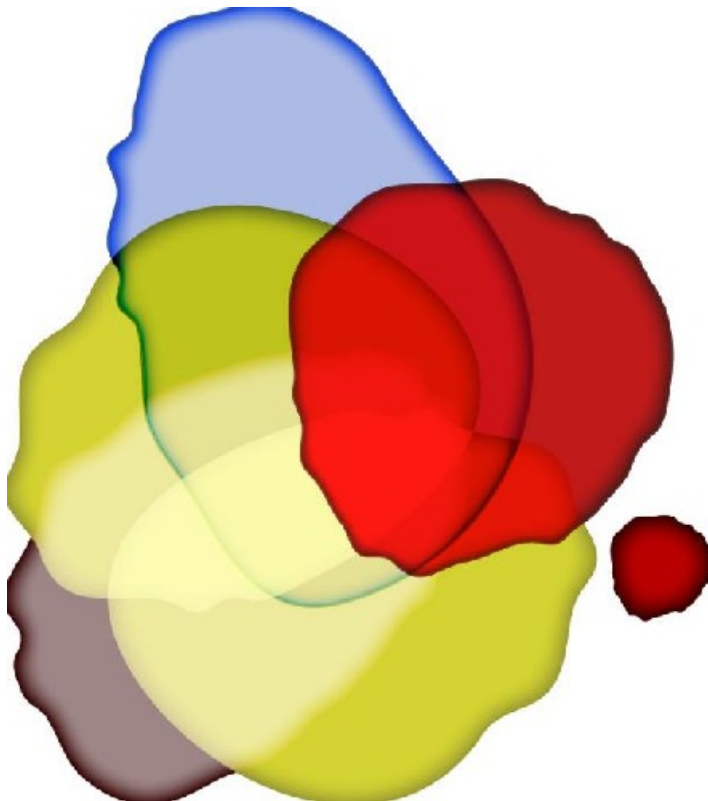
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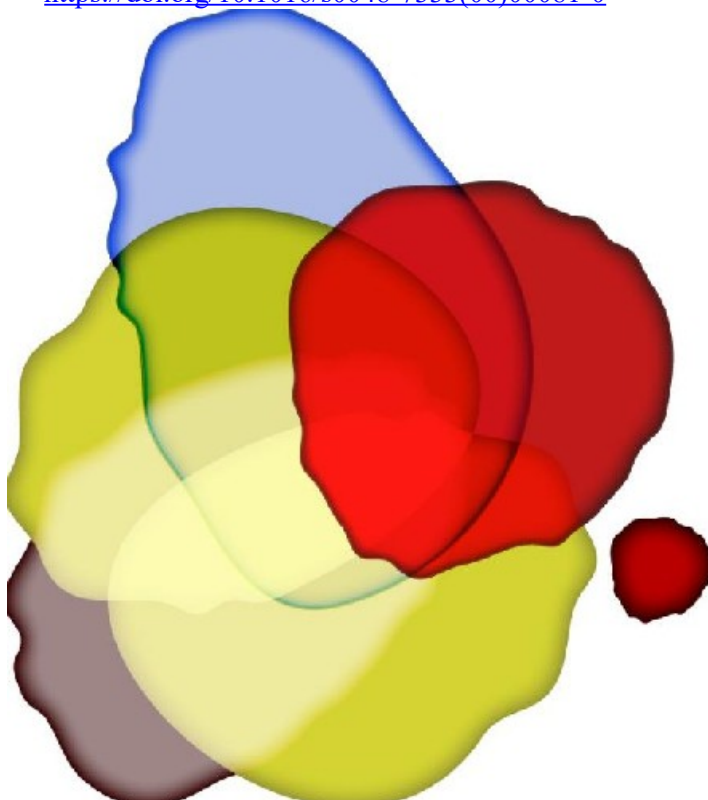
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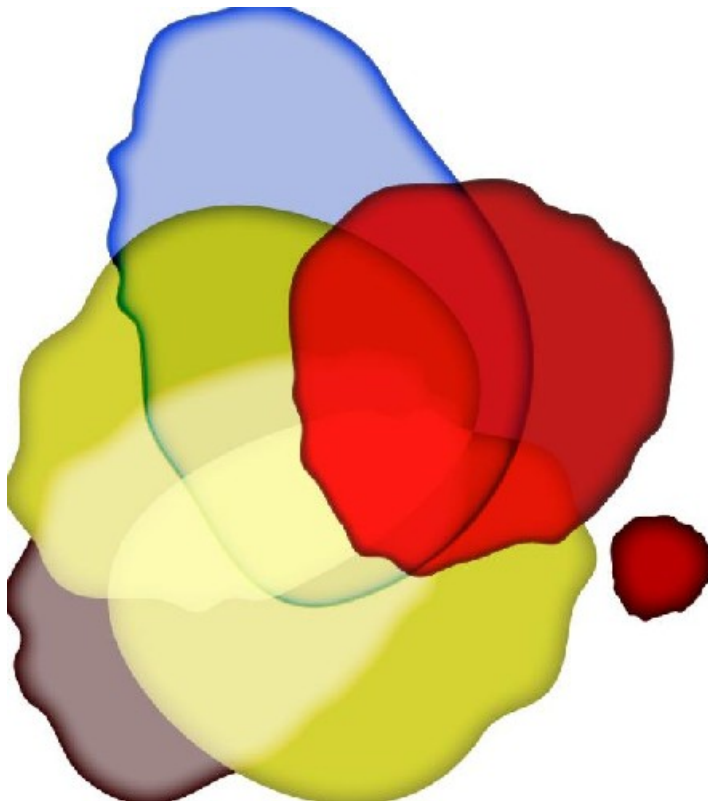
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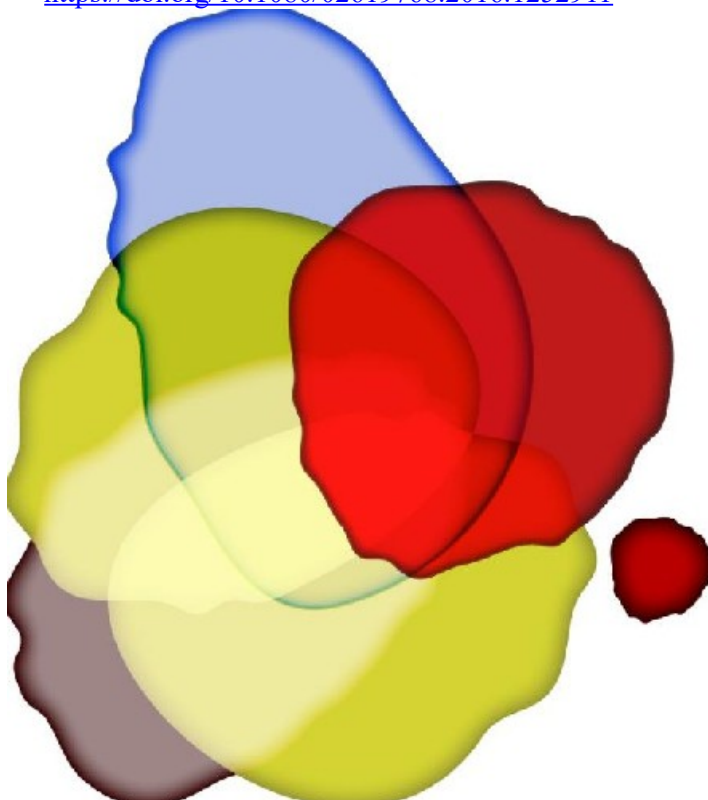
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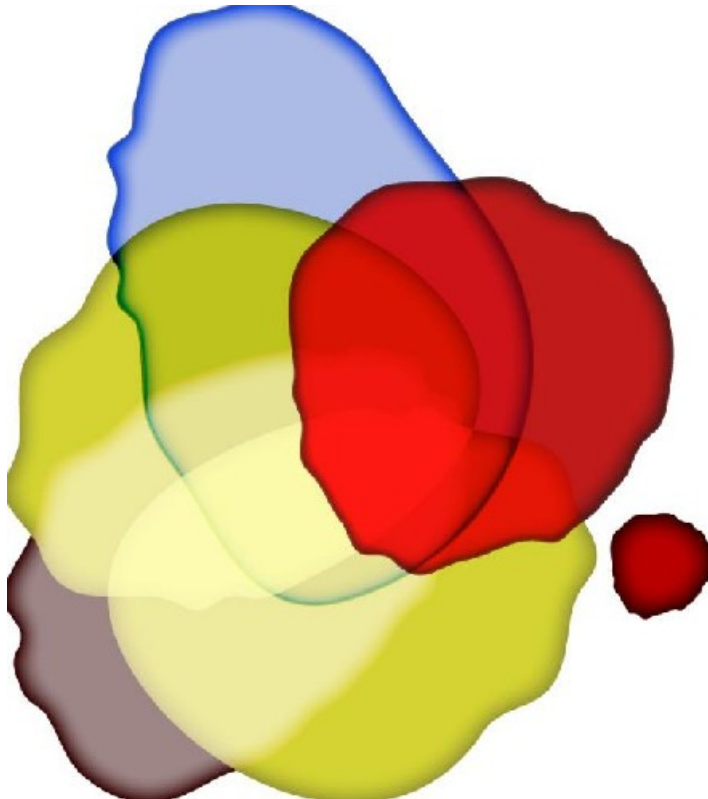
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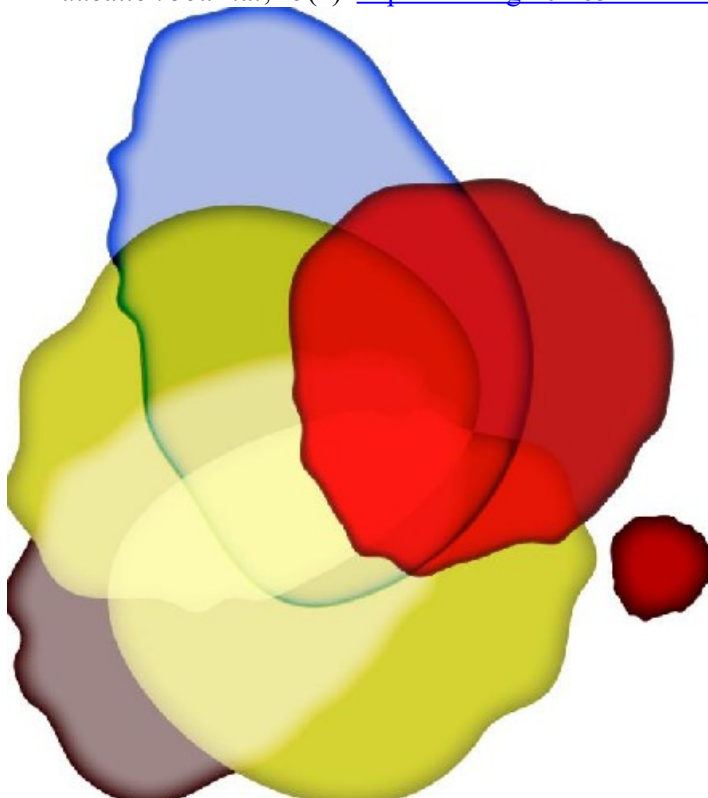
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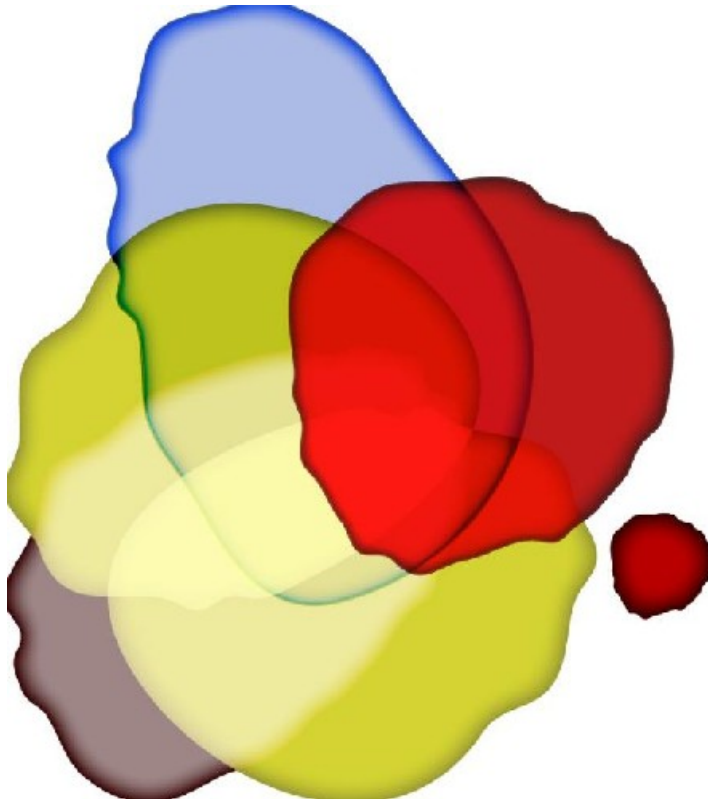
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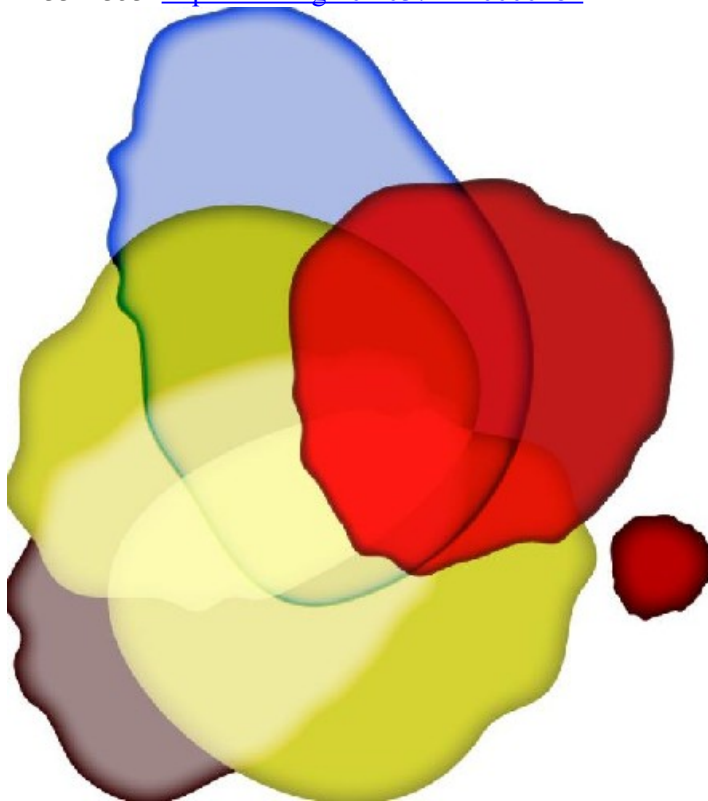
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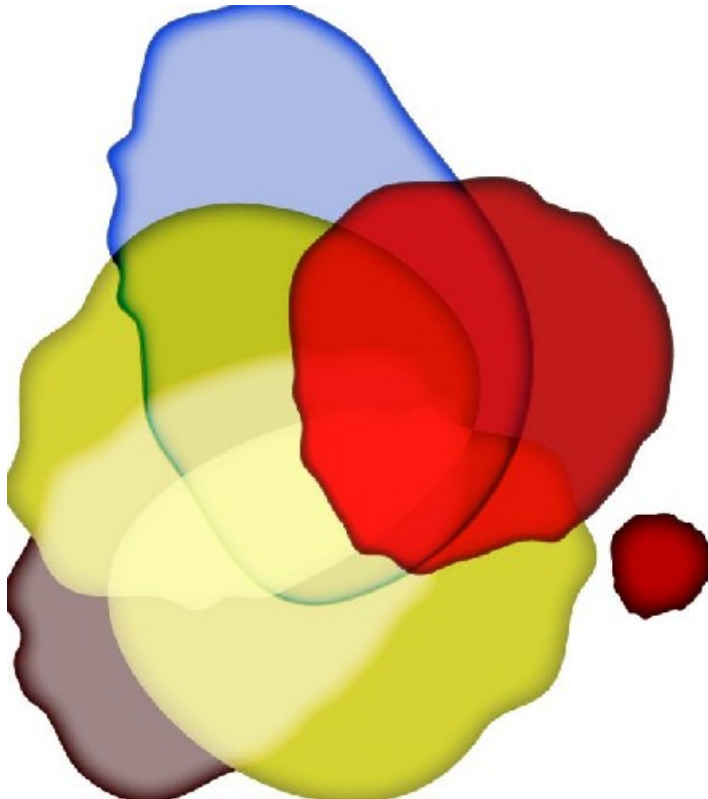
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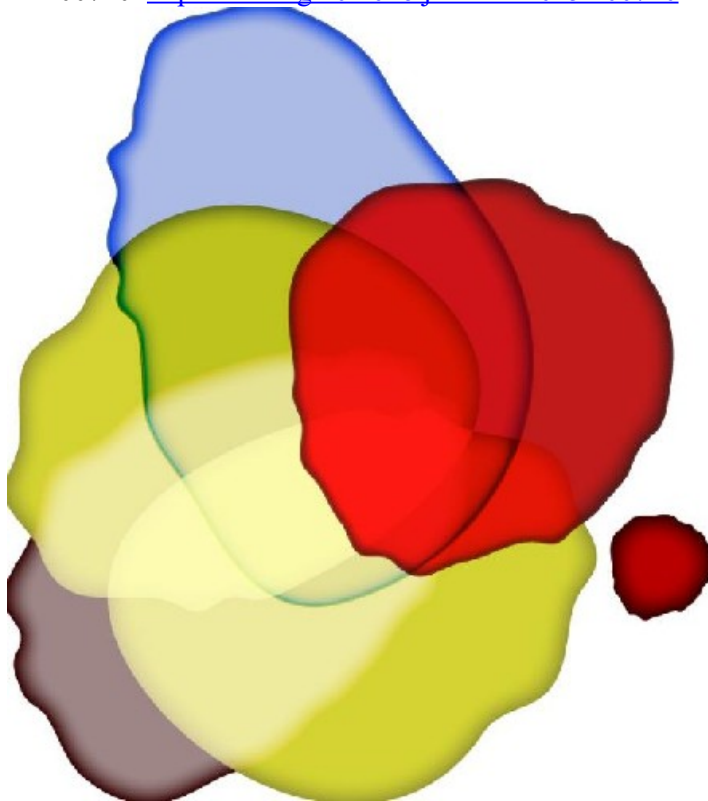
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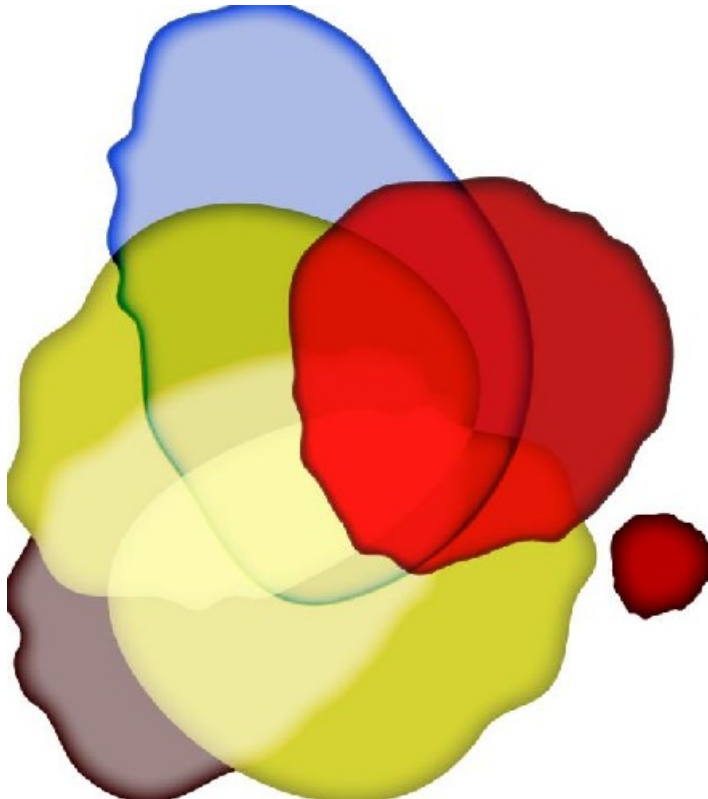
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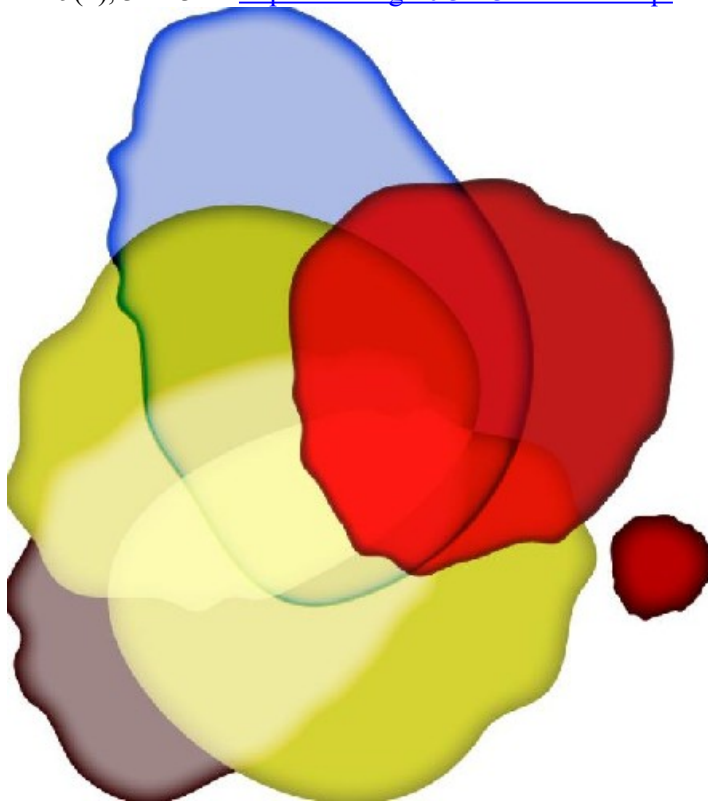
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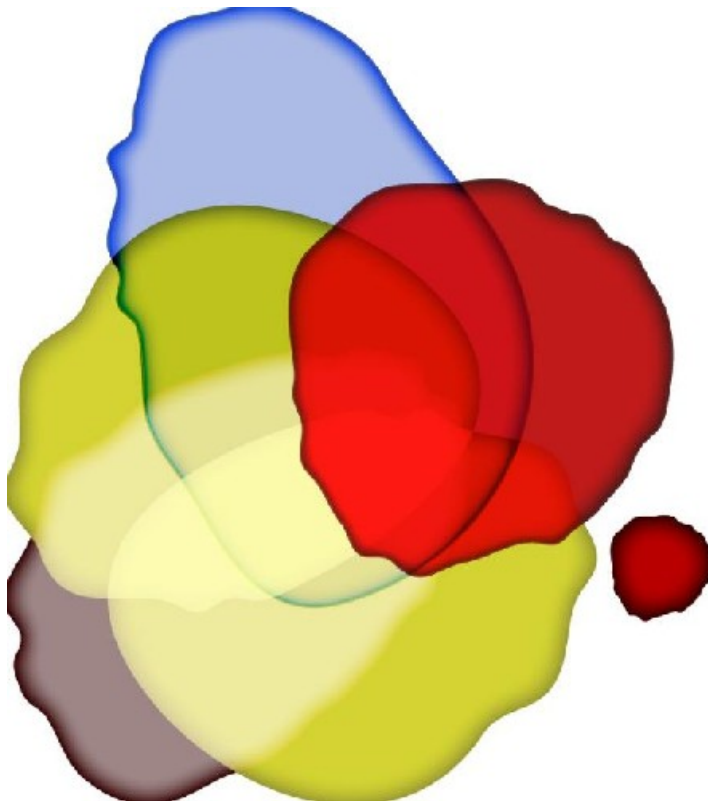
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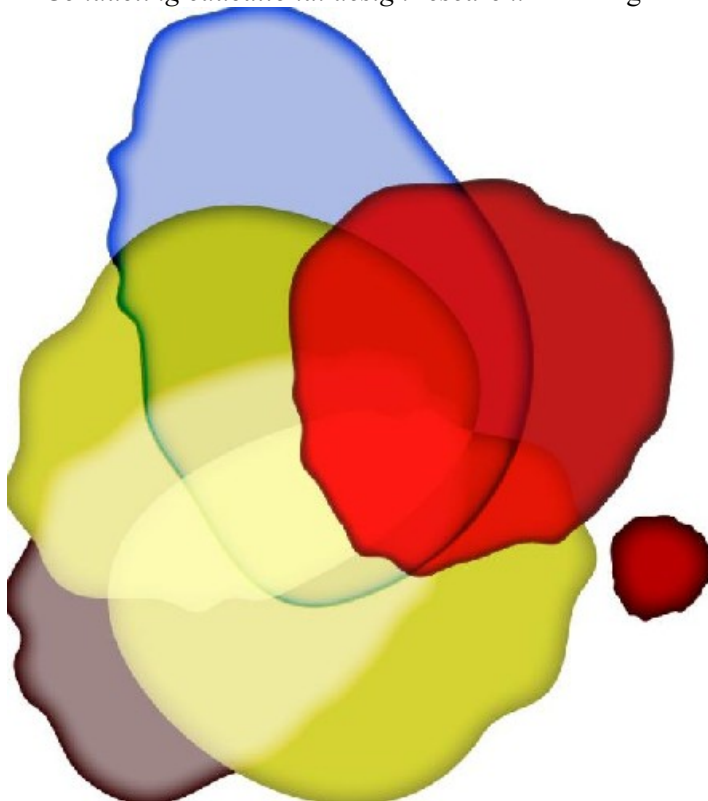


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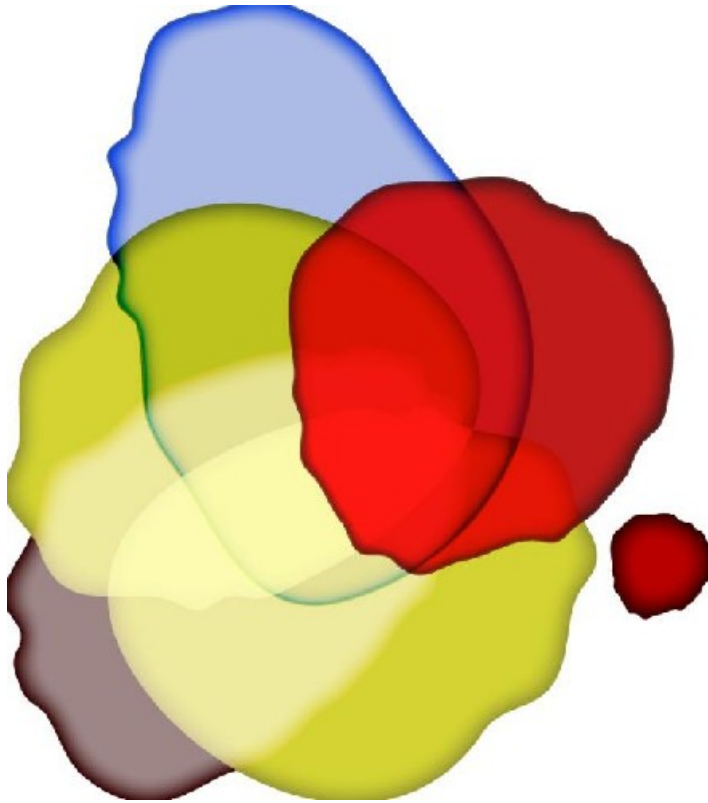
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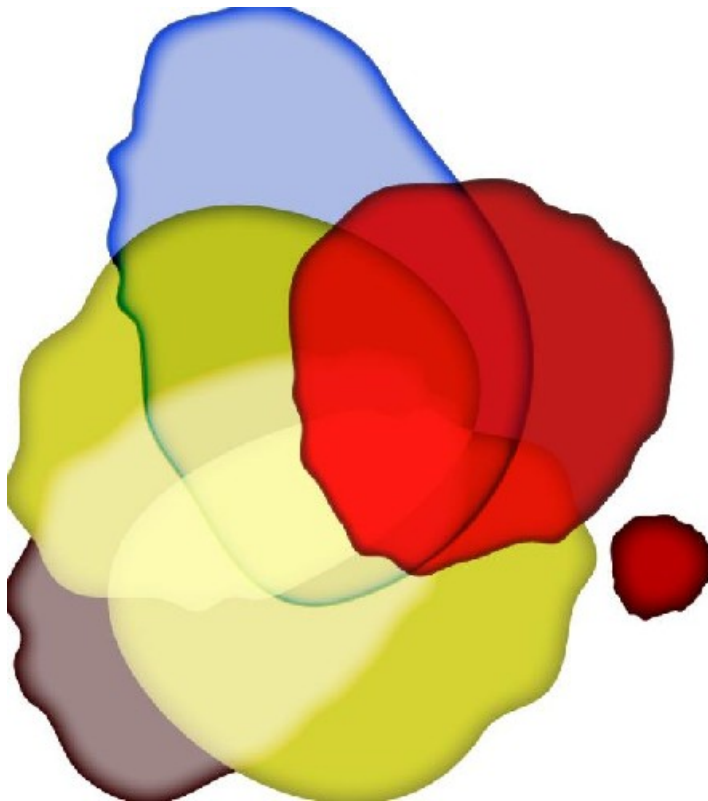


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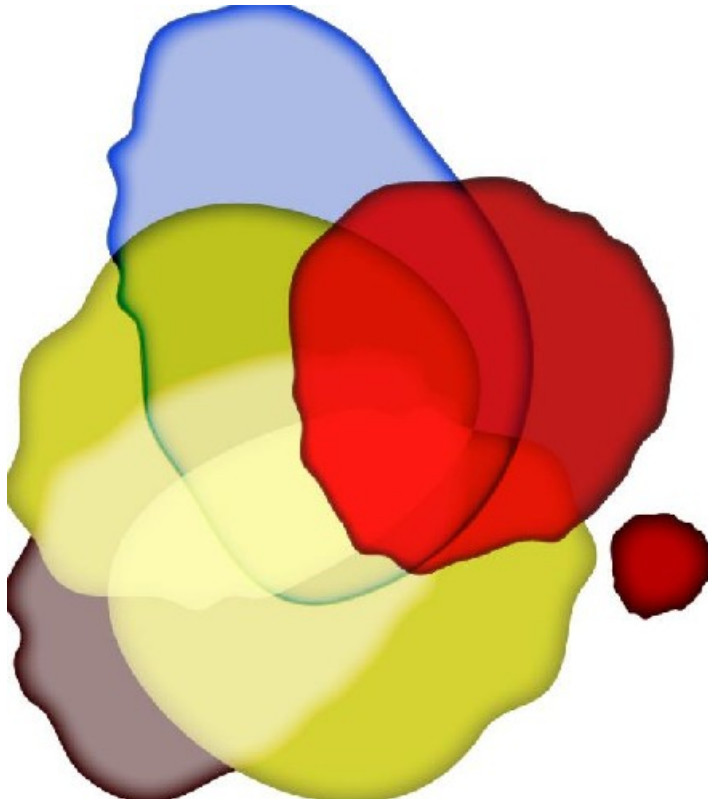
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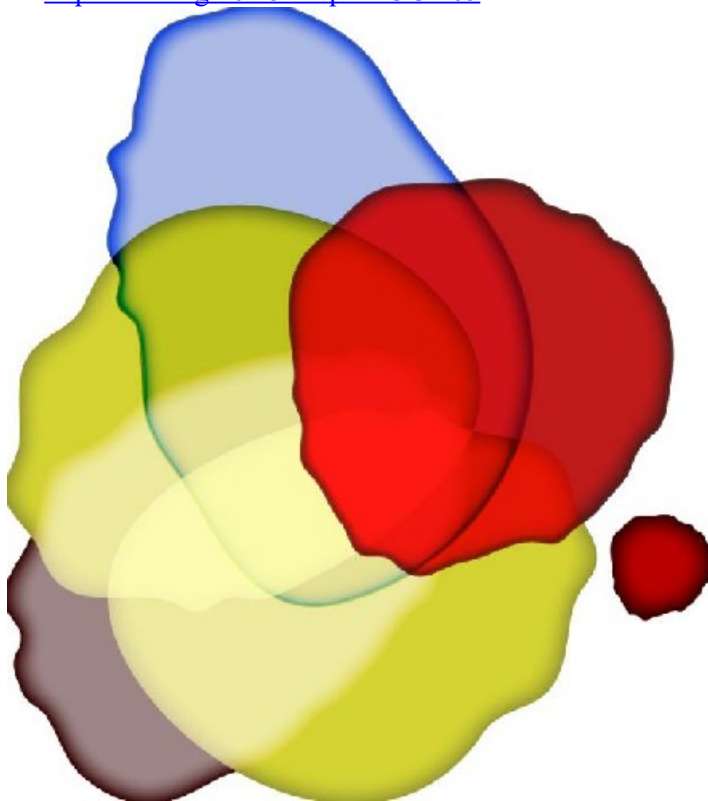
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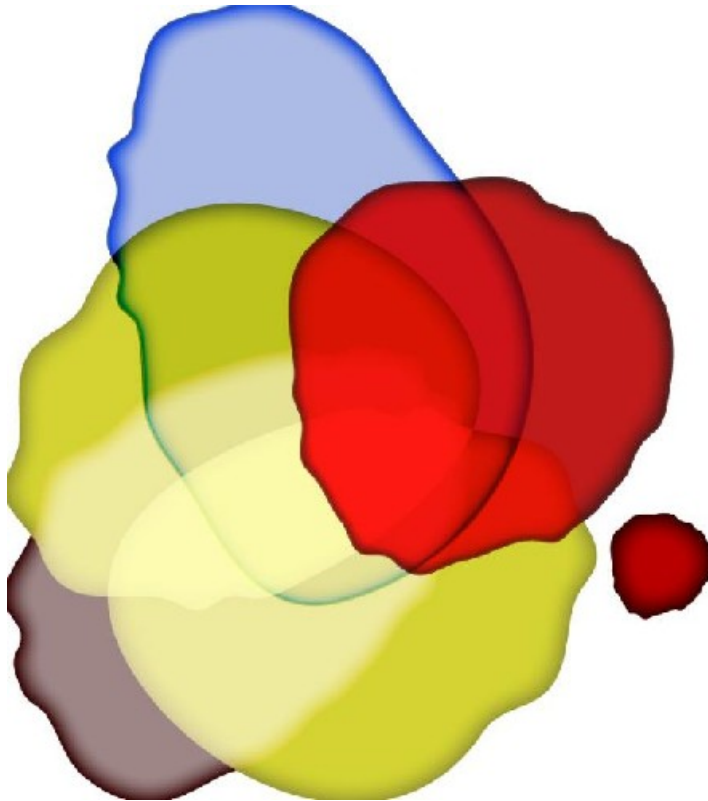
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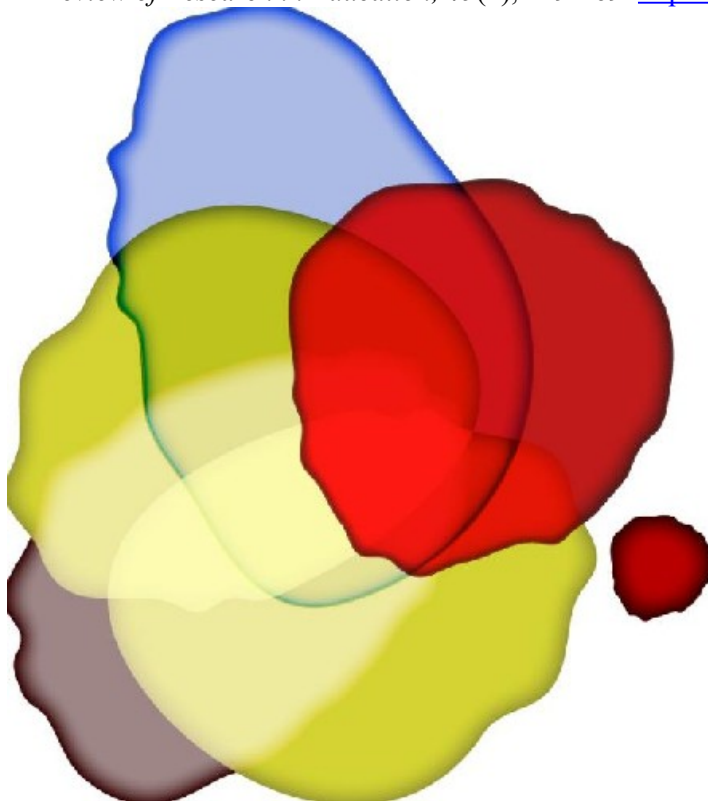
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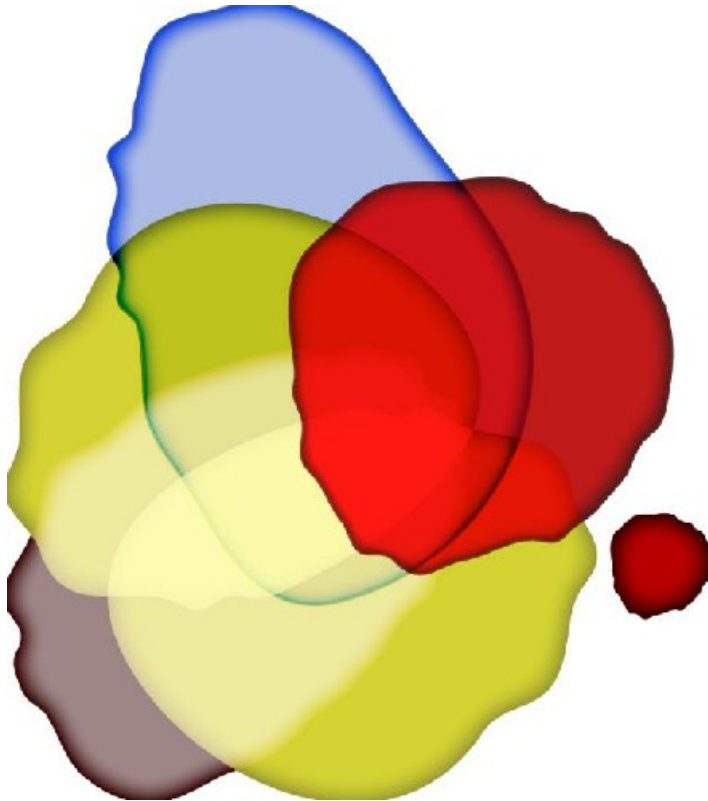
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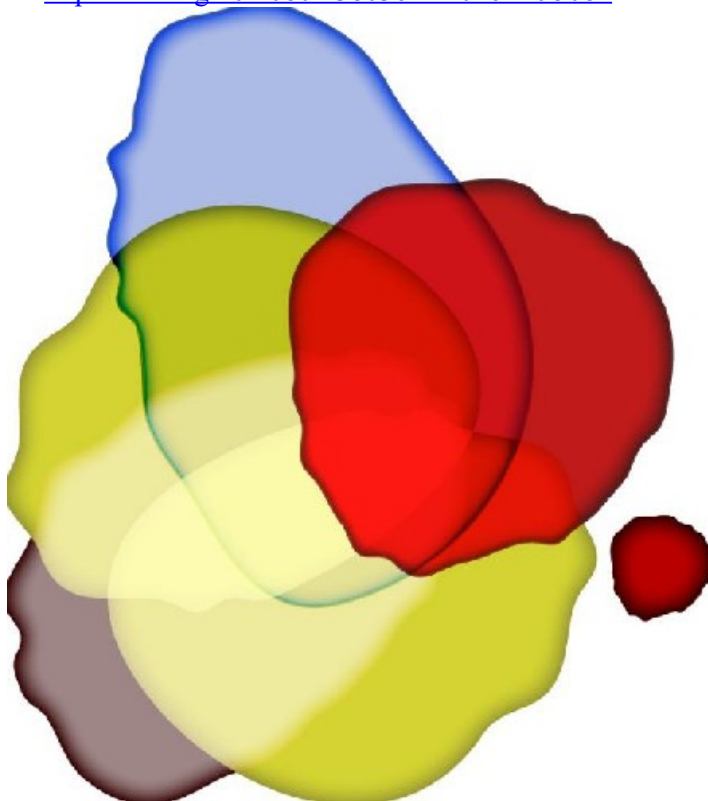
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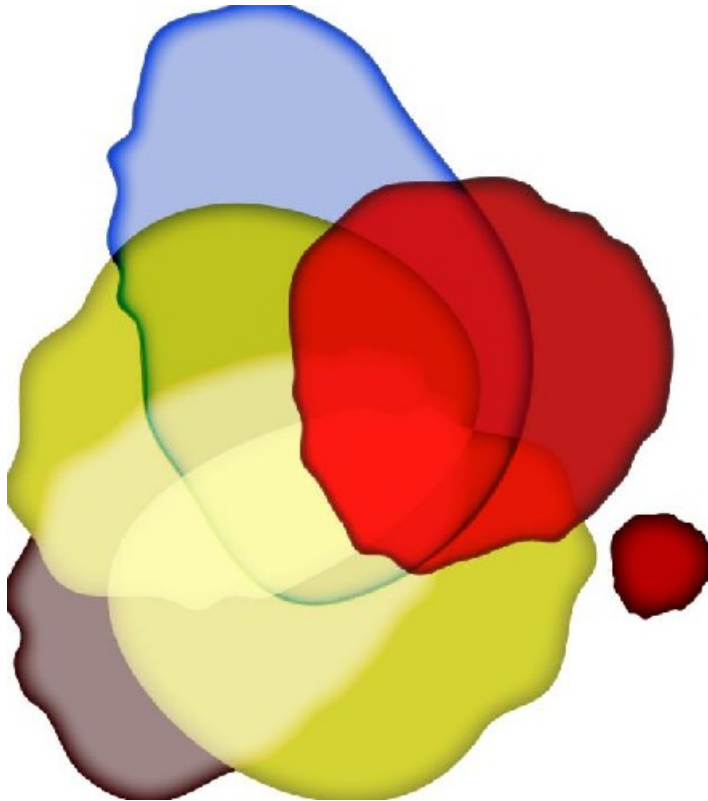
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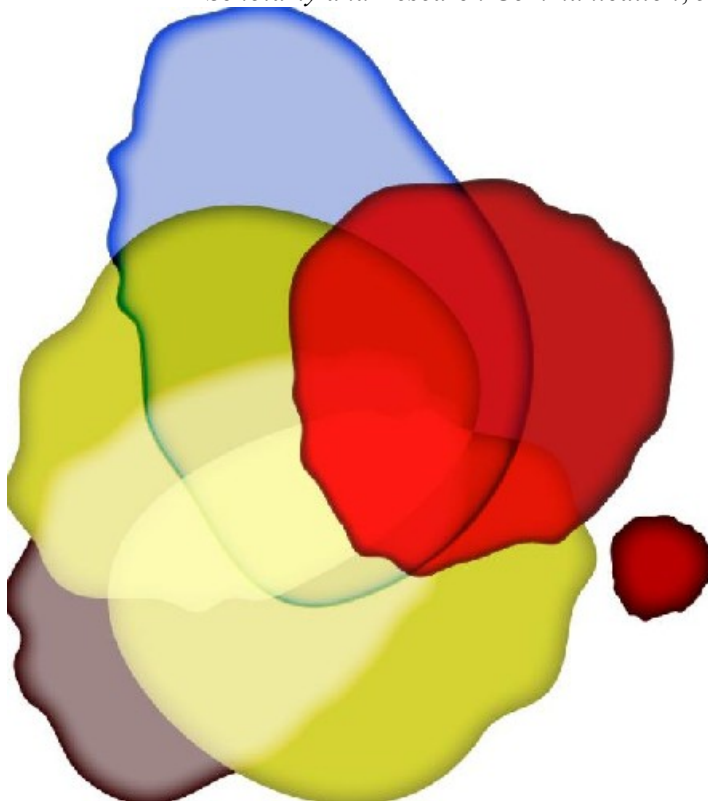
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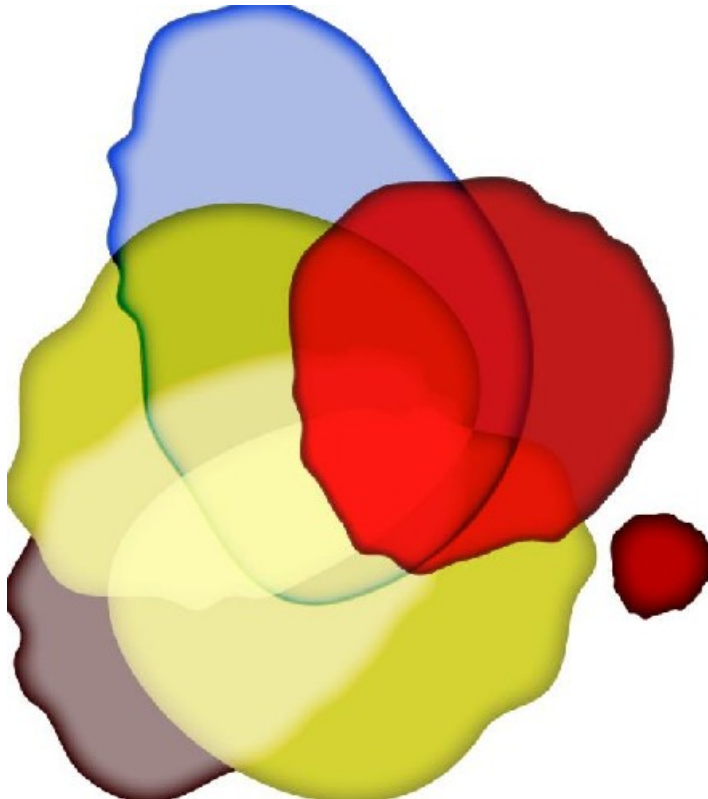
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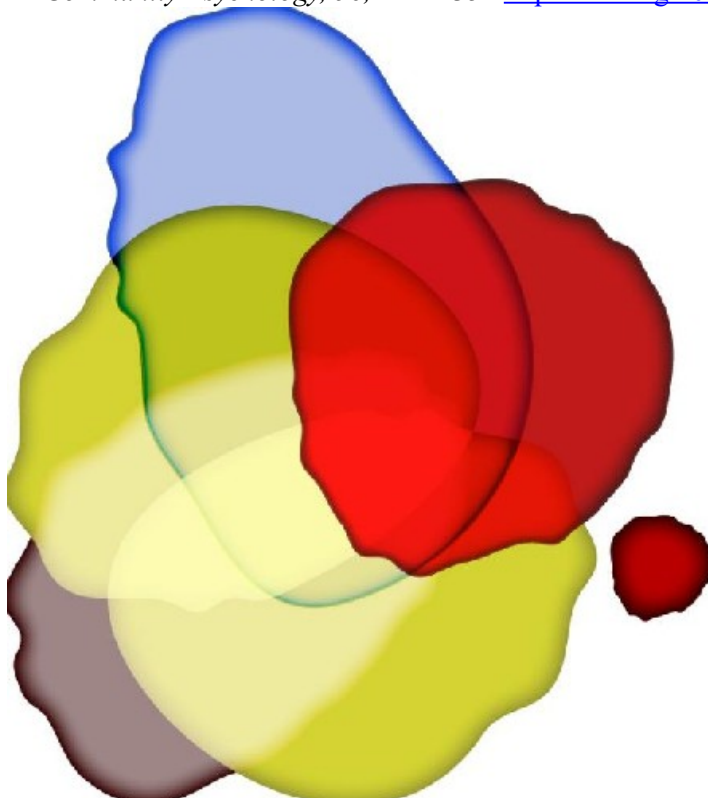
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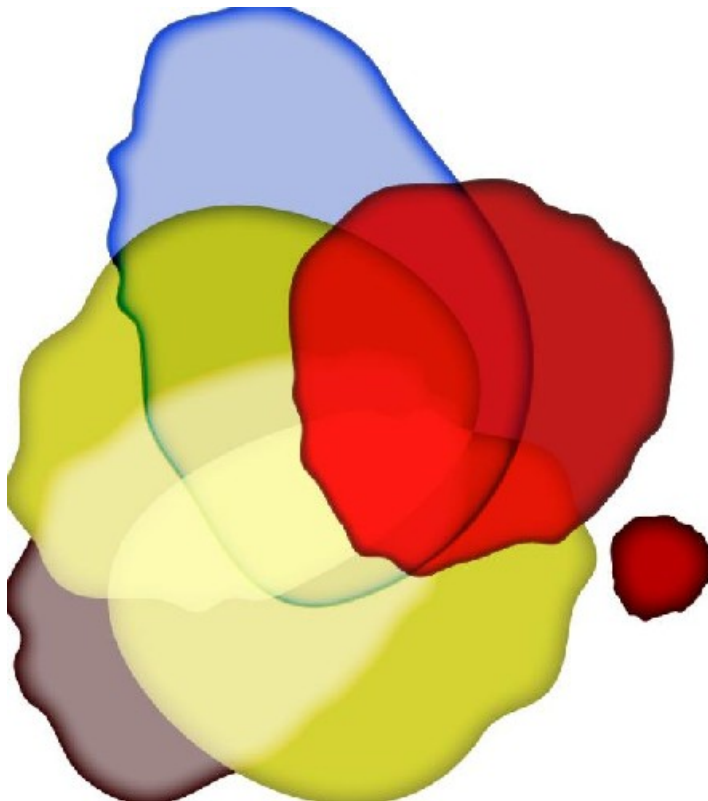
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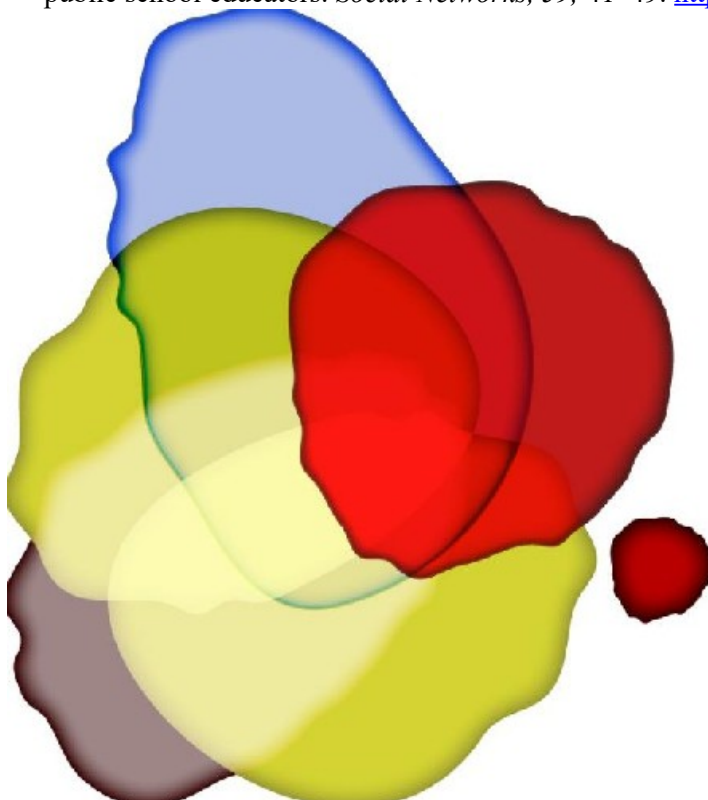
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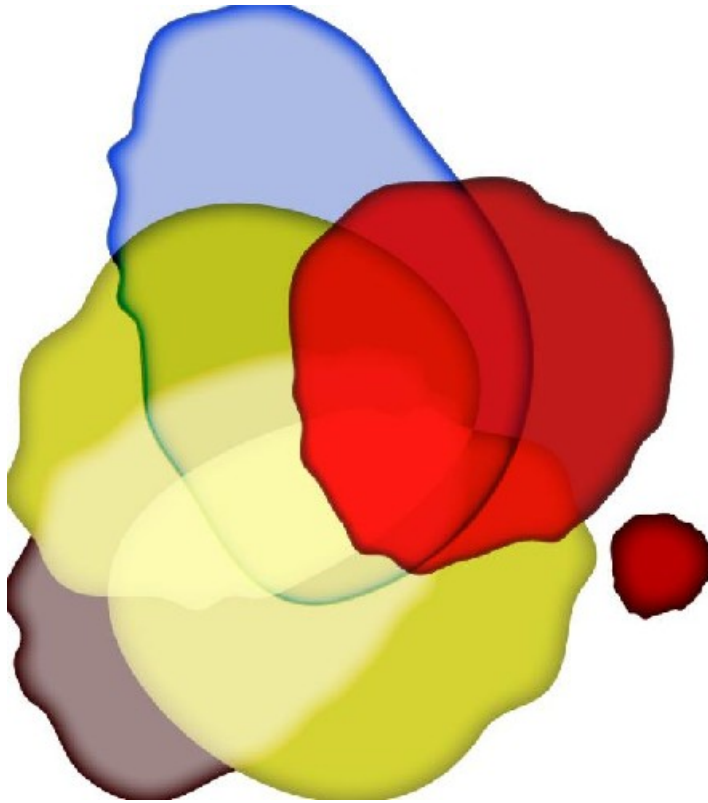
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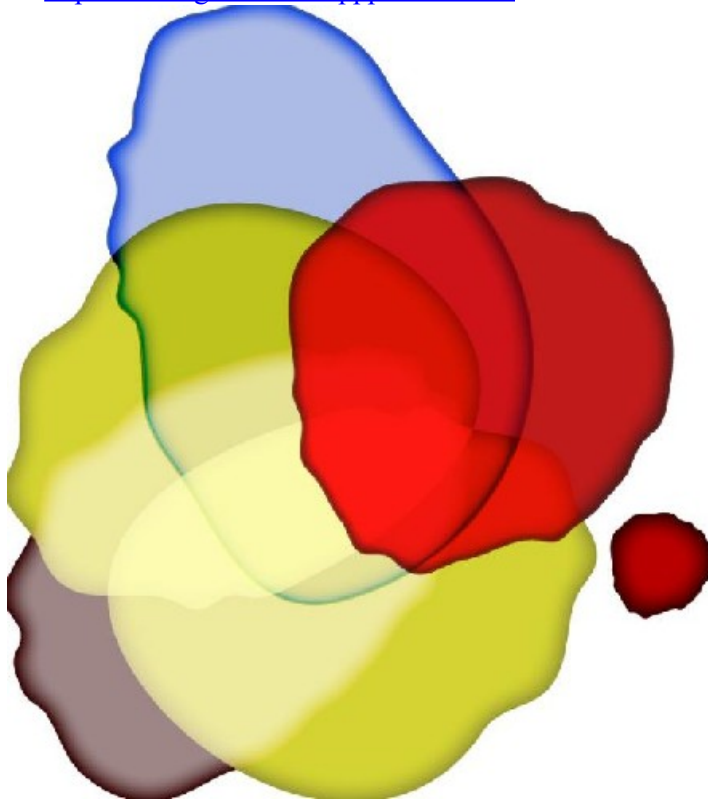
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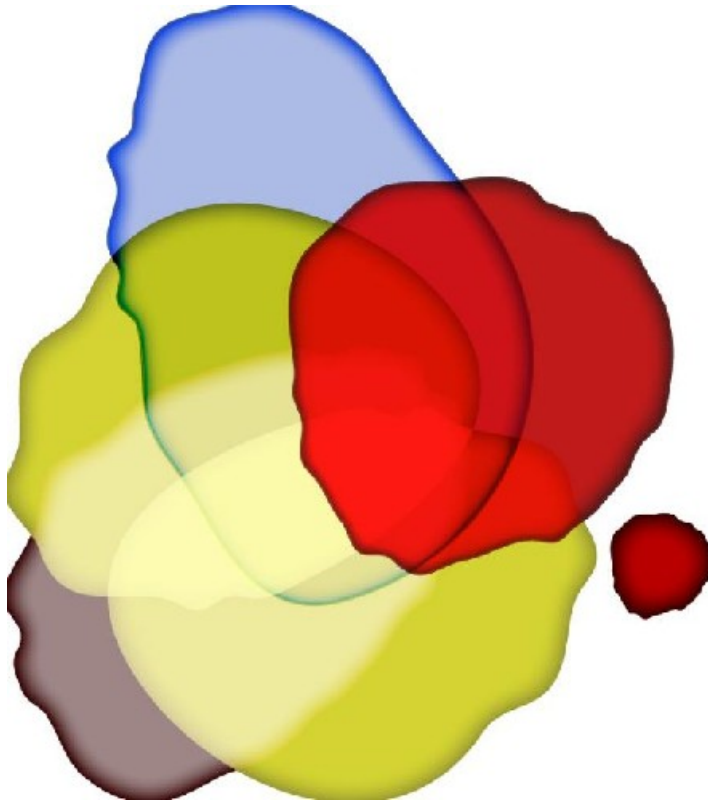
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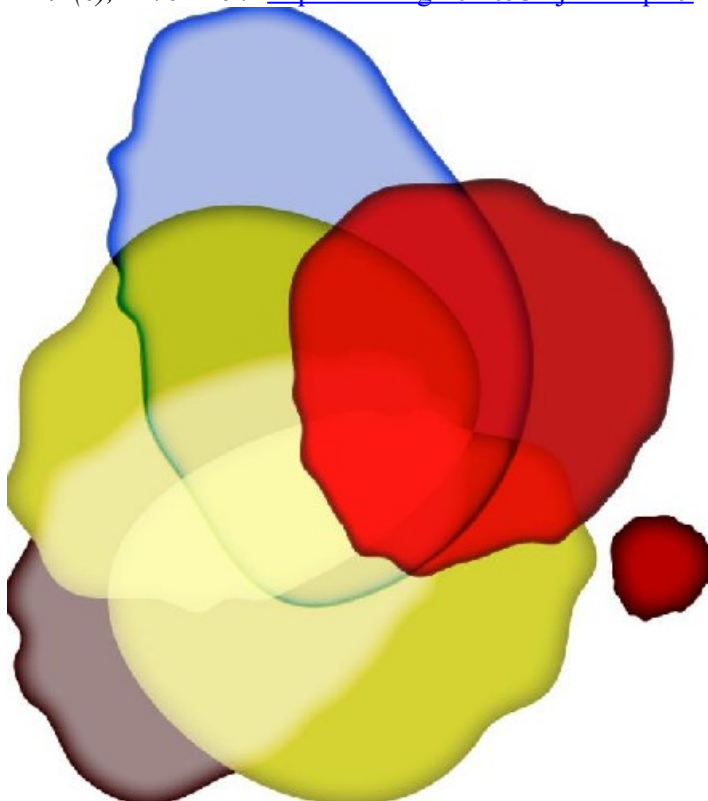
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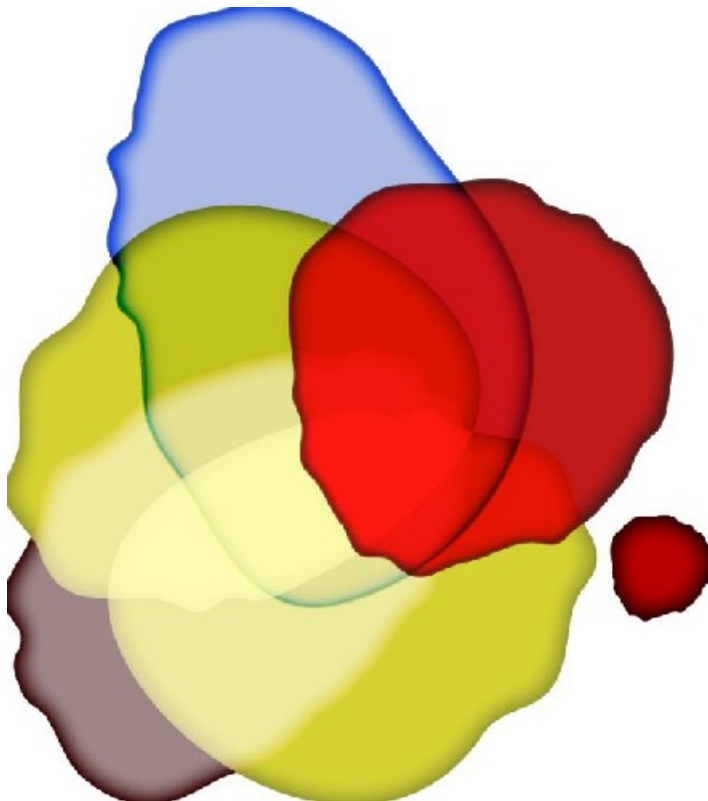
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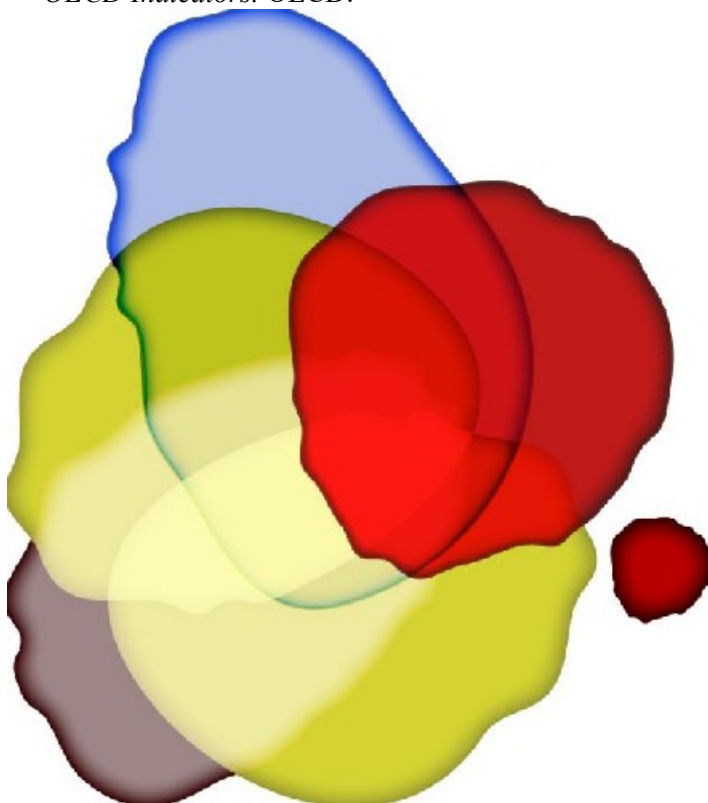


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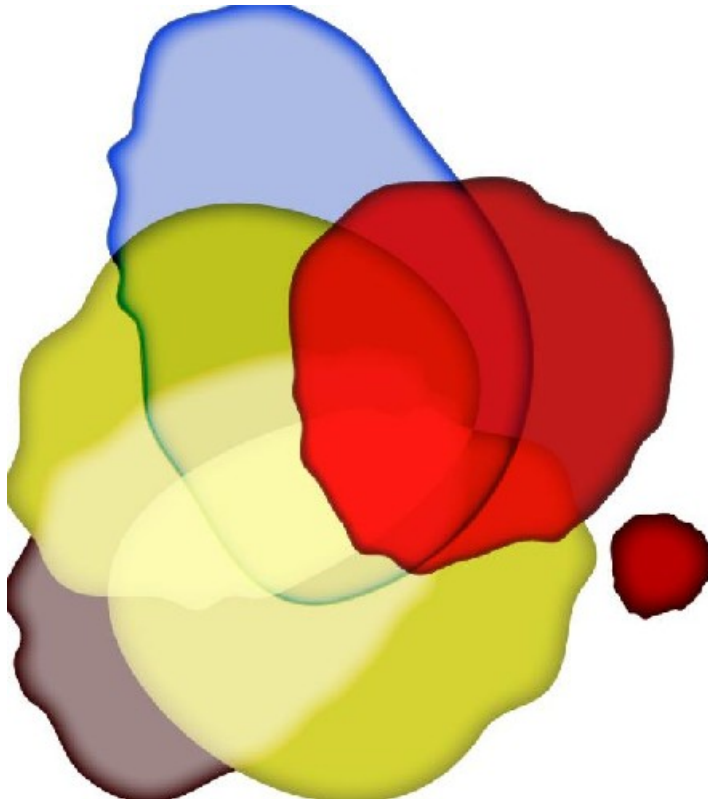


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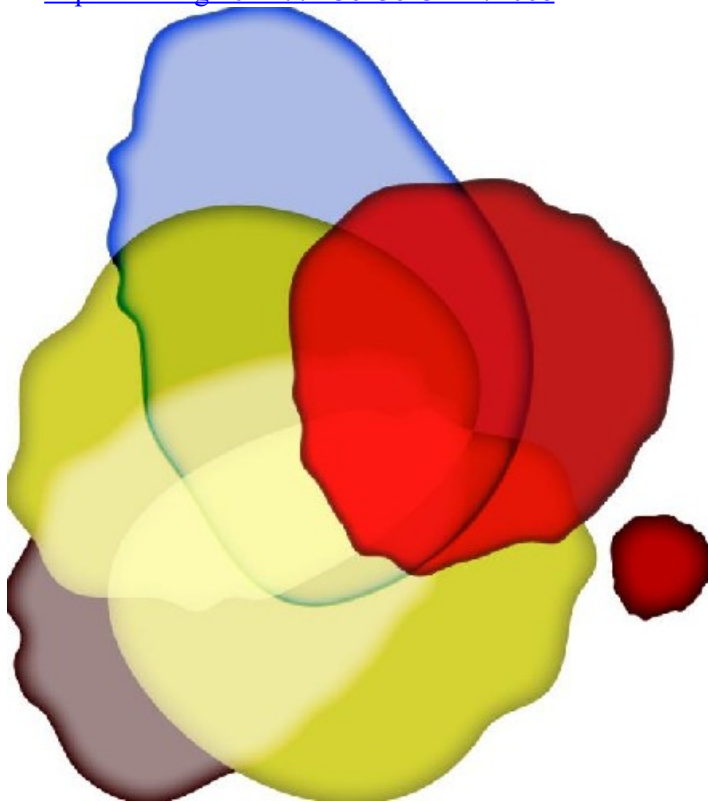
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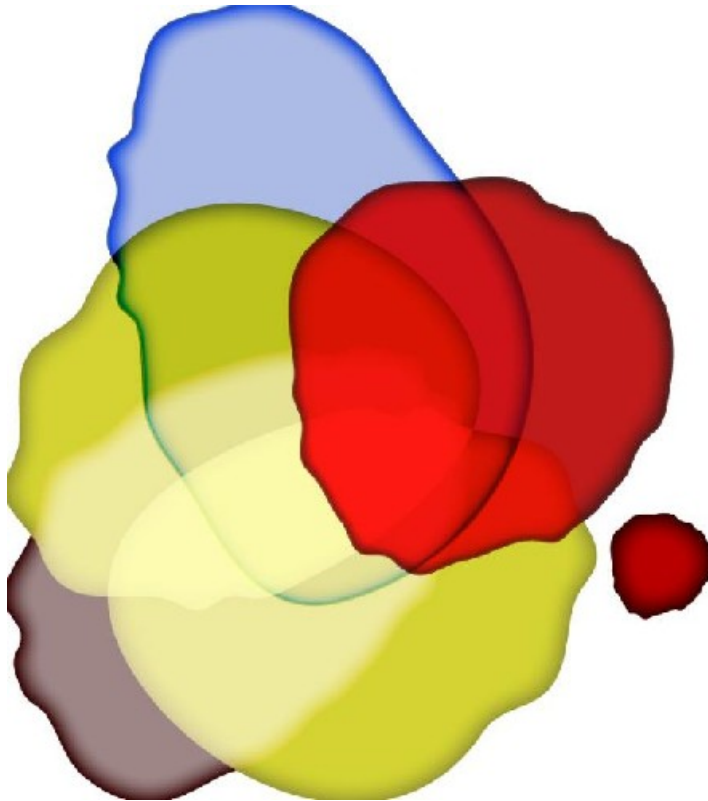
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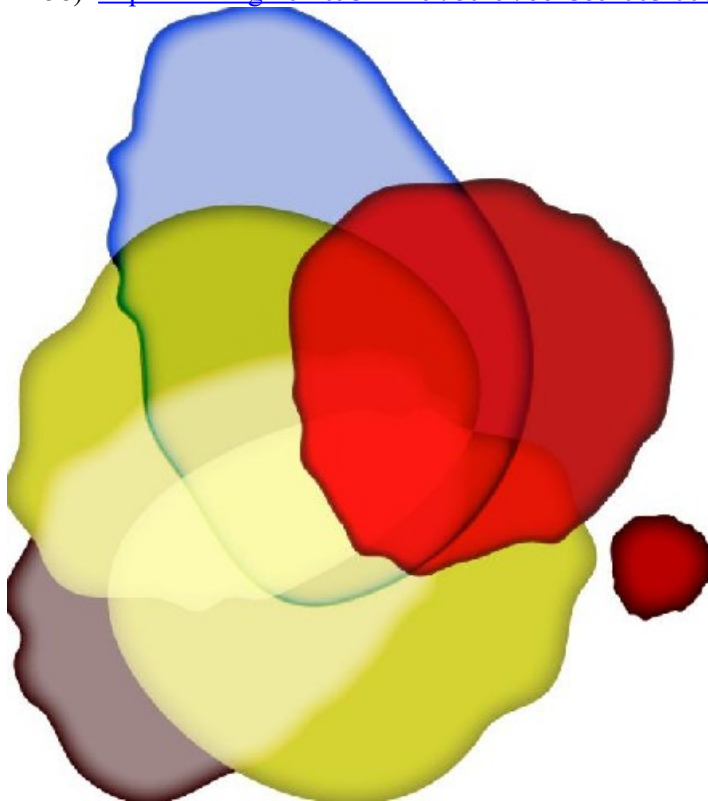
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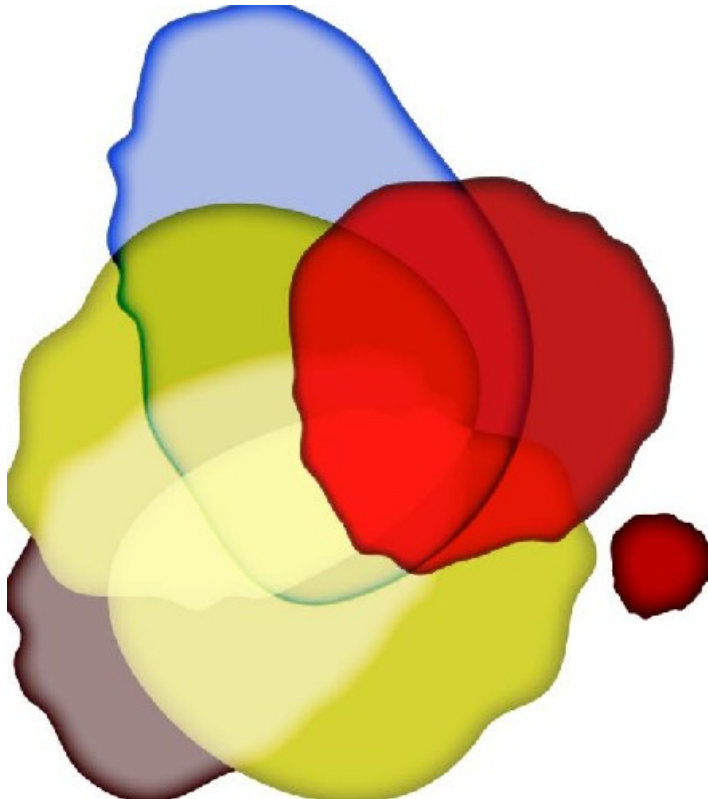
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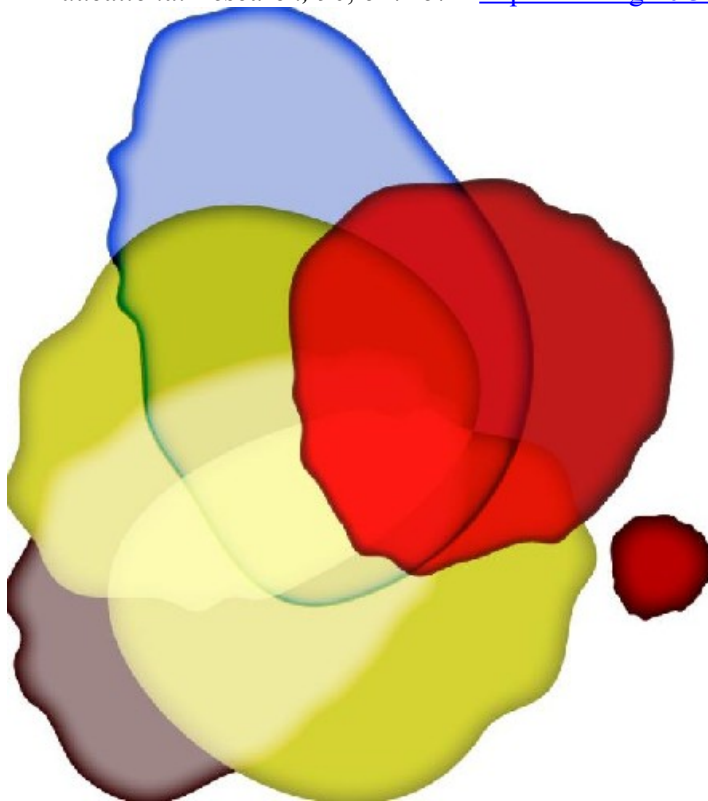
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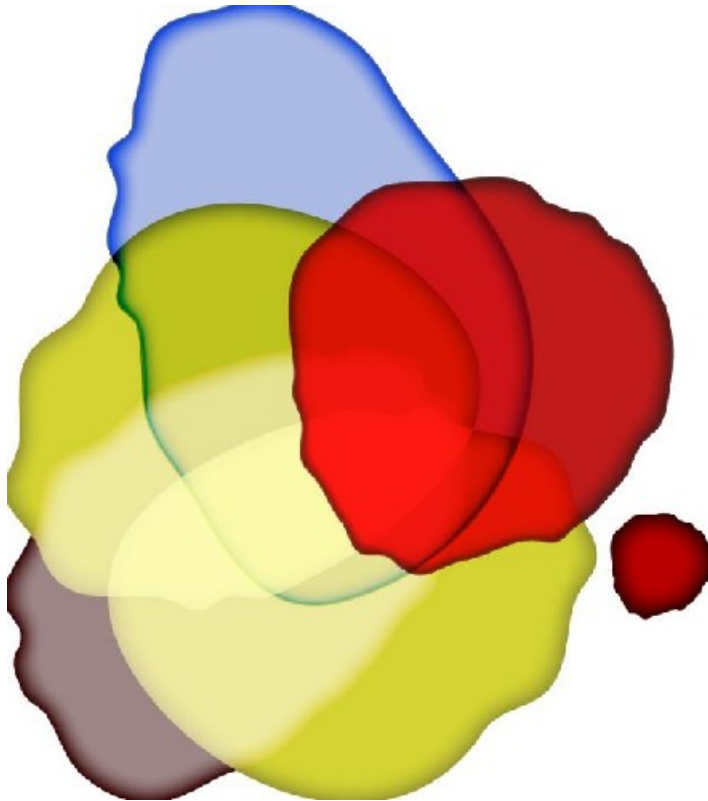


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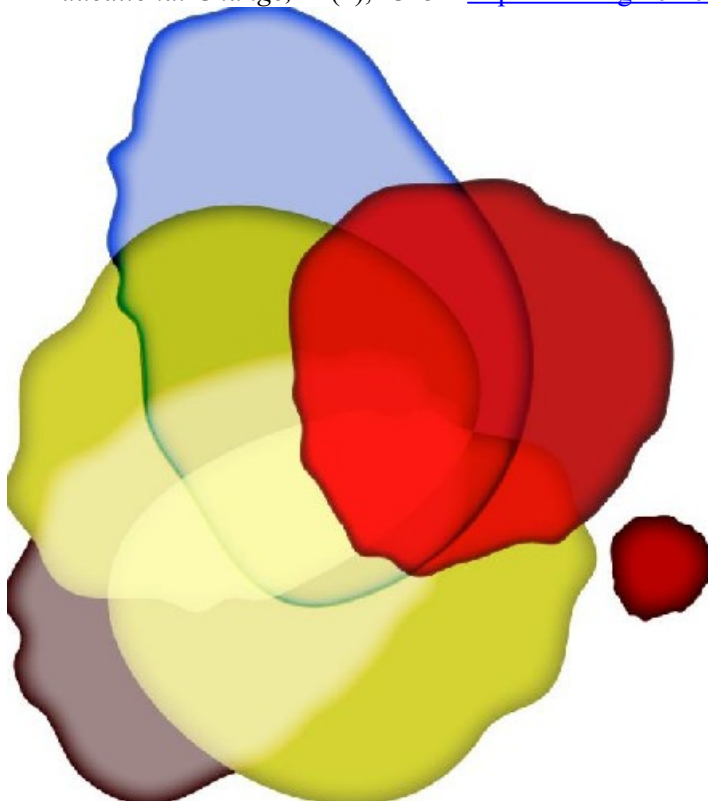


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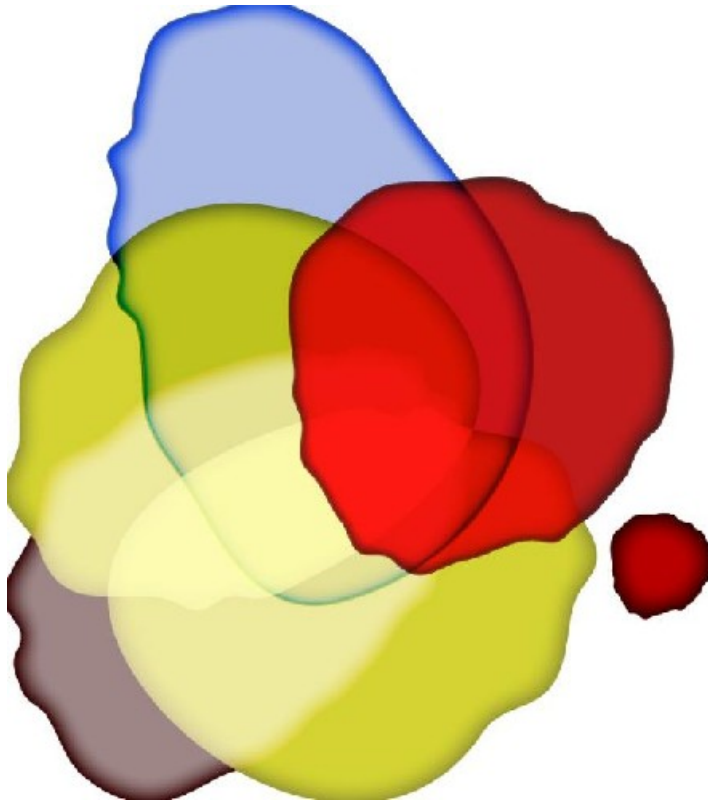
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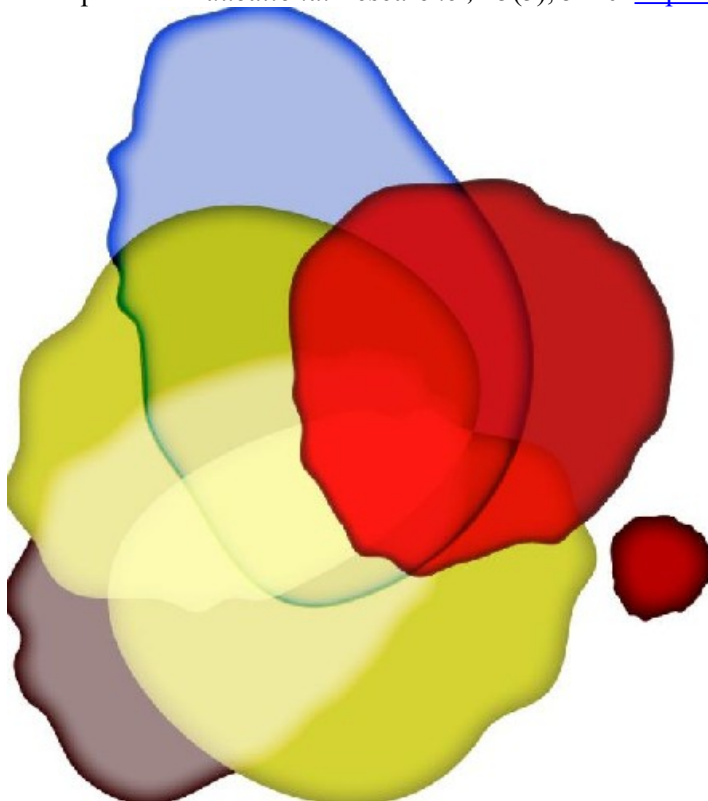
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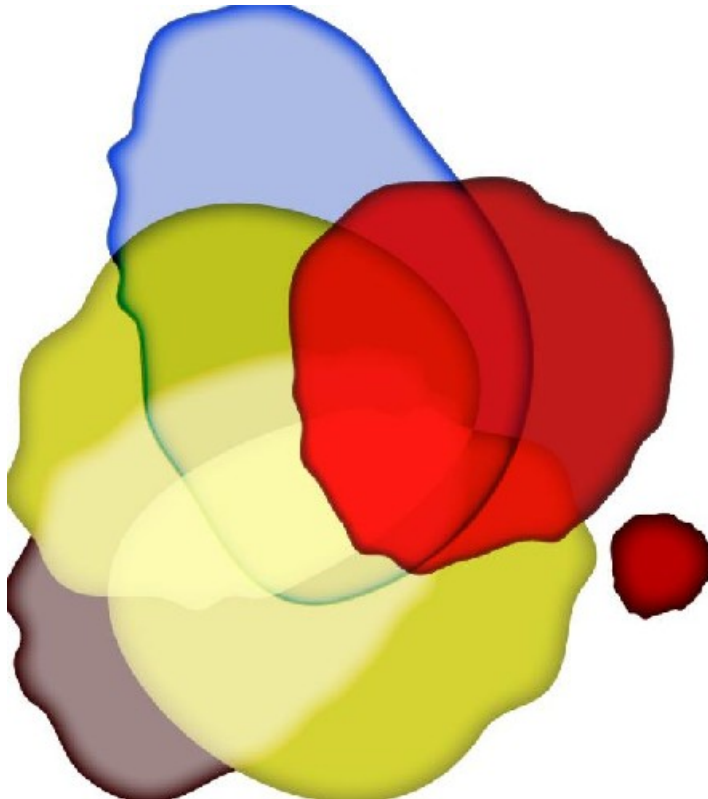
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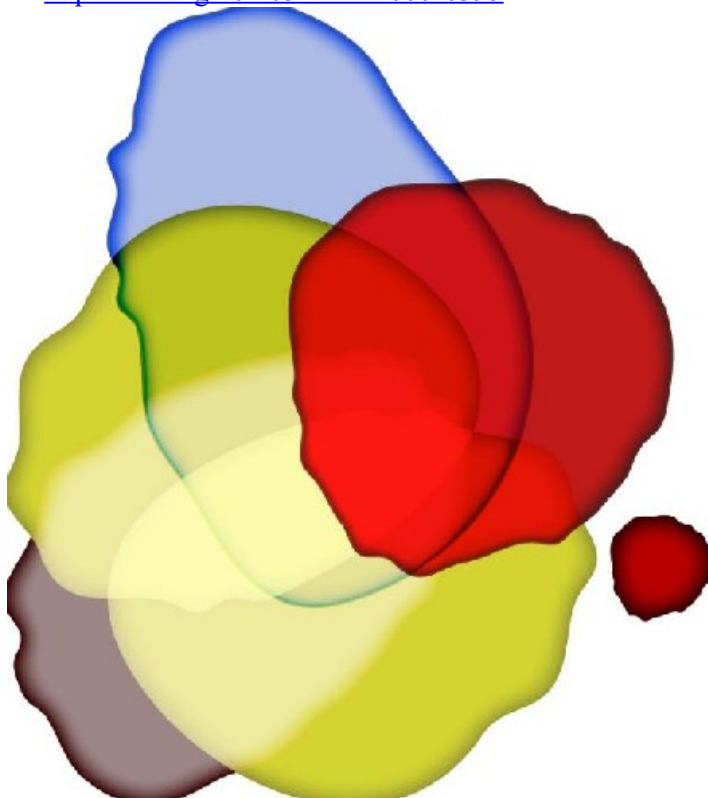
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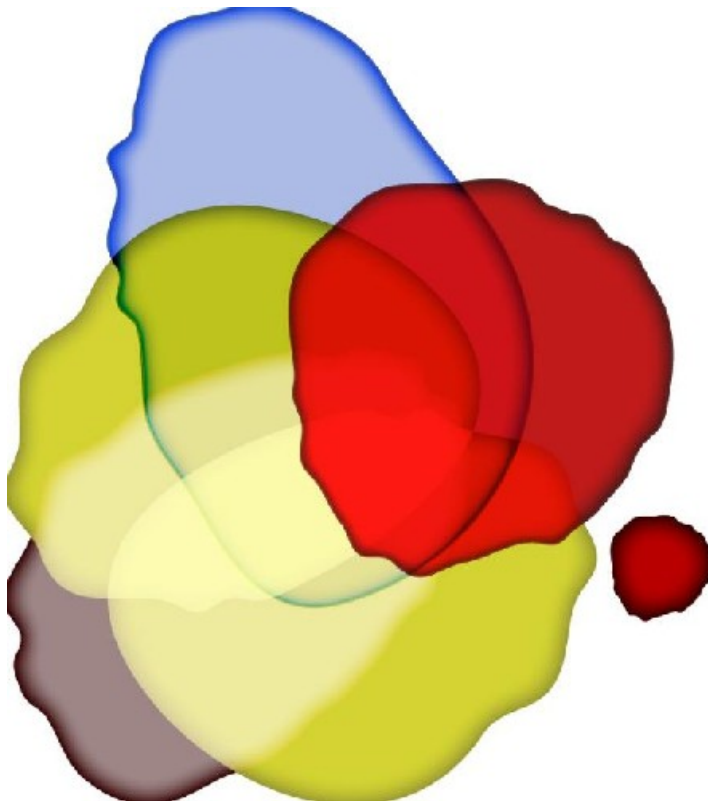
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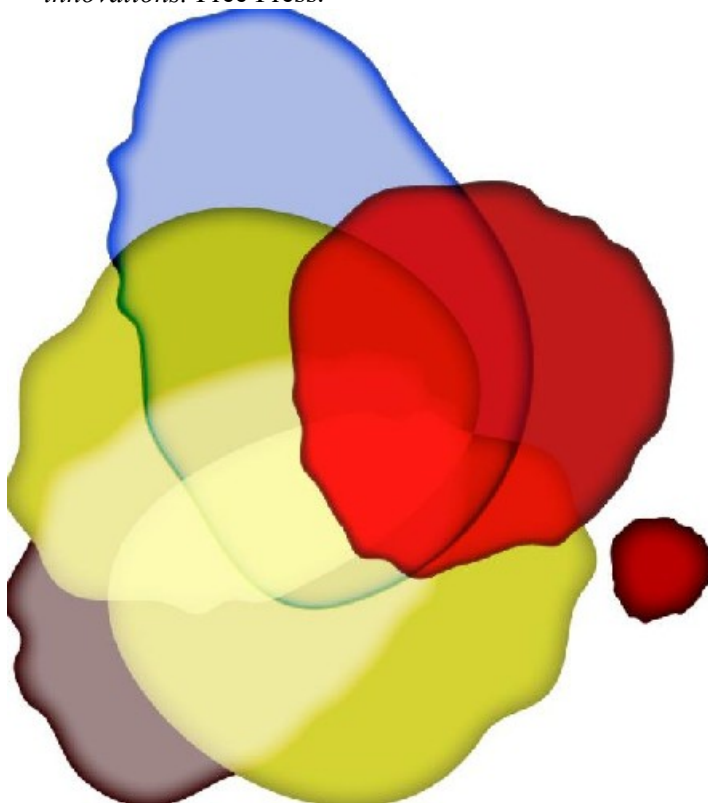


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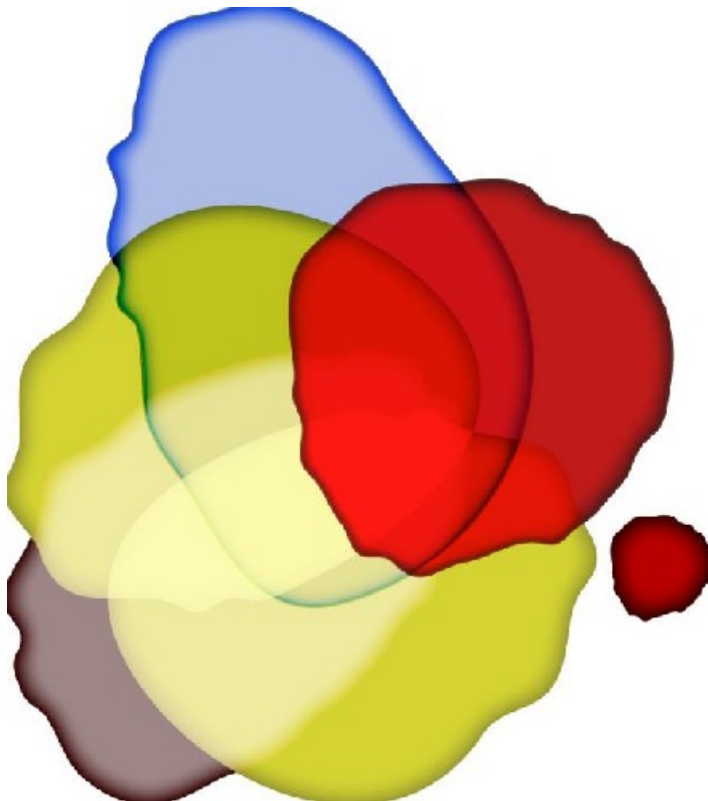
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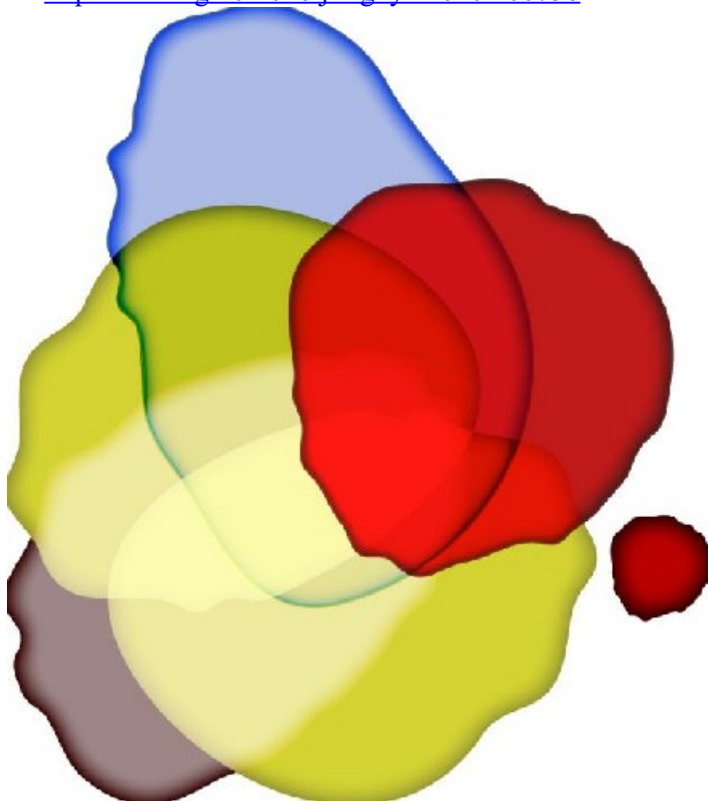


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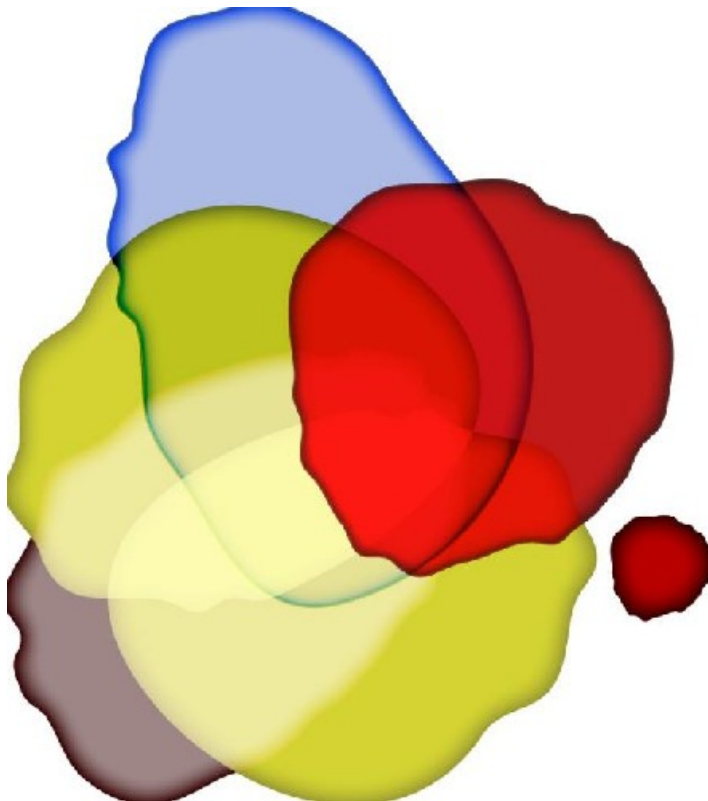
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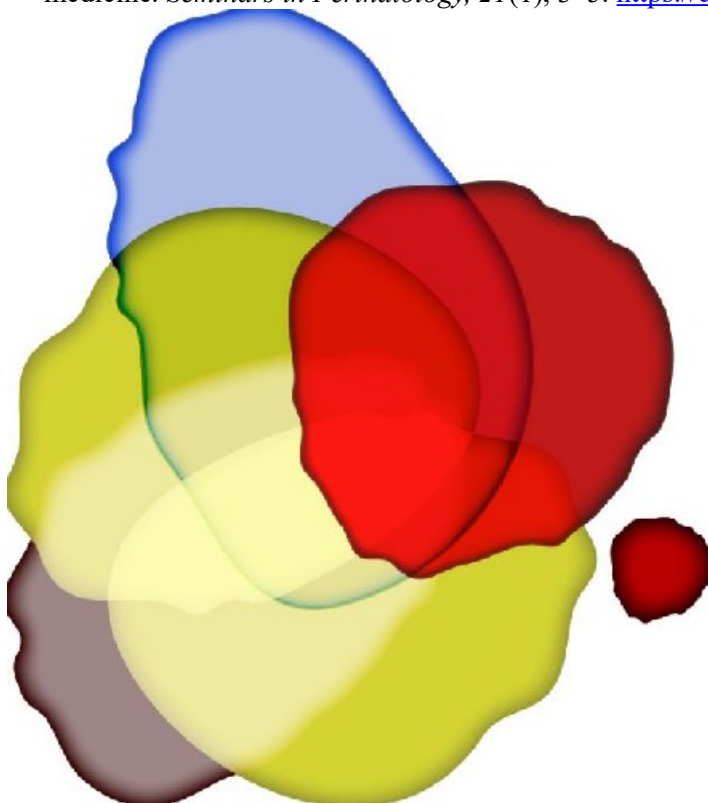
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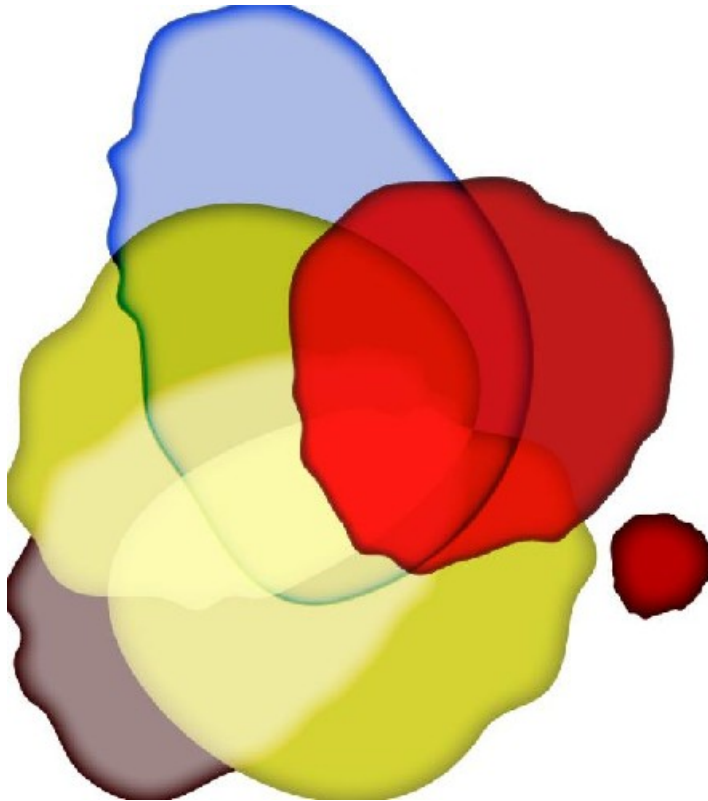
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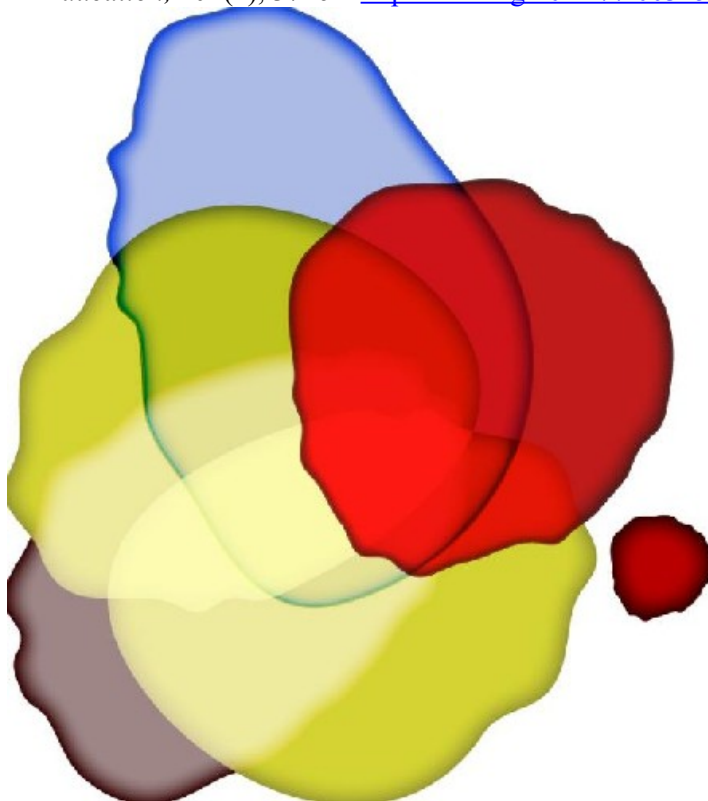
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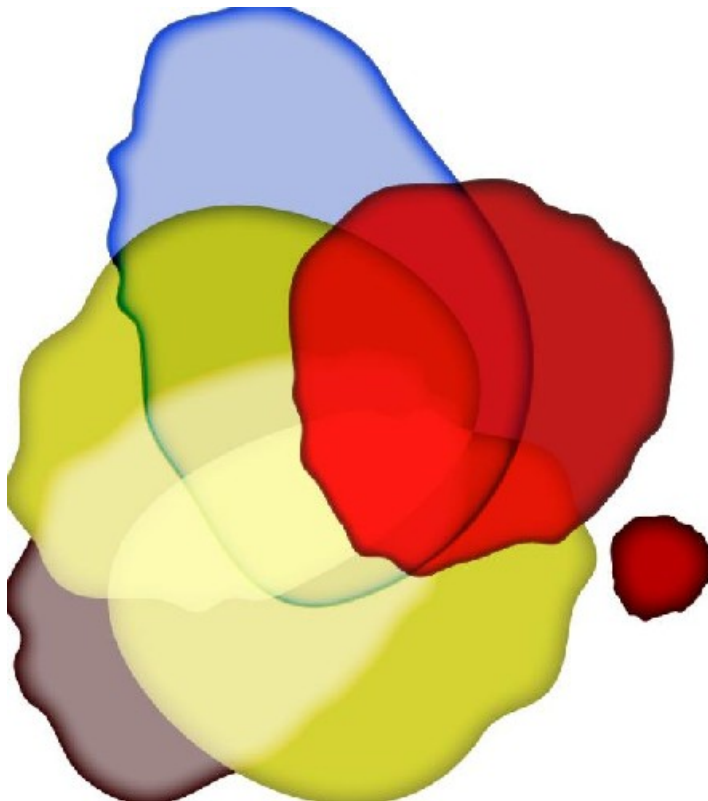
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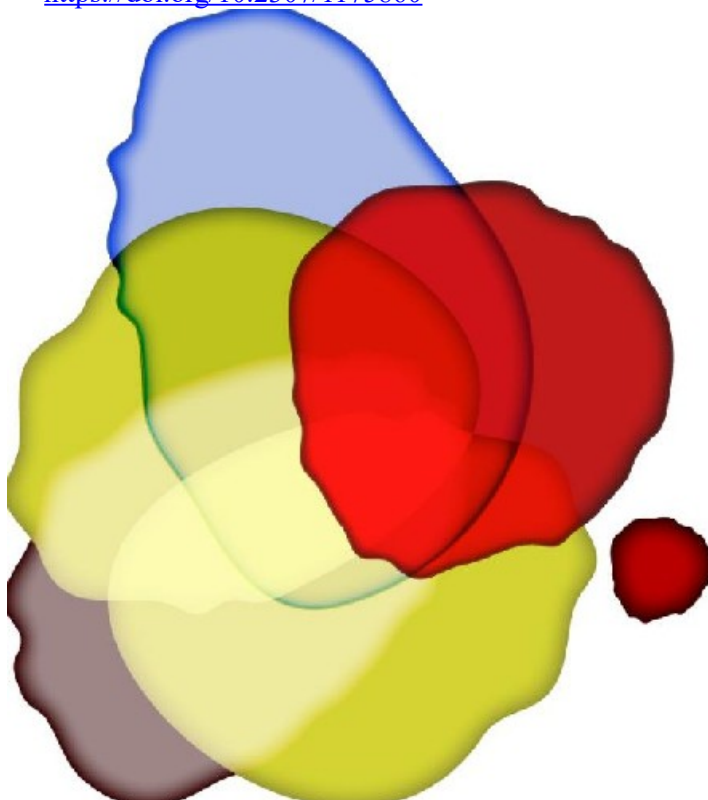


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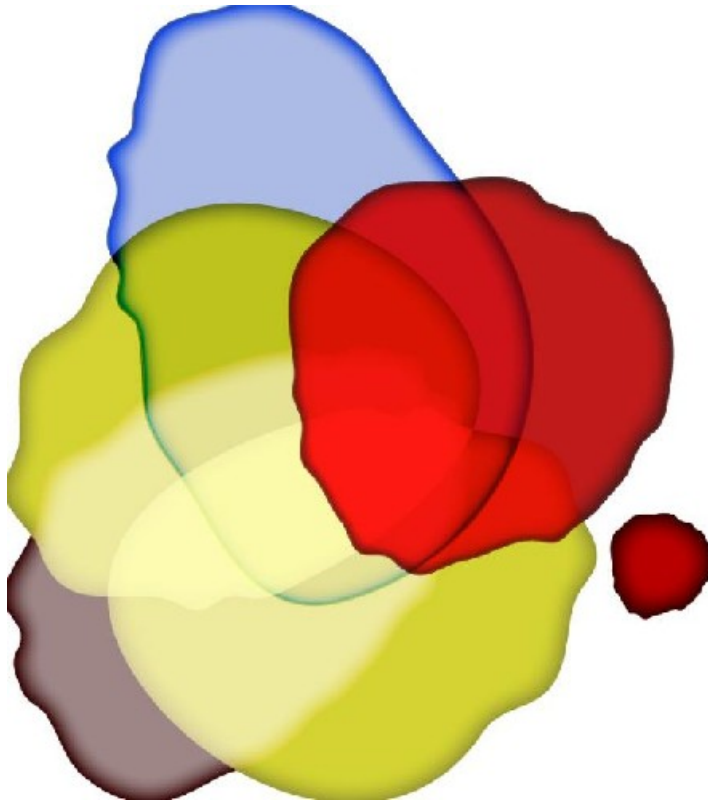
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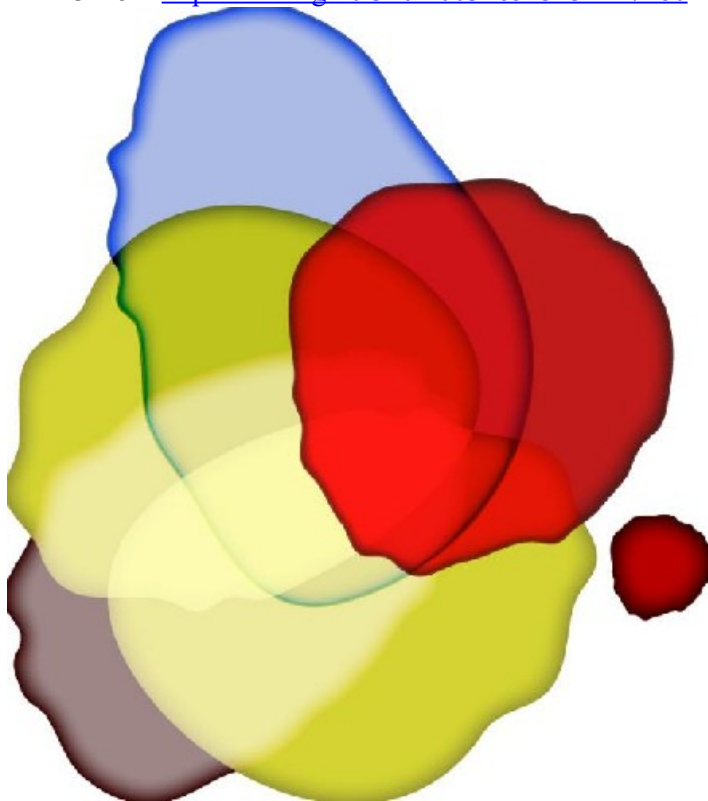


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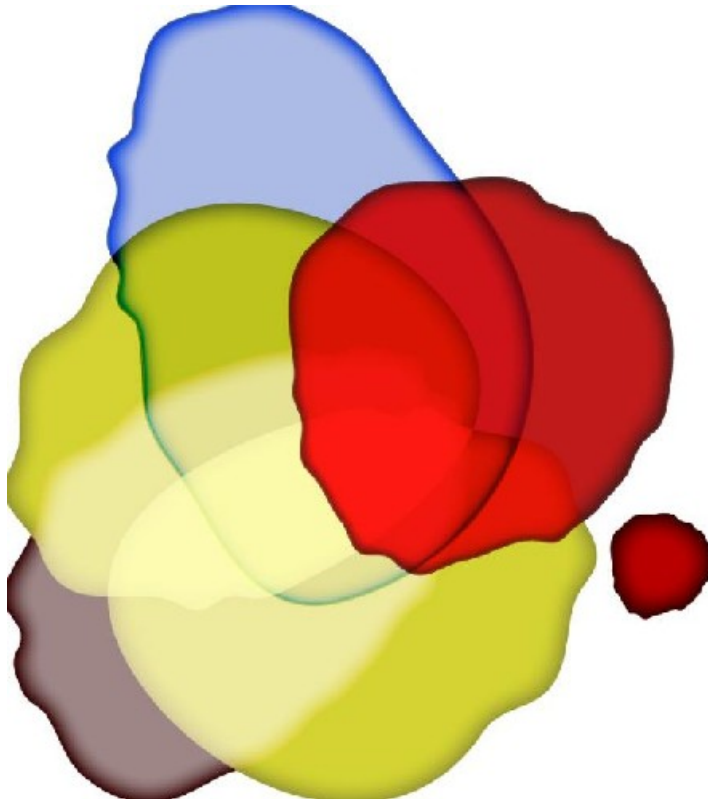
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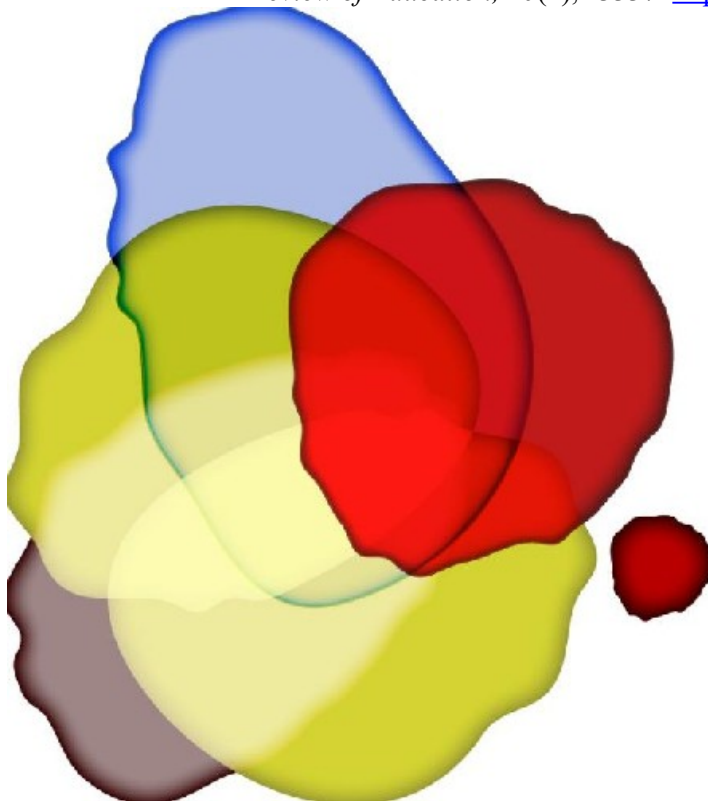
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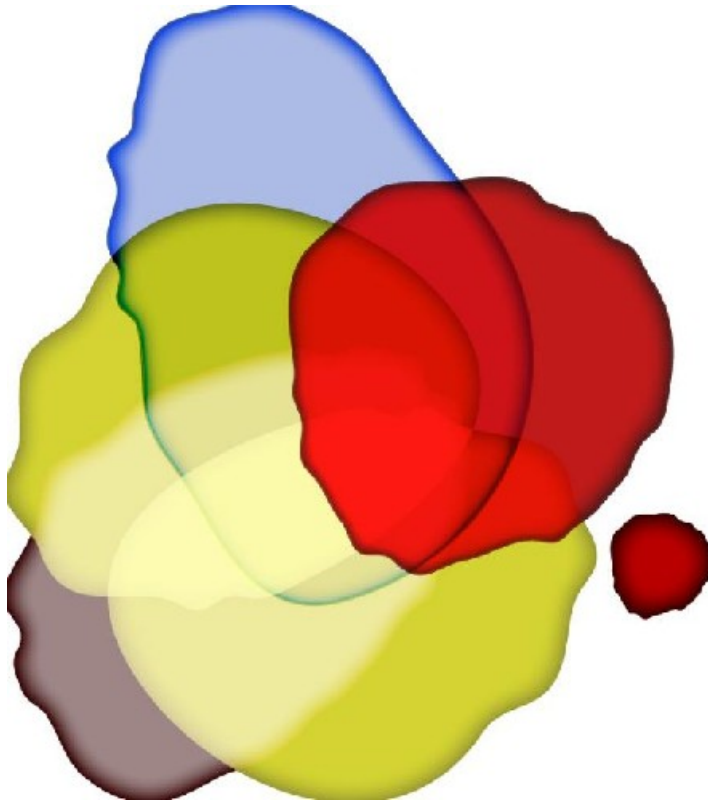
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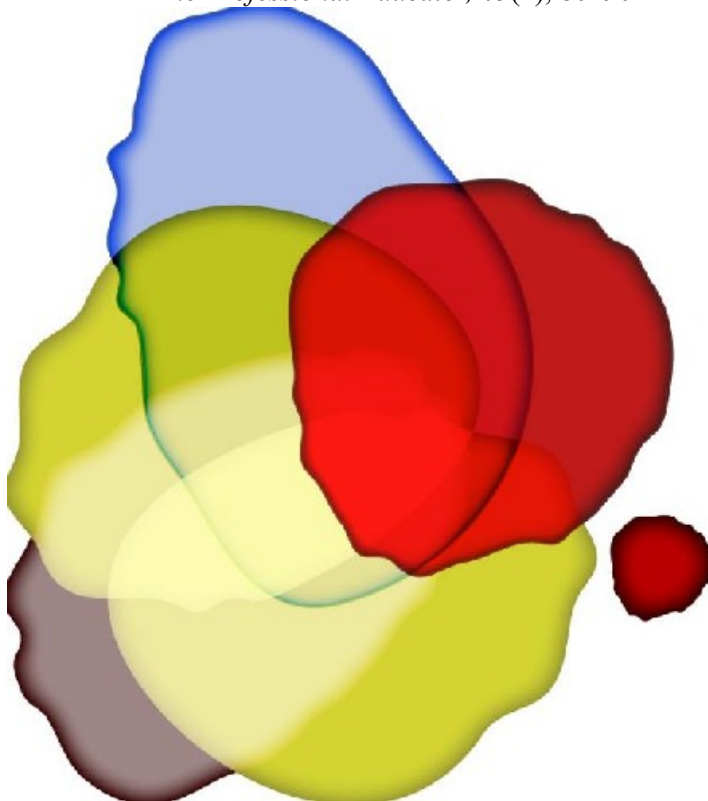
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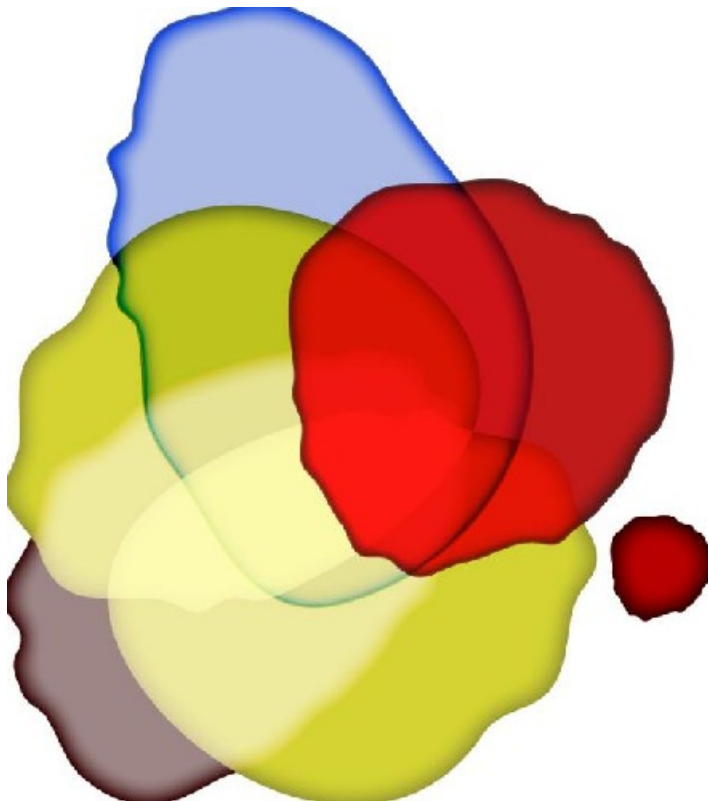
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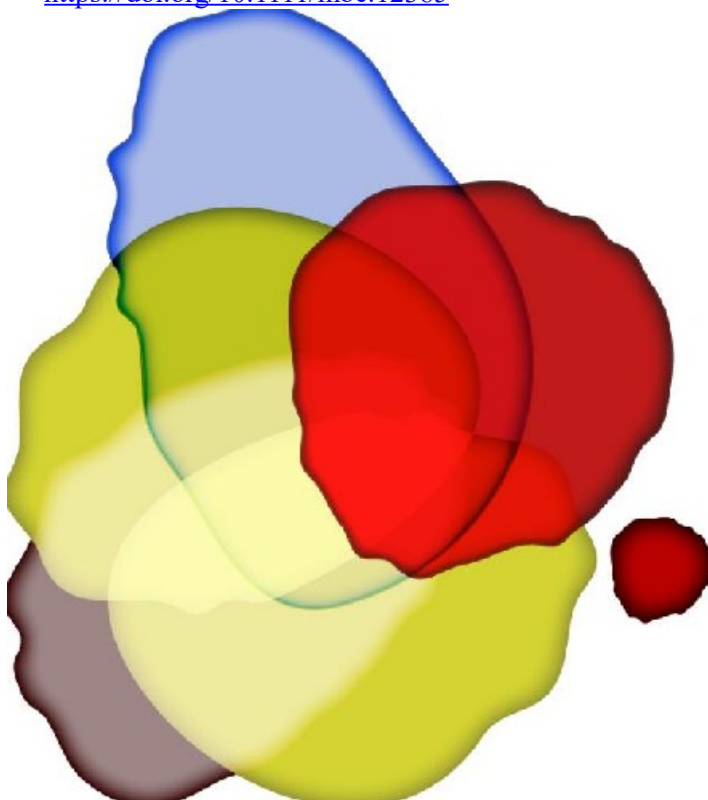
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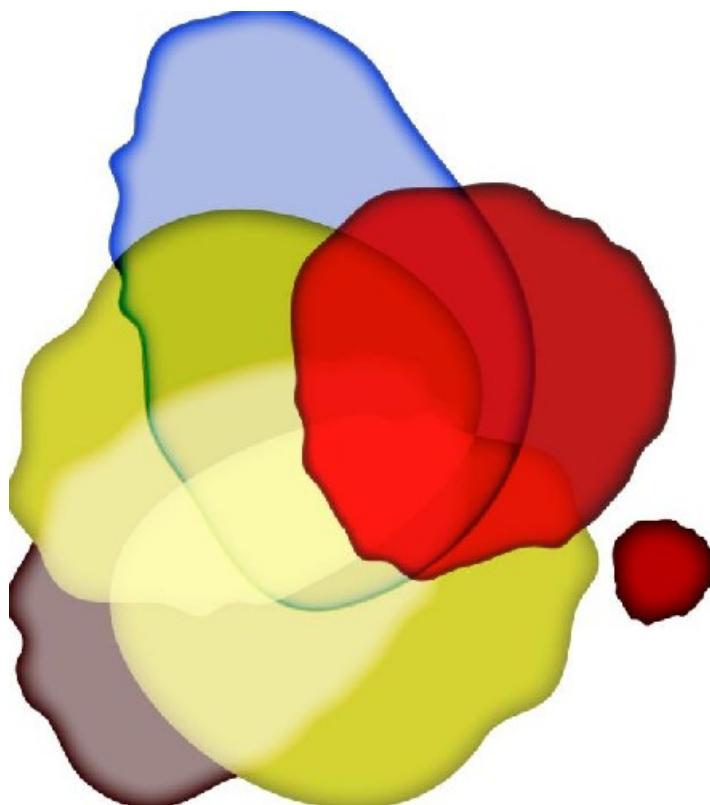
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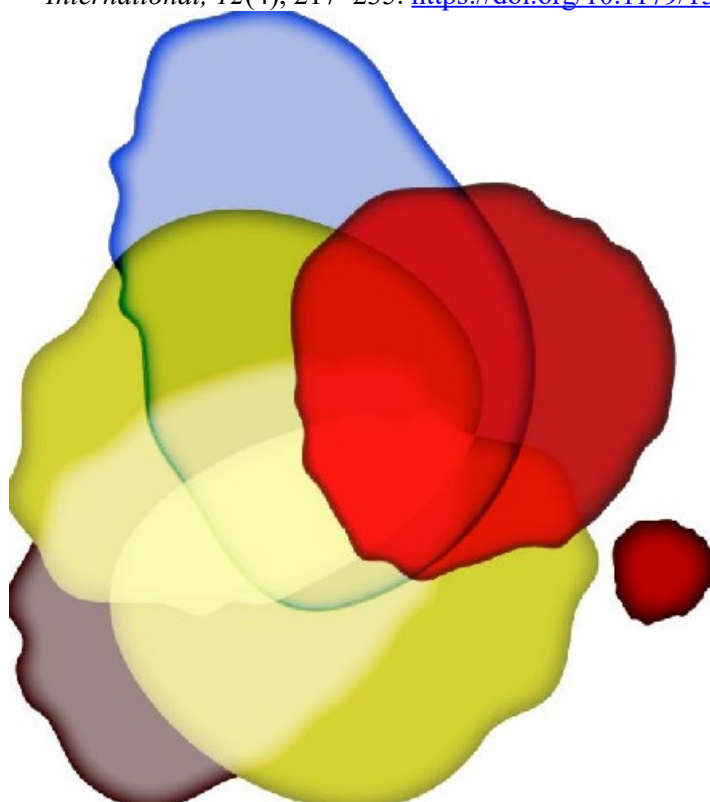
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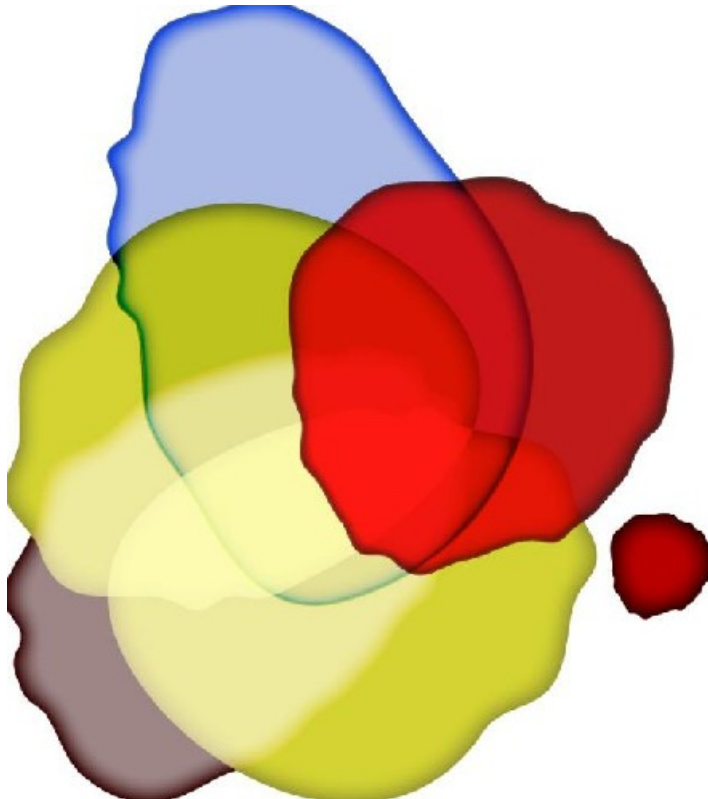
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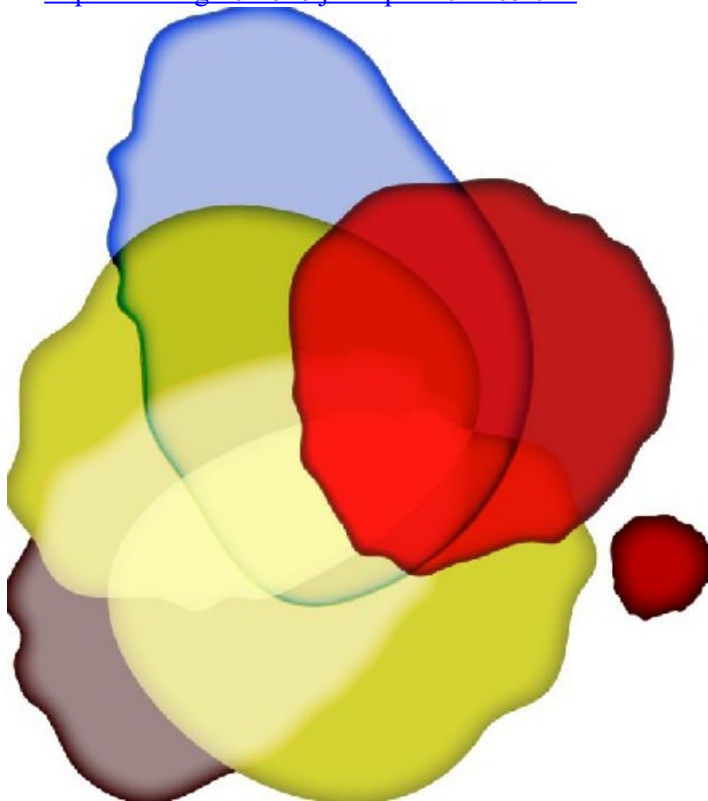
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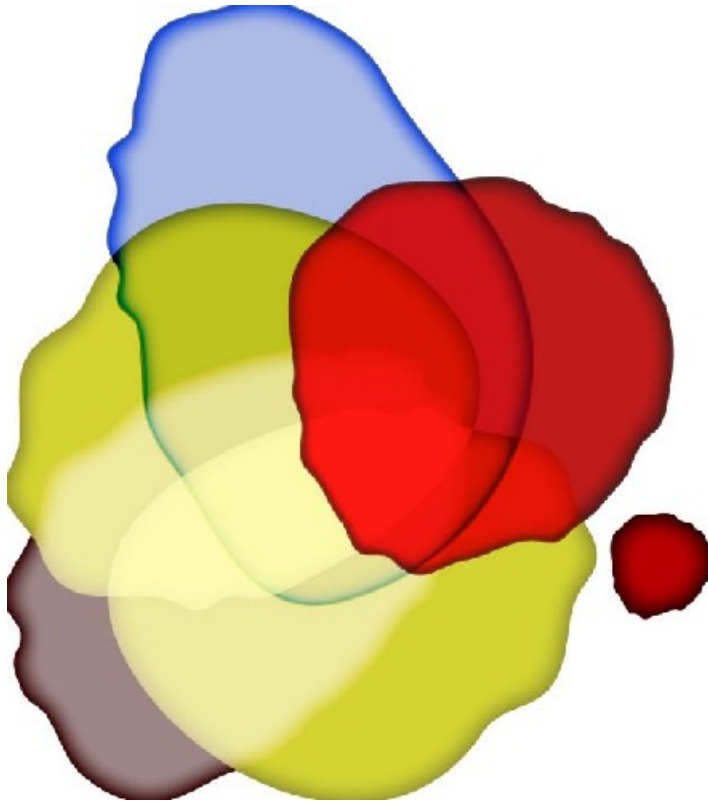
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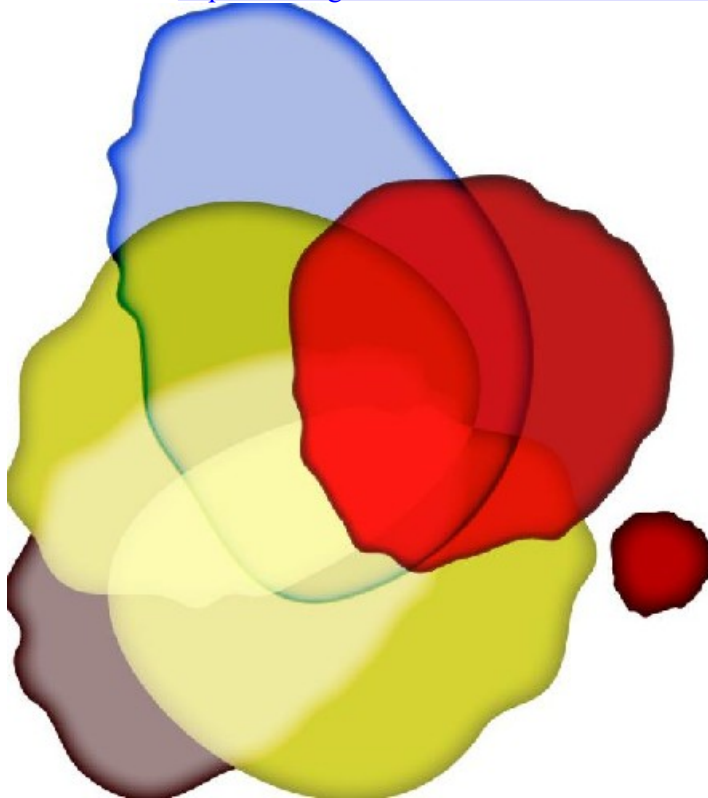
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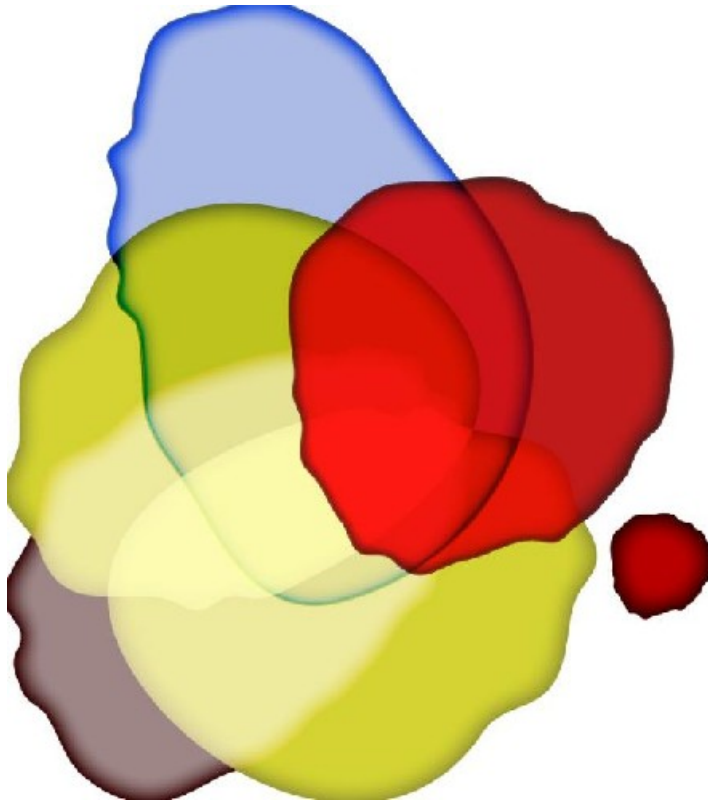
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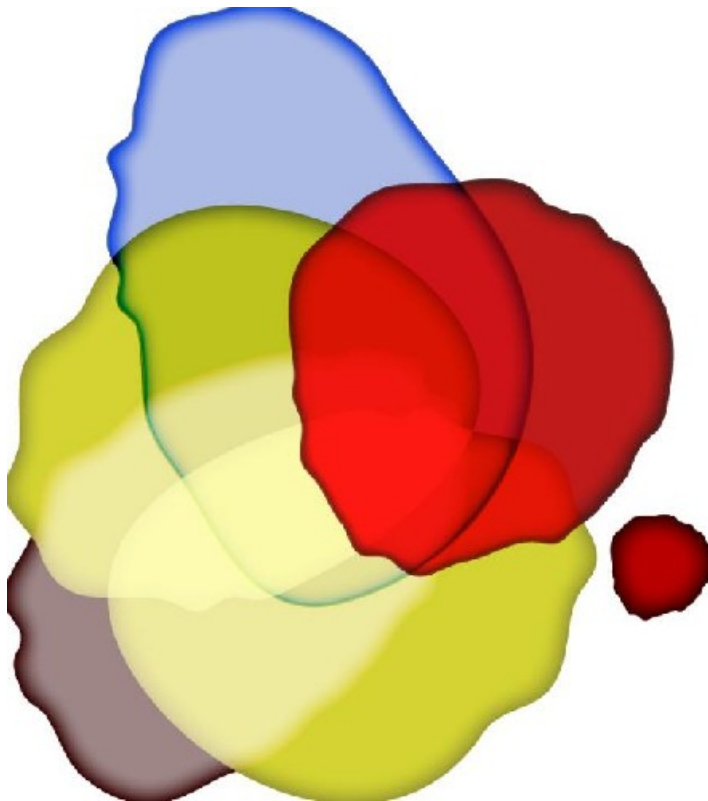
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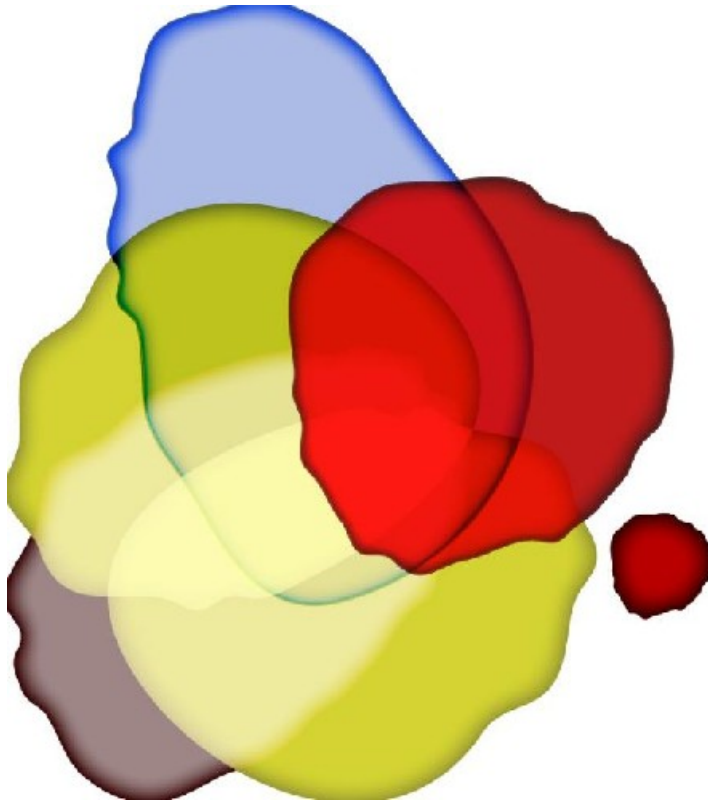
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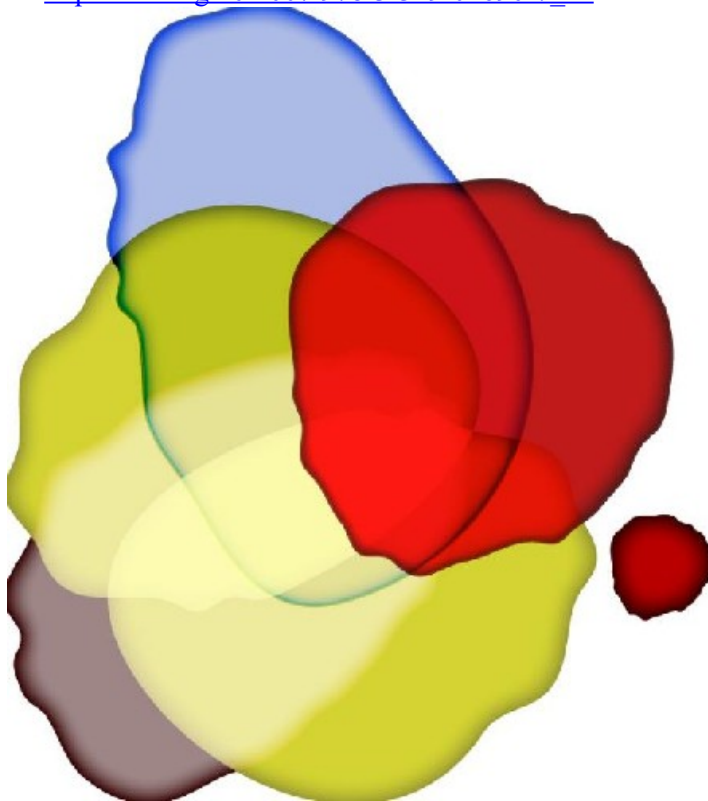
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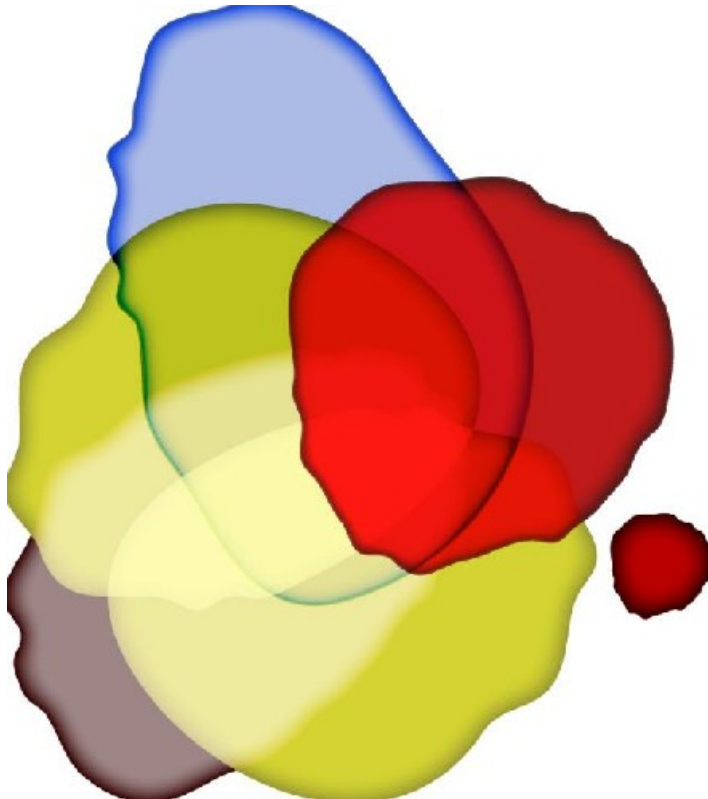
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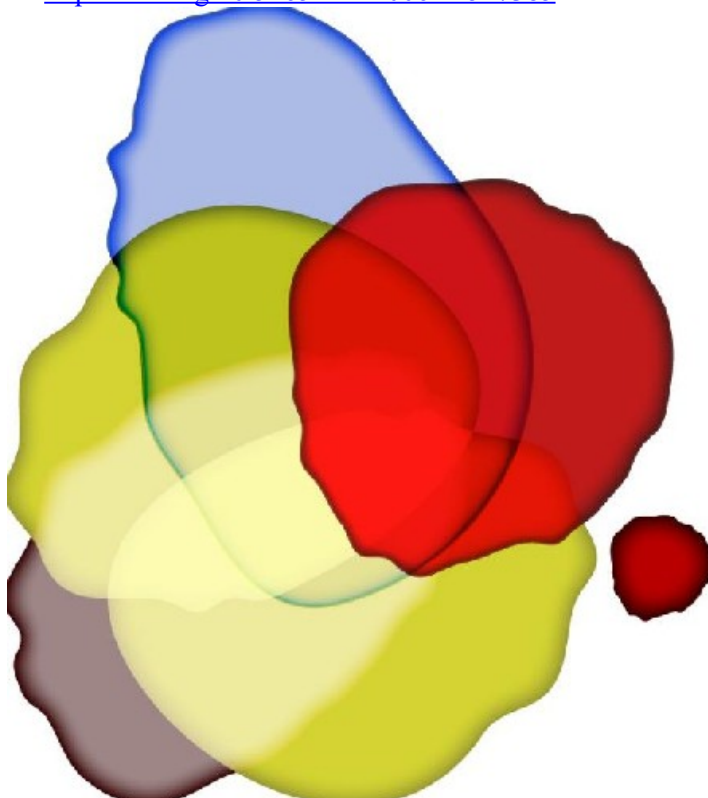
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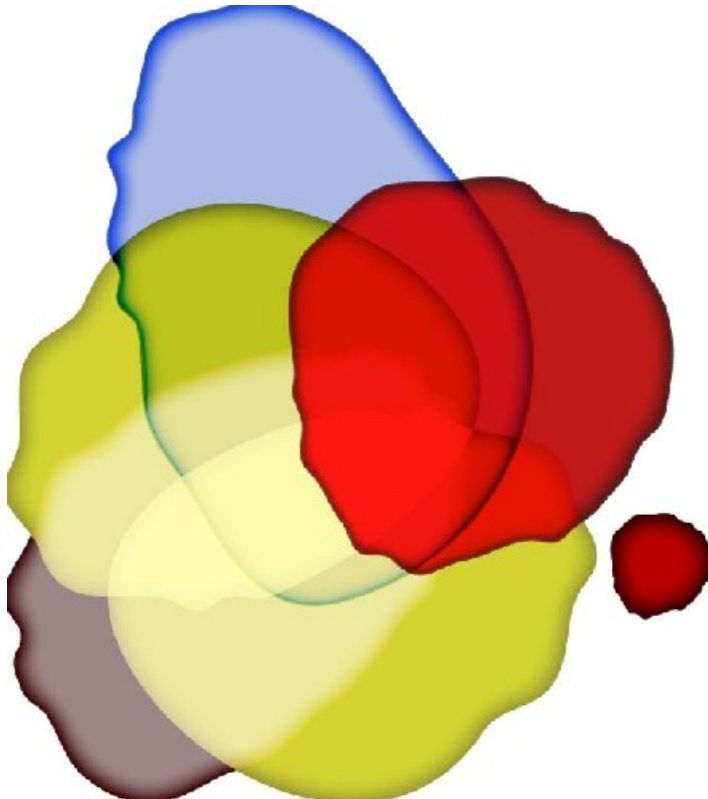
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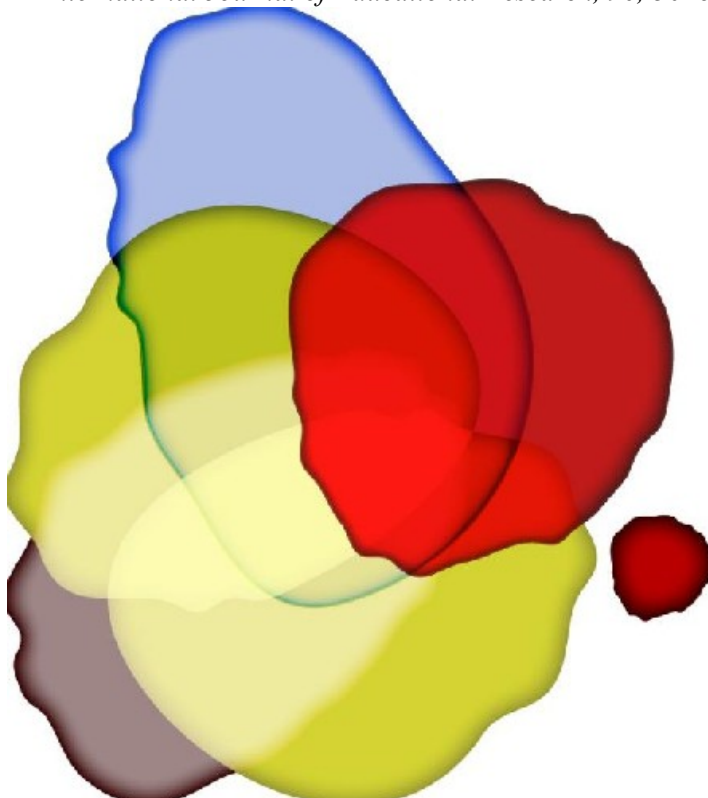
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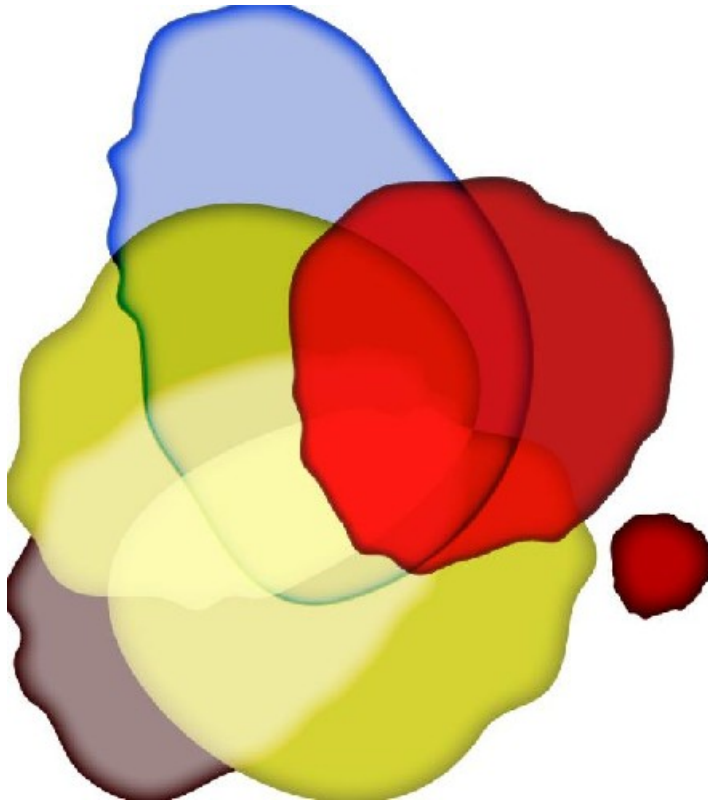
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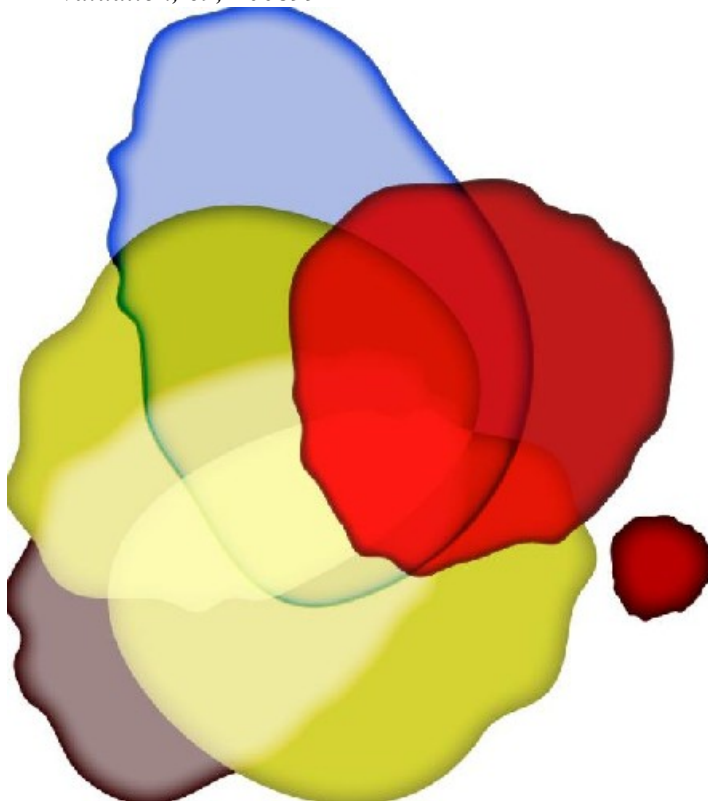
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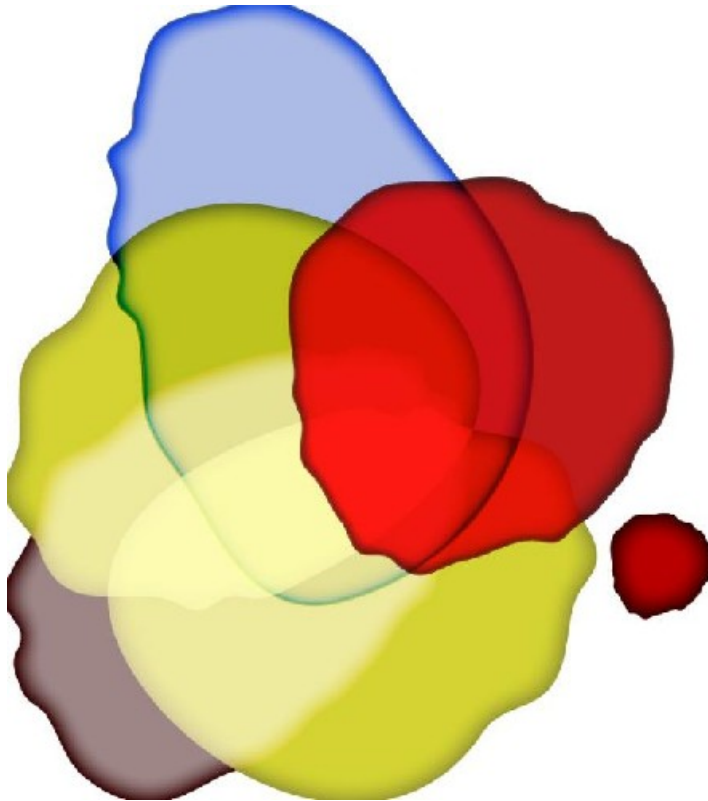
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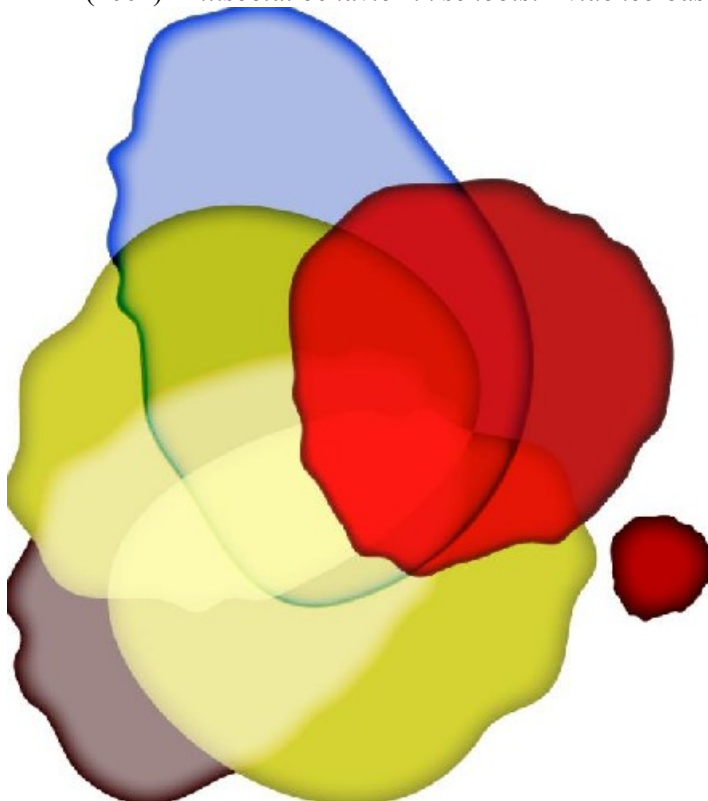
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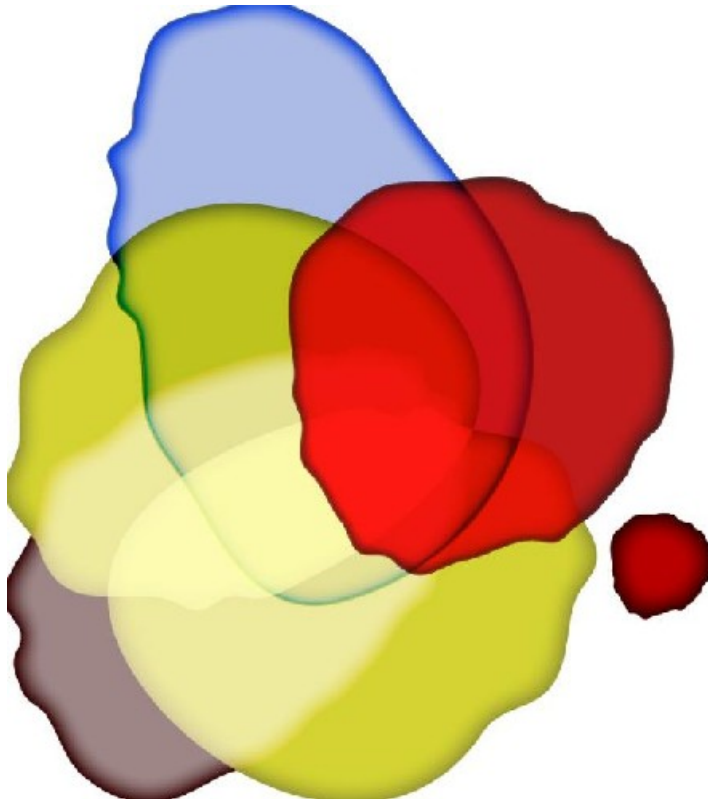
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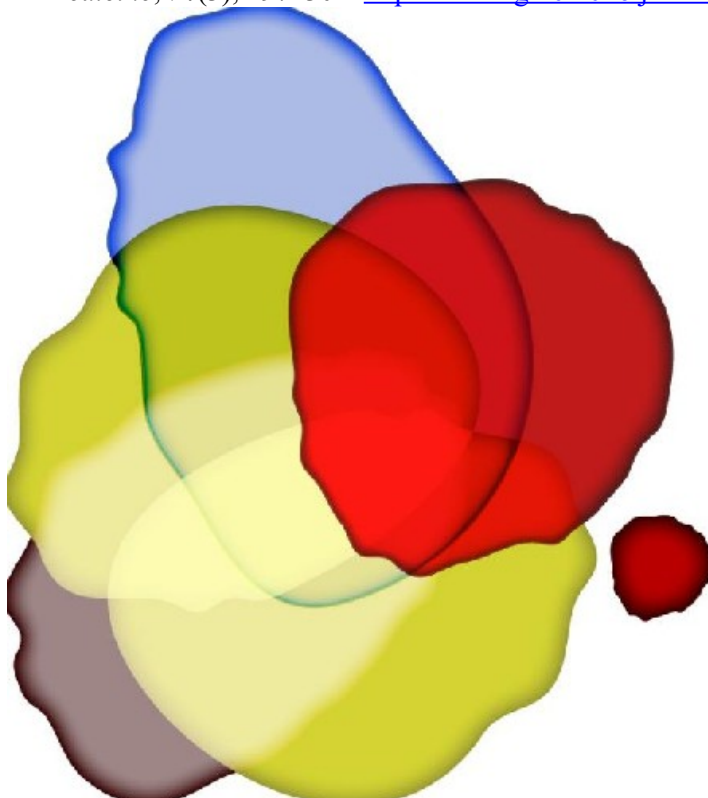
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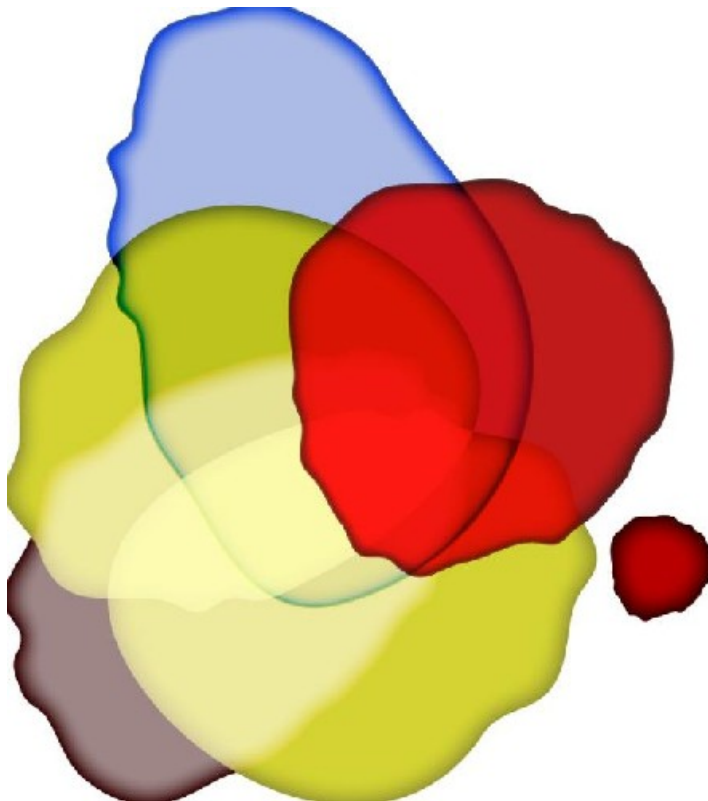
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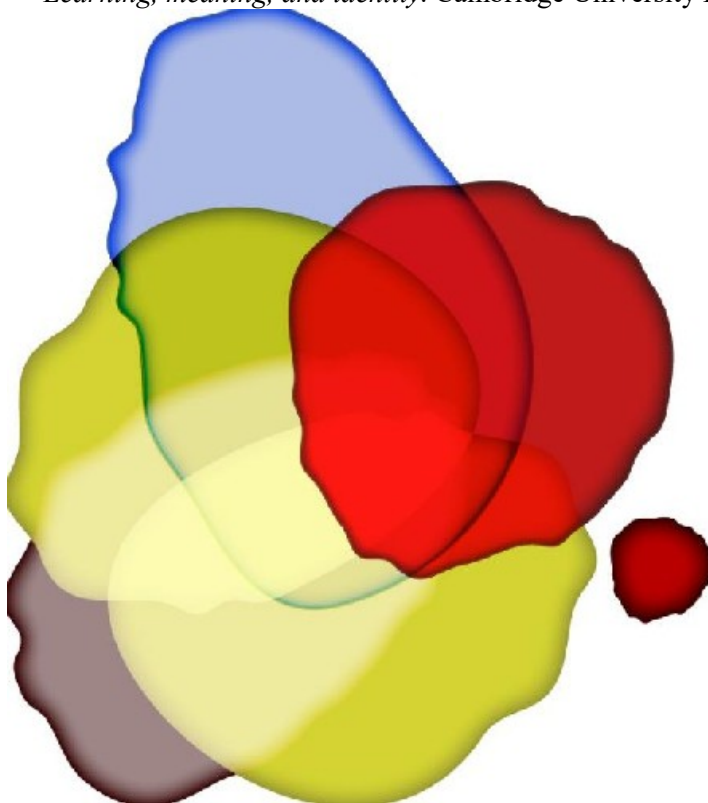
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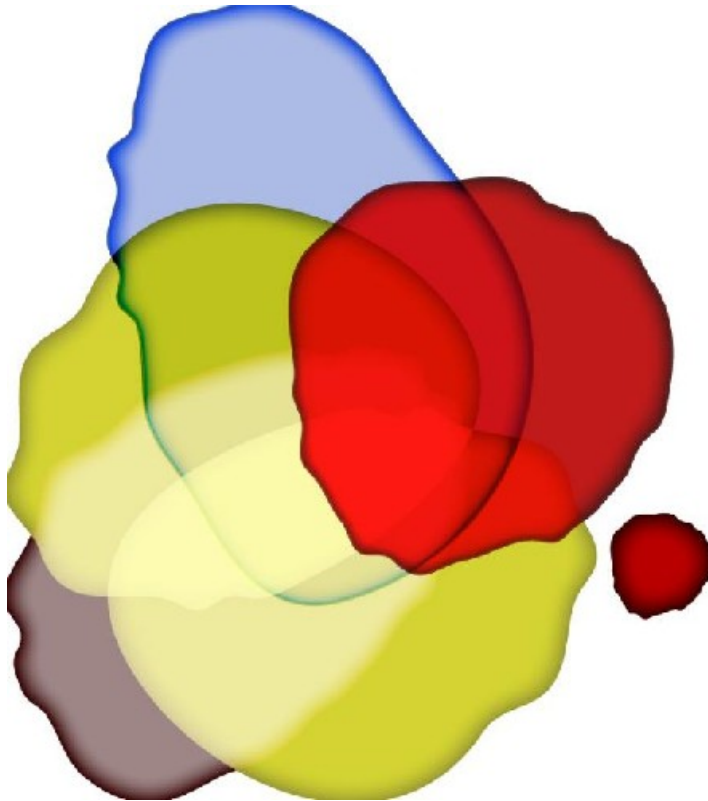
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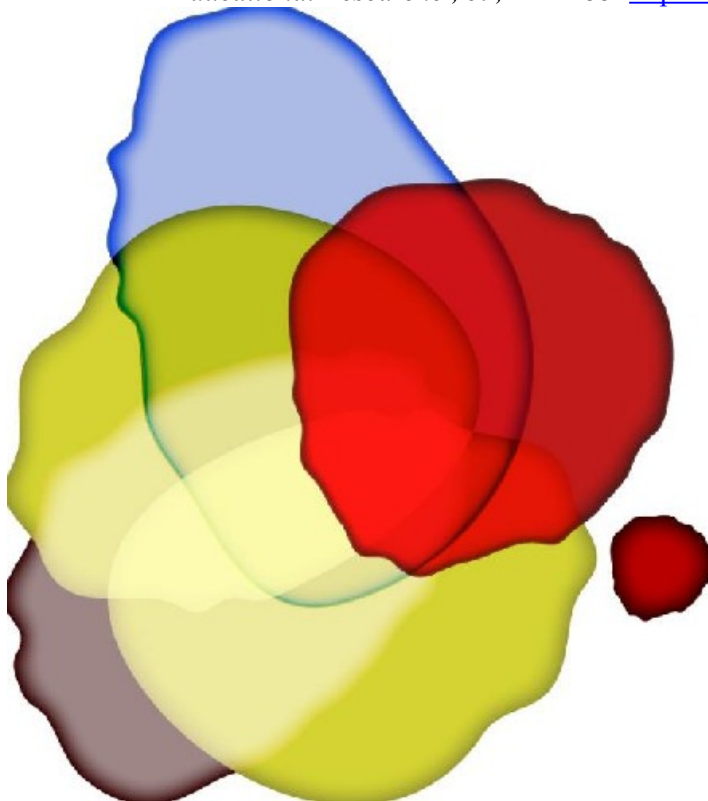
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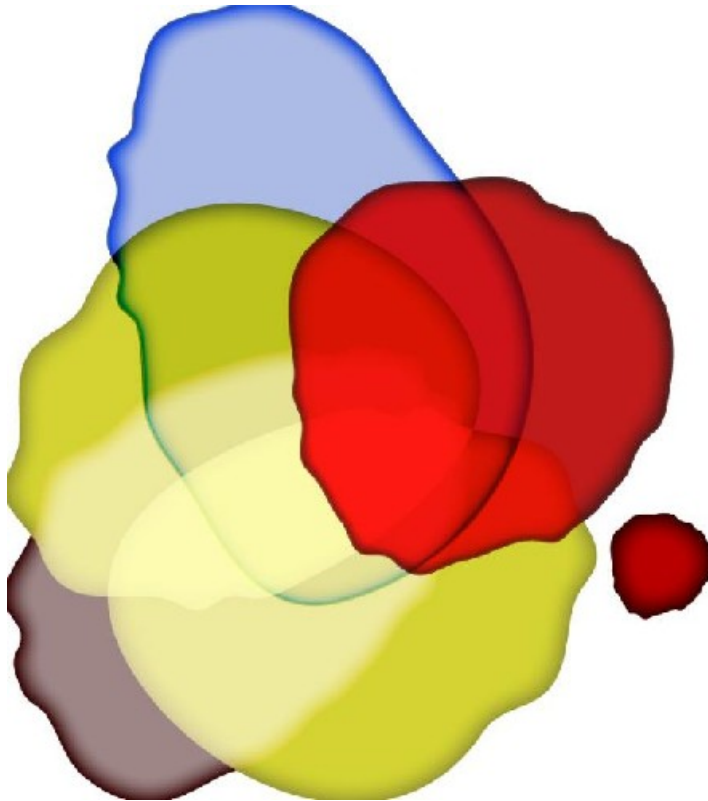
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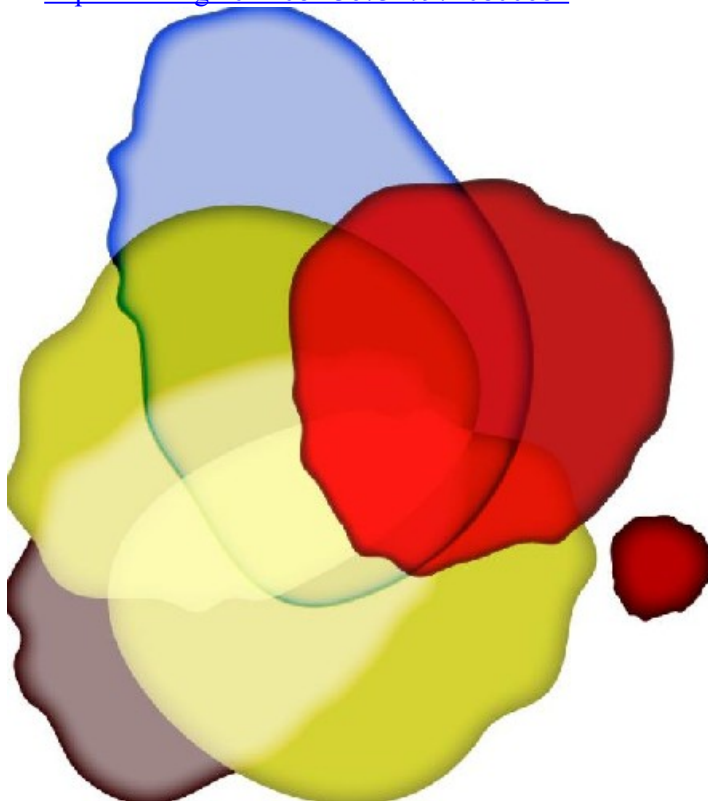
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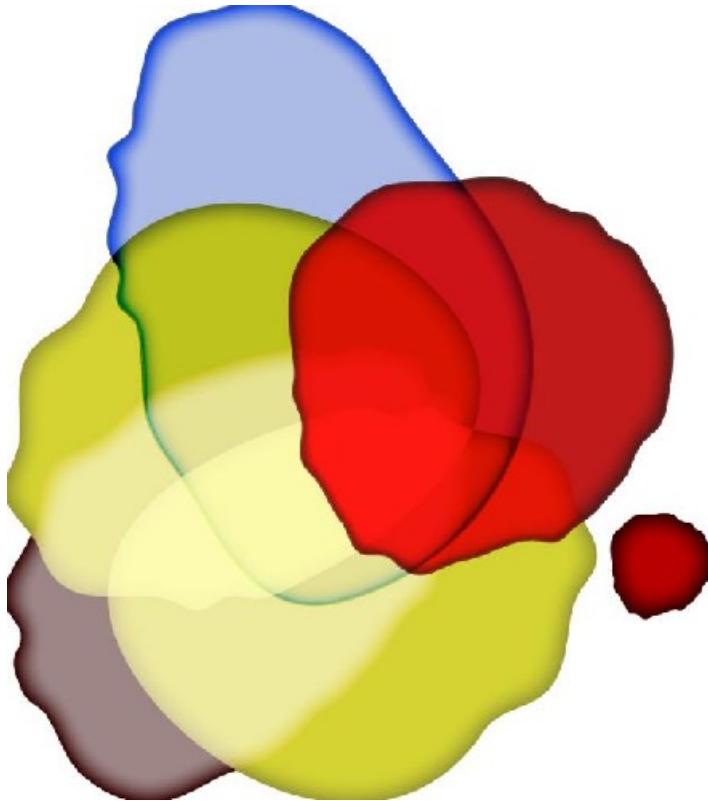
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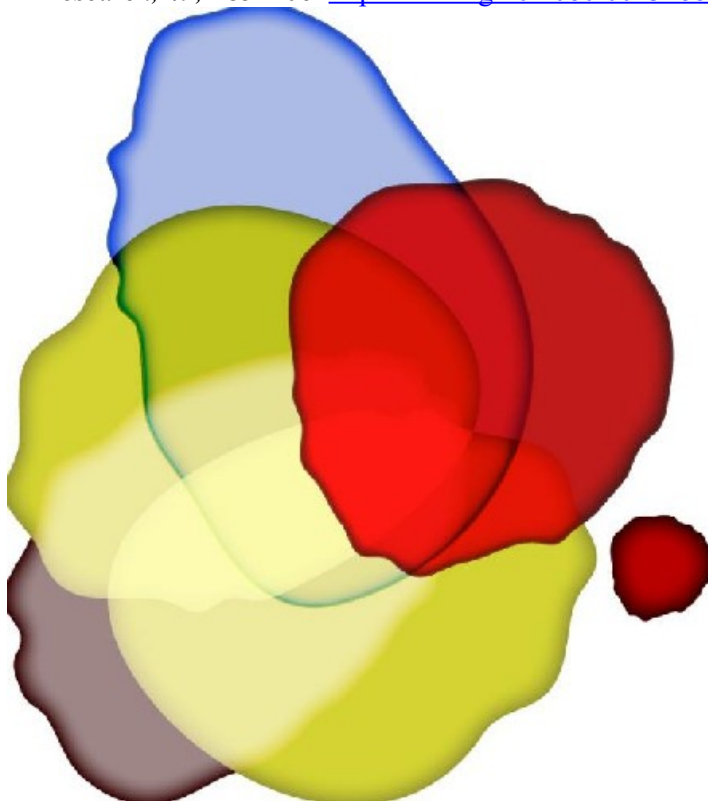
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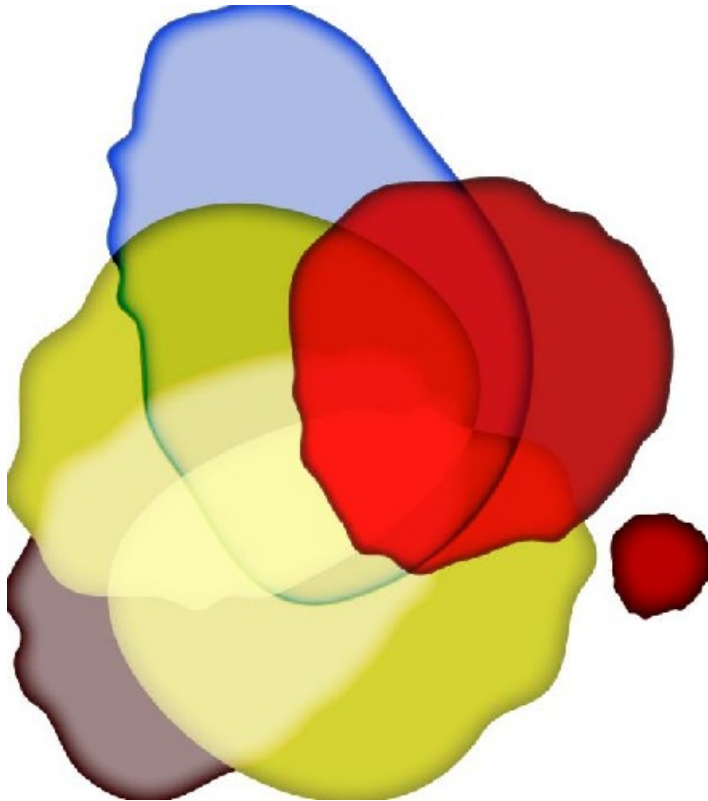
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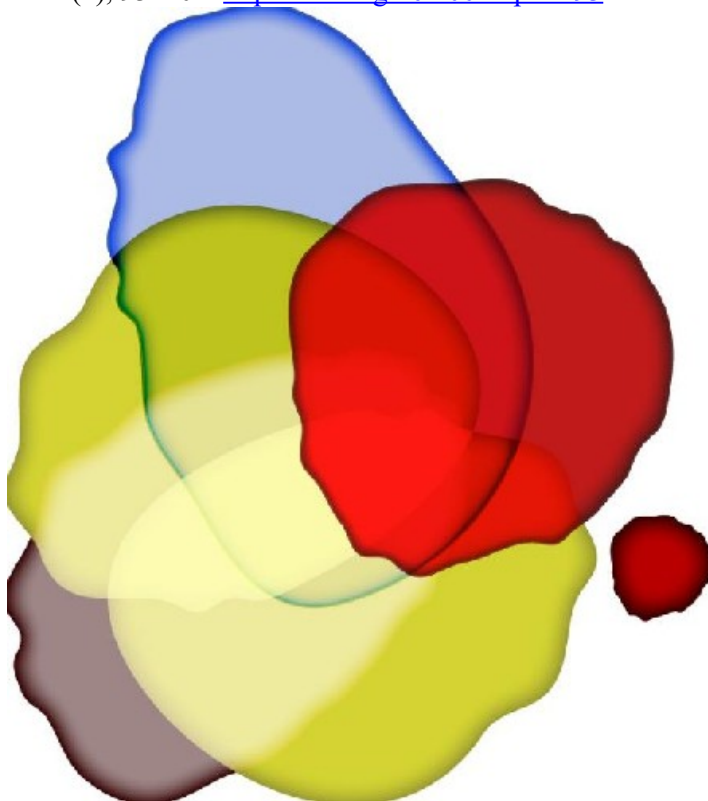
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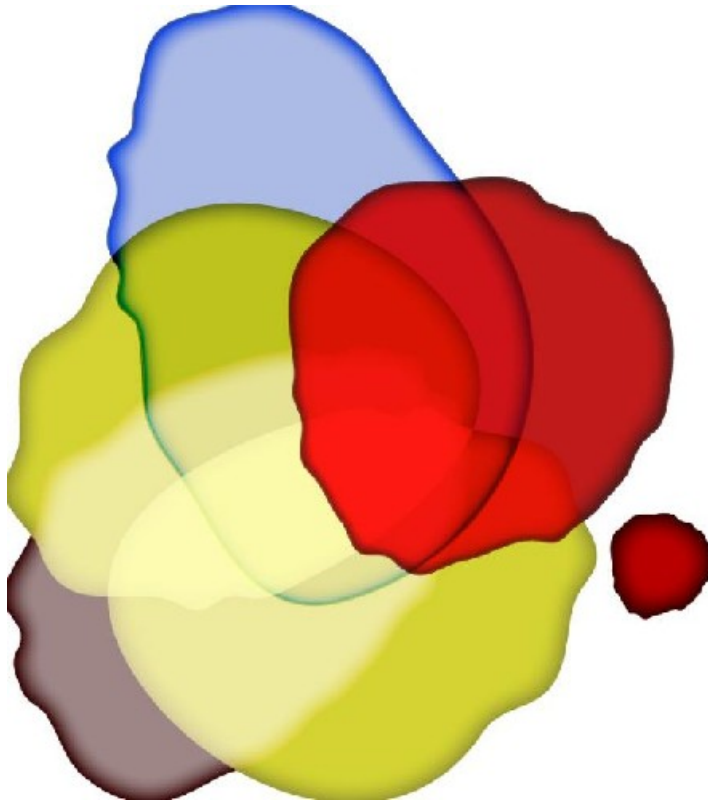
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